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Technical Assistance to Support the Government of Lebanon's Preparation of Exploiting and Producing Offshore Oil and Gas Resources

Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon

SEA Report
VOLUME 1

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Your contact persons within
GFA Consulting Group GmbH are:

Mark Bear (Team Leader)
Sholto West (Acting Project Director)

Republic of Lebanon
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SEA Report – Volume 1

Author: Ricardo Khoury, Klemen Strmsnik, Dima Alhaj, Manal Nader, Manale Abou Dagher, Shadi Andari, Charbel Afif, Rana Ghoussainy, Rachad Ghanem, Sara Al Boustani, Tarek Tabaja

Address:
GFA Consulting Group GmbH
Eulenkrugstraße 82
D-22359 Hamburg
Germany

Phone: +49 (40) 6 03 06 – 154
Fax: +49 (40) 6 03 06 – 159
E-Mail: mark.bear@gfa-group.de

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ACCOBAMS	The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
AEWA	The African-Eurasian Migratory Waterbird Agreement
ALARP	As Low As Reasonably Practicable
AMD	Acoustic Mitigation Devices
AQ	Air Quality
AQMN	Air Quality Monitoring Network
BAT	Best Available Techniques
BAU	Business As Usual
BHA	Bottom Hole Assembly
BHP	Bottom-Hole Pressure
BHT	Bottom-Hole Temperature
BOD	Biochemical Oxygen Demand
BoP	Blow out Preventer
BRT	Bus Rapid Transit
BUNKER	International Convention on Civil Liability for Bunker Oil Pollution Damage
CBD	Convention on Biological Diversity
CDL	Variable Deck Load
CDR	Council for Development and Reconstruction
CFCs	Chlorofluorocarbons
CH4	Methane
CLC	International Convention on Civil Liability for Oil Pollution Damage
CLP	Classification, Labelling and Packaging of Substances And Mixtures

CNRS	Centre National de la Recherche Scientifique/National Council for Scientific Research
CO	Carbon Monoxide
CO2	Carbon Dioxide
CO2 eq.	Carbon Dioxide Equivalent
CoM	Council of Ministers
CPT	Seabed Sampling
CSR	Corporate Social Responsibility
DG	Directorate General
DGLMT	Directorate General for Land and Maritime Transport
DGPS	Differentially Corrected GPS
DGUP	Directorate General of Urban Planning
DP	Dynamic Positioning
DPSIR	Driving Force –Pressure– State – Impact – Response
DRR	Disaster Risk Reduction
E&P	Exploration and Production
EBSA	Ecologically and Biologically Significant Areas
ECHA	European Chemical Agency
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ELARD	Earth Link and Advanced Resources Development
ELCA	East Levantine Canyons Area
EM	Electromagnetic
EMS	Environmental Management System
EPA	Exploration and Production Agreement
ERML	Environmental Resource Monitoring in Lebanon
ERP	Emergency Response Plan
ESDV	Emergency Shutdown Valves
EU	European Union
EW	Energy and Water
FADs	Fish Aggregating Devices
FEED	Front End Engineering Design

FLNG	Floating Liquefied Natural Gas
FPSO	Floating Production Storage and Offloading Platforms
GDP	Gross Domestic Product
GFCM	General Fisheries Commission for the Mediterranean
GHG	Greenhouse Gas
GHS	United Nations' Globally Harmonised System of Classification and Labelling of Chemicals
GNSS	Global Navigation Satellite Systems
GoL	Government of Lebanon
HC	Hydrocarbon
HCFCs	Hydro-chlorofluorocarbons
HCP	Higher Council for Privatization
HCRs	Hydrocarbon Releases
HSE	Health, Safety and Environment
HWDP	Heavy Weight Drill Pipes
IADC	International Association of Drilling Contractors
IAGC	International Association of Geophysical Contractors
IAS	Invasive Alien Species
ICS	Incident Command Structure
ICZM	Integrated Coastal Zone Management
IEE	Initial Environmental Examination
ILO	International Labour Organization
IMCA	International Marine Contractors Association
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
IOGP	International Oil & Gas Producers
IUCN	International Union for Conservation of Nature
JMOC	Joint Maritime Operations Chamber
JNCC	Joint Nature Conservation Committee
LAEC	Lebanese Atomic Energy Commission
LLMC	Limitation of Liability for Maritime Claims
LNG	Liquefied Natural Gas
LPA	Lebanese Petroleum Administration

LWD	Logging While Drilling
MARPOL	The International Convention for the Prevention of Pollution from Ships
MATTE	Major Accident to the Environment
MGO	Marine gas oil
MoA	Ministry of Agriculture
MoC	Ministry of Culture
MODUs	Mobile Offshore Drilling Units
MoE	Ministry of Environment
MoEHE	Ministry of Education and Higher Education
MoET	Ministry of Economy and Trade
MOEW	Minister of Energy and Water
MoF	Ministry of Finance
MoI	Ministry of Industry
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transport
MoSA	Ministry of Social Affairs
MoT	Ministry of Toursim
MPA	Marine Protected Area
MW	Mega Watt
MWD	Measurement While Drilling
N2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NBSAP	National Biodiversity Strategy and Action Plan
NCMS	National Centre for Marine Sciences
NCS	Norwegian Continental Shelf
NDC	Nationally Determined Contribution
NEBA	Net Environmental Benefit Analysis
NEEAP	National Energy Efficiency Action Plan for the republic of Lebanon
NG	Natural Gas
NMVOC	Non-Methane Volatile Organic Compounds
NOAA	National Oceanic and Atmospheric Administration
NORM	Naturally Occurring Radioactive Material

NOSCP	National Oil Spill Contingency Plan
NOx	Oxides of Nitrogen
NPTP	National Poverty Targeting Program
NSEQ	National Standards for Environmental Quality
OBF	Oil-based Fluid
OBM	Oil-Based Mud
OCEANA	Ocean Conservation and Advocacy Organizatio
OPEX	Operating Expense
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation
OPRL	Offshore Petroleum Resources Law
OSCP	Oil Spill Contingency Plan
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAM	Passive Acoustic Monitoring protocol
PAR	Petroleum Activities Regulations
PCBs	Polychlorinated Biphenyls
PDC	Polycrystalline Diamond Compact
PDP	Development and Production Plans
PGS	Petroleum Geo-Services
PM	Particulate Matter
PPE	Personal Protective Equipment
PPP	Public Private Partnership
PSU	Practical Salinity Unit
PTS	Permanent Threshold Shift
QHSE	Quality, Health, Safety, Environment
Ramsar	The Convention on wetlands of international importance
RE	Renewable energy
RMS	Root Mean Square
ROP	Rate of Penetration
ROV	Remotely Operated Vehicle
RSS	Rotary Steerable System
SBF	Synthetic Based Fluid
SBM	Single Buoy Mooring

SBM	Synthetic Based Mud
SCP	Sustainable Consumption and Production
SCP-NAP	Sustainable Consumption and Production National Action Plan
SDATL	Schéma Directeur D'aménagement du Territoire Libanais/National Spatial Land Use Plan
SDGPS	Clock and Orbit Corrected GPS
SDGs	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SHEP	Stakeholder Engagement Plan
SME	Small and Medium-Sized Enterprises
SNR	Signal-to-Noise Ratio
SO2	Sulfur Dioxide
SOP	Standard Operating Procedure
SPAR	Single Point Anchor Reservoir
SRs	Scoping Reports
SWF	Sovereign Wealth Fund
TCNR	Tyre Coast Nature Reserve
TTS	Temporary Threshold Shift
UN	United nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VMS	Vessel Monitoring System
VOC	Volatile Organic Compound
VTS	Vessel Traffic services
WBF	Water Based Fluid
WEF	World Economic Forum
WHO	World Health Organization
WOB	Weight On Bit
WWF	World Wildlife Fund

MOEW FOREWORD

This Strategic Environmental Assessment (SEA) presents a profound step towards the achievement of the sector's long-term vision of developing an oil and gas sector that ensures Lebanon's competitiveness, fosters sustainability, creates value for economic and social development, guarantees energy security and enhances accountability for the stewardship of Lebanon's energy resources for present and future generations. This SEA clarifies the environmental and social context and aims to reduce risks and liabilities and enhance competition and visibility for International Oil Companies (IOCs). On the other hand, it defines responsibilities on IOCs as well as on the various relevant government entities to ensure an integrative approach.

Recommendations of this study provide further guidance for the development of the oil and gas sector, mainly from an environmental point of view addressing data collection, block opening, mainstreaming of impact assessments, development options and environmental management which also aligns perfectly with the national commitments to the Sustainable Development Goals (SDGs) and to the Nationally Determined Contributions (NDCs) for combating climate change. It was crucial that this SEA adopted an integrated, participative and inclusive approach where a comprehensive stakeholder engagement process was undertaken including the establishment of a taskforce, the initiation of transboundary consultation, a distinctive and state-of-the-art approach of online consultation and open public consultation sessions.

I seize this opportunity to thank all contributors to this strategic environmental assessment and I am also grateful to the European Union for their support and their kind grant which made this study possible. I strongly believe that the takeaway messages of this SEA are promising, as with this acquired knowledge, Lebanon is better preparing itself to address the environmental, social and economic challenges potentially associated with the oil and gas sector. However, this comes with bigger responsibilities. It will remain critical that the Lebanese government, including policy makers and decision makers, and all governmental and non-governmental entities strictly commit to the full and effective implementation of this SEA to enable a successful, sustainable and inclusive development of petroleum activities for the benefit of current and future generations.

Minister of Energy and Water
Nada Boustani
18/09/2019

MOE FOREWORD

The exploitation of oil and gas resources poses several challenges to sustainability, and environmental matters are defining a new agenda for offshore energy research and development. There is increasing recognition of the need to address the environmental implications of energy development early in the planning process, before irreversible decisions are taken and energy projects become a burden, at the strategic tier of policies and plans.

This higher-order environmental assessment, known as Strategic Environmental Assessment (SEA), is broadly recognized as an important instrument to promote sustainability-driven decision-making. Thus, the SEA can inform and improve the efficacy and efficiency of offshore projects' environmental assessment.

In 2012, the Government of Lebanon decreed *(Decree 8213/2012)* that the SEA is a mandatory procedure to be followed for the assessment of potential environmental impacts of any policy, plan, program, study, investment or organization proposal that tackles an entire Lebanese region or an activity sector, in order to ensure that these activities are compliant with conditions related to health, public safety, the protection of the environment and the sustainability of natural resources.

Under the context of the Decree 8213/2012 and the general provisions of the national petroleum activities regulations, this report titled "SEA Study of the Oil & Gas Sector in the Lebanese Maritime Waters" has been prepared as a reflection to adopt a distinct path and approach towards the development and advancement of the petroleum activities, enabling decision-makers to adopt the principles of strategic environmental assessment into the policies that govern Lebanon's offshore resources. The Ministry of Environment reviewed this SEA, provided its observations and approved it.

As the SEA is a continuous process and regular updates can be expected as result of the implementation of the project activities and related control and monitoring of environmental impacts, the Ministry of Environment will continue to deploy all efforts to safeguard Lebanon's rich and diverse natural heritage and invites all stakeholders to join hands and tightly cooperate in this challenging mission.

Minister of Environment
Fadi Jreissati
18/09/2019

EUROPEAN UNION FOREWORD

Our health, social protection and ability to live in a healthy environment, are all closely connected. Hence, the plans and programmes that result from government policies in certain areas have a big influence on decisions that affect people's lives for many generations to come, their quality of life as well as the environment they live in and its natural resources.

Many countries, including European countries, use the Strategic Environmental Assessment (SEA) as a regulatory planning tool to ensure the environmental, health and social implications of decisions are taken into account before decisions are made. The SEA when used well helps those involved reach informed decisions by carefully considering reasonable alternatives as well as the pros and contras associated with each planning option. This is done in an inclusive way, as both the public and the environmental authorities should equally have a say in the process.

The SEA can help prevent costly and irreversible risks to human health and the environment, such as accidents leading to spills of hydrocarbons and chemicals in the sea that often occur due to poor planning. The SEA can also help improve public trust in decision-making and transparency.

Since the adoption of Law 444/2002 on Environmental Protection, the SEA is one of the several environmental safeguards Lebanon has gradually adopted. Thanks to Decree 8213/2012, considered a pioneer in the Middle East and North Africa region, the SEA became a legal requirement.

The EU gladly contributed to the update of the first SEA study for the offshore exploration and production activities in Lebanon undertaken early 2012. The process involved many different stakeholders, from key government entities part of the SEA Task Force to members of the scientific community, civil society organisations, private sector, associations, including fishermen and citizens. Public consultation sessions held in 2019 covered many regions of the country with stakeholders participating in the coastal towns of Beirut, Tripoli, Byblos, Saida and Naqoura.

Following through the recommendations emerging from the SEA is something the Lebanese people deserve. With the first impending drilling scheduled for December 2019 the timing of these recommendations is crucial. If discoveries are confirmed and the associated risks properly managed, what is left is to make sure that the revenues generated from the development of the offshore oil and gas sector in Lebanon truly benefit Lebanon's socio-economic development and the Lebanese people's well-being.

We thank all those involved in making the SEA update possible, in particular the Ministries of Energy and Water and of the Environment as well as the Lebanese Petroleum Administration for the good partnership developed over these last years, which we look forward to seeing sustained in the future.

Ambassador Ralph Tarraf
Ambassador of the European Union to Lebanon
18/09/2019

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The authors would also like to thank all the members of the SEA Task Force from the Ministries of Energy and Water, Environment, Public Works and Transport, Agriculture (Fisheries department), Social Affairs and Economy and Trade, as well as the National Center for Marine Sciences. All Task Force members have provided significant input to the SEA through guidance and participation in various Task Force working sessions.

The contributions of all stakeholders who have participated in consultation workshops and meetings are also highly appreciated.

Last but not least, the authors would like to thank the European Union (EU) for financing the preparation of this SEA, and the staff of the EU Delegation in Lebanon for their continuous support.

EXECUTIVE SUMMARY

I. INTRODUCTION

Within the framework of the first offshore oil and gas licensing round in Lebanon, the Minister of Energy and Water (MOEW), following the recommendation of the Lebanese Petroleum Administration (LPA) and in consultation with the Ministry of Environment (MoE), launched the update of the Strategic Environmental Assessment (SEA) for exploration and production activities for offshore petroleum resources in Lebanon. Previously, the first SEA study for the offshore E&P activities in Lebanon was undertaken in early 2012.

In April 2012, the Lebanese government issued the SEA Decree No. 8213, stipulating the procedures for conducting SEA studies for policies, plans and programmes in Lebanon. According to Article 2 of the decree, "SEA is a planning and management method for avoiding or, at minimum, reducing sources of pollution and depletion of natural resources by way of assessing environmental impacts of policy, program, plan, study, investment or organization proposals that tackle a Lebanese region or an activity sector, identifying necessary mitigation measures and enhancing positive outcomes on the environment and natural resources, prior to their acceptance or refusal". It is important to note that while the definition of the SEA in the SEA Decree focuses on the impacts on the environment and natural resources, the impact assessment also considers social and economic impacts (Refer to Annex 3 of Decree 8213/2012). The SEA however does not attempt to assess whether the sector is promising or not from an economic point of view or to demonstrate that negative and positive impacts are balanced, but rather, the SEA aims to ensure that impacts and their sources are identified, and that effective measures to manage these impacts are in place early on prior to the start of petroleum activities.

The SEA Study Update is conducted under the European Union (EU) financed PROMARE Technical Assistance Project ("Technical assistance to support the Government of Lebanon's preparation of exploiting and producing offshore oil and gas resources") and is implemented by the international GFA Consulting Group and its consortium partners, and led by its local partner, Earth Link and Advanced Resources Development (ELARD).

The objectives of this SEA study update are to:

- Inform the exploration activities in the awarded blocks (4 & 9) and subsequent exploration activities arising from future licensing rounds taking into consideration environmental criteria;
- Inform the next licensing rounds with respect to blocks to be opened taking in consideration environmental criteria;
- Inform the Development and Production Plans (PDP) taking into consideration environmental criteria;
- Ensure consistency of E&P activities with other national, regional, sectorial plan/strategies /policies and international commitments;

- Engage stakeholders including interested public in a participatory approach and build trust;
- Advise on the need for transboundary notification and consultation;
- Advise on filling existing gaps in environmental and social requirements;
- Provide environmental management and monitoring frameworks for the sector; and
- Streamline the EIA process for E&P activities that will be subject to an EIA study.

II. Background on the Offshore Oil and Gas Sector in Lebanon

In 2010, the Offshore Petroleum Resources Law (OPRL) – Law 132 dated 24/8/2010 - was endorsed by the Lebanese parliament establishing the overall legal framework for offshore petroleum Exploration and Production (E&P) activities in the Lebanese Waters. Subsequently, the Council of Ministers (CoM) established the Lebanese Petroleum Administration (LPA) mandates and modus operandi through Decree No. 7968 in April 2012. The LPA board members were appointed through Decree No. 9438 in December 2012. The Petroleum Activities Regulations (PAR) were issued by Decree No. 10289 in April 2013 to further implement the OPRL provisions.

As required by Article 7 of the OPRL, a Strategic Environmental Assessment (SEA) study was conducted for offshore E&P activities in Lebanon between 2011 and 2012 before opening the first licensing round in 2013. In 2013, Lebanon completed a first pre-qualification round to enable prequalified companies meeting technical, financial, legal and QHSE criteria to participate in the 1st offshore licensing round. However, the bid round was postponed until January 2017 when two pending decrees were approved by the Council of Ministers, namely Decrees No. 42 and 43. Decree number 42/2017 delineates the division of the Lebanese Maritime Waters into ten (10) Blocks which will be open for bidding in a gradual manner throughout the licensing rounds. Additionally, the decree accounts for a buffer zone[1] (of 3 nm within the territorial waters) where petroleum activities are not allowed unless the Council of Ministers issue a decree to permit otherwise. Decree No. 43/2017 established the tender protocol and the model Exploration and Production Agreement (EPA) (Annex 2 of the Decree).

The first licensing round was successfully completed (where 5 blocks were open for bidding (Blocks 1, 4, 8, 9 and 10)) with the signature of the first two (2) Exploration and Production Agreements (EPA) for Blocks 4 and 9 on December 14, 2017 with a consortium of three international oil companies (IOCs) (Total SA, ENI International BV and JSC Novatek). On the 17th of May 2018, the CoM approved the recommendation of the Minister of Energy and Water and LPA to undertake the preparation for a second offshore licensing round. On the 5th of April 2019, the Minister of Energy and Water declared that blocks 1, 2, 5, 8 & 10 are open to receive bids for the second offshore licensing round.

[1] Buffer zones as used in the report refer to zones established by legislation where petroleum activities are not allowed. It also refers to protection zones around features that require protection such as protected areas, archeological sites, infrastructure, etc.

III. SEA Policy Recommendations

In addition to the various mitigation measures recommended in the SEA, various policy recommendations are made to inform the sustainable development of the oil and gas sector.

Sector Development Policies

- ✓ **Blocks Environmental Sensitivity**: Based on the baseline review conducted under this SEA, near shore blocks are the most environmentally sensitive blocks. This is because the continental slope is part of a considerable portion of the areas of these blocks. It is recommended that, if these blocks are to be licensed, in-depth baseline surveys (including eco-toxicological studies) and stricter controls shall be adopted, as applicable.
- ✓ **EIA for Plan for Development and Production:** Based on the nature of stages of the field development, it is recommended that an EIA is submitted at the conceptual design and preliminary engineering stages then updated EIAs at the preliminary and final design and construction phases.
- ✓ **Gas export**: As a general policy, an LNG export option is to be avoided, given its high impact on the carbon footprint of Lebanon jeopardizing meeting national commitments towards GHG emissions reduction and not being in line with the global need to mitigate the effects of climate change. Export through pipelines should be considered instead. If LNG option is a preferred option for technical or commercial reasons, emissions should be offset to ensure compliance with Lebanon's international commitments.
- ✓ **Processing Facilities**: The SEA preferred option for multi-phase separation (i.e. separation of water, oil and gas from the extracted hydrocarbons) is to conduct such processing offshore in deep sea. It is recommended that these processes are not brought to shore or to the continental shelf to avoid significant impacts on the marine environment, fisheries and public health particularly given the likely generation of produced water from this process.

Environmental Governance

Despite of its importance, the required independence of the HSE regulator(s) must not become a pursuit of altruism since the only way to remove HSE risks from economic activity is to take land/sea bed out of economic use. The regulator is an enabler of high hazard industries on behalf of the state, and the economic activity is the primary purpose of allowing high hazard industries to operate. Nevertheless, identifying and mitigating the risk is indispensable at the short and long terms.

- ✓ On the short term: The principal organizational adaptation will be the creation of functional separation between the HSE decision making and the economic decision making (resource management) at the Petroleum Administration. In such circumstances, every endeavor must be made from the Minister down to ensure at all times the independence and objectivity by preventing conflicts of interest between the HSE regulation on one hand and the considerations of economic regulation and revenue collection on the other hand.

- ✓ On the long term: The principal organizational adaptation will be the creation of structural separation that is the complete separation of the HSE regulator from the economic regulator. This is the recognized international best practice model. Such structural separation could take place through various scenarios while taking into consideration the following key issues:
    1. The existing mandated roles & responsibilities of the key HSE regulatory authorities in Lebanon
    2. The existing offshore oil & gas regulatory framework (i.e. OPRL, PAR, LPA Decree, EPA)
    3. Fulfilling all, or to the maximum extent possible, the requirements of the international best practice principles
    4. Ensuring that the occupational health & safety and Major Accident prevention (including Major Accident to the Environment) are regulated by a single entity
    5. Achieving sufficient independence between HSE regulation and economic regulation
    6. Government's constraints regarding mobilization of resources

As a first scenario, an entity responsible for Occupational Health & Safety and Major Accident Prevention (including MATTE) will be established. Such entity could operate in parallel to LPA under the tutelage of the Minister of Energy and Water or under the tutelage of another ministry or be a fully independent regulatory authority. In this scenario, the follow up of all environmental matters sits with the Ministry of Environment (MOE). This will entail a close interface between the proposed health and safety regulator and the environmental regulator (MOE) namely on common topics (MATTE, management systems, etc.). Such a scenario would require active capacity building at the Ministry of Environment on the supervision of the new emerging sector. It may also require organizational arrangements at the Ministry of Environment to better follow up on the sector e.g. the provision of a specific unit.

As a second Scenario 2, an entity is established as fully independent regulatory authority that regulates all HSE aspects including day-to-day environmental matters. If need be, such entity could communicate with other ministries e.g. Ministers of Labor and Environment.

In both scenarios, all economic regulations (resource management) remains at LPA under the tutelage of MOEW.

Baseline Surveys

Based on the baseline review and analysis and in light of the identified gaps given the lack of data on the Lebanese offshore, baseline surveys (environmental, social, economic) should be undertaken prior to any petroleum activity in order to develop an understanding of the environmental and socio-economic conditions, identify sensitivities, develop background levels, assess the environment's capacity for restoration and inform the impact assessment.

The scope and scale of these baseline surveys will necessarily vary depending on the associated activity (reconnaissance or drilling or production).

The approach and methodology of baseline surveys should be based on international best practices, such as IOGP, OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities.

Data Management: All currently available data, as well as new emerging data and/or studies linked to any SEA relevant topic, should be continuously collected, verified and stored in appropriate databases, in order to support decision making as well as:

- Support responsible authorities in the monitoring process.
- Support operators in the development of high-quality EIAs, as well as other plans and baseline studies.
- Support transparency and accountability across the sector.

Waste Management Policies

Main policy recommendations related to the management of waste streams that could potentially be generated during the exploration, production and decommissioning phases include:

- ✓ Waste management hierarchy should be respected throughout the lifecycle of the upstream petroleum activities
- ✓ Priority should be given to waste prevention and minimization throughout the entire value chain, without entailing excessive costs. Implementation of the prevention principle should be equally directed toward reduced consumption patterns and better utilization of resources. Waste Management Plans should demonstrate that opportunities for prevention and minimization were used to the highest feasible extent
- ✓ Drilling fluids and cuttings should not be discharged to the sea; ship-to-shore for treatment or shipment outside Lebanon are acceptable options. Any other potential option shall be subject to a detailed environmental assessment.
- ✓ Operators are recommended to use water-based drilling fluids unless safety of the well could be jeopardized
- ✓ Produced water generated offshore should not be brought onshore for handling/treatment or disposal. Produced water should be preferably discharged into injection wells
- ✓ Only in the case that re-injection of produced water offshore is technically not feasible, discharge in the sea is allowed following strict conditions; it is recommended

to follow OSPAR's risk based approach to the Management of Produced Water discharges from offshore installations in the marine environment

- ✓ In case discharge to the sea is the only option available, treated produced water cannot be discharged in the continental shelf or continental slope, or near any other sensitive ecosystem
- ✓ If NORM wastes are generated, the Lebanese Atomic Energy Commission (LAEC) should be immediately notified and these wastes should be managed according to the requirements of the LAEC; The Lebanese government should be prepared to have a state-of-the-art radioactive waste handling facility, adequately sited, and capable to store, treat and dispose of radioactive wastes generated by the petroleum sector.

Chemical Management

Main policy recommendations related to the management of chemicals include:

- ✓ Relevant authorities to develop a chemical management framework which defines the import, handling, use, storage, transport and disposal of chemicals, particularly those relevant to the oil and gas sector
- ✓ Chemicals storage onshore should be centralized and limited to zones classified for such purposes (e.g. industrial zones)
- ✓ Eco-toxicity data shall be always available for chemicals intended for use where preference should be given to chemicals registered in international databases such as European Chemical Agency (ECHA) or equivalent
- ✓ Chemicals Management Plans should be developed to be approved prior to the start of any activity involving the use of chemicals in line with EU regulations
- ✓ Continuous efforts should be targeted to substitute chemicals with hazardous characteristics with less hazardous alternatives
- ✓ International Maritime Dangerous Goods (IMDG) Code should be adopted for the transportation of dangerous goods or hazardous materials by vessels
- ✓ For the transport by road of chemicals considered dangerous goods, Lebanese Transport Operators are recommended to follow the rules of European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR and its protocol)
- ✓ Government to consider ratifying the hazardous noxious substances related Convention and Protocols

Requirements for EIA Studies

Environmental impact assessment studies shall be prepared for petroleum activities according to the requirements of the petroleum and environmental legislation, namely: Law No. 132/2010 (OPRL), Decree No. 10289/2013 (PAR), Decree No. 43- Annex 2/2017 (EPA), Law No. 444/2002 and Decree No. 8633 /2012 (EIA).

The current SEA provides a substantial amount of information that will provide a basis for the subsequent EIA studies, however, the assessment is conducted at a high level and shall be subject to detailed assessment during EIA studies as more information becomes available on the techniques to be used (i.e. type of drilling rigs, type of production platforms and the type and usage of extracted hydrocarbons). The following recommendations related to future EIA studies are proposed:

- Conducting pre-activity baseline survey, activity-level monitoring during implementation (based on environmental monitoring plan), and post-activity monitoring to assess pre and post conditions for performance reporting and national reporting, including at least:
    - Surveys of benthic species at work locations.
    - Survey of mammal species, turtles and seals which could be present in the study area during the time of the proposed activity.
    - Defining and mapping birds' migration routes and time of migration, and habitats of marine birds.
    - Survey of underwater shipwrecks and archeological sites.
    - Defining underwater infrastructure corridors and survey of underwater infrastructure.
    - Survey of water quality and bottom sea sediments quality. Digital imagery of bottom type and macrofauna; sediment profile imagery or alternatively sieved benthic grab samples to characterize infauna; grain size and organic carbon analysis of surficial sediment samples; field measurements of water temperature and pH at surface and bottom throughout the year.
    - Defining important fishing areas within the area of the proposed activity and documenting of spawning and other sensitive life stages of commercially important species.
    - Defining and mapping water ways crossing the area of the proposed activity.
    - Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area.
    - Considerations relevant to sensitive areas, protected sites and proposed protected sites (please refer to mitigation measures in the SEA Report)
- A Guidance to be followed for establishing environmental baseline prior to offshore reconnaissance and exploration drilling activities is provided in Appendix D.

- Conducting social baseline studies, commensurate with the expected significance of social impacts (lower during exploration, higher during development and production) in line with the monitoring framework (Table 10-6).
- Conducting specific studies, as applicable:
    - Underwater noise modelling.
    - Conducting air dispersion modelling studies for drilling and production activities.
    - Conducting ambient noise modelling studies for onshore facilities.
    - Conducting dispersion modelling in case of discharge
    - Conducting oil spill modeling
- Mandatory GHG assessment for all production facilities and demonstration of effective integration of BAT in design and implementation of facilities.
- Preparation of needed environmental and social management plans e.g. waste management plan, chemical management plan, chemicals substitution plan, chemicals database, compensation plan, pollution prevention, environmental emergency plan, environmental monitoring…etc.
- The site selection of proposed land-based activities shall be based on an analysis of alternatives, and shall be in compliance with SDATL (National Spatial Land Use Plan).
- Specifying land-based infrastructure that will be used to support the proposed activity (such as ports and airports). The adequacy of existing infrastructure to cater for the requirement of proposed activity shall be assessed.
- Use of Offset mechanism for ecological losses and devaluation after all other opportunities for avoidance and mitigation have been exploited
- Contingency plans: OSCP, gas blow-out, chemical spill
- Assessment of impacts from Transportation between offshore and supply base
- Assessment of cumulative and transboundary impacts
- It is recommended that future EIA studies demonstrate compliance with the SEA recommendation.

Transparency & Fiscal Policy

The E&P sector in Lebanon has already established strong safeguards to enable transparency and control corruption within the sector; this includes the recently adopted Transparency Law for the offshore oil and gas sector and the provision of a Sovereign Wealth Fund to manage revenues from the sector. However, it is still vital that the Government of Lebanon ensures the enforcement of both set-up mechanisms throughout all phases of the sector.

Potential investment from Sovereign Wealth Fund reserves into productive sectors, infrastructure and social welfare could significantly contribute to enhancing socio-economic conditions in Lebanon, as well as providing investments in "green industries", leading to further improvement of living conditions in Lebanon. Therefore, the design and operational management of the SWF should be carefully done, preferably in a highly participatory and transparent manner, not only to mitigate exposed social and economic risks, but also to ensure long-term and sustainable development of Lebanon.

Management of Expectations

Development of any important economic sector, such as the petroleum sector, brings important impacts on the Lebanese society – both positive and negative. Therefore, it is important for the Government of Lebanon to understand the key drivers of change in social conditions in order to enhance positive impacts and mitigate negative ones.

Since first signs of unrealistic expectations from the petroleum sector were already identified, substantial responsibility lies on the shoulders of responsible authorities to communicate realistic and evidence-based information to the Lebanese society. It is highly recommended that responsible authorities develop and enforce a comprehensive communication strategy, which will:

- Raise the awareness on relevant topics;
- Ensure active and constructive stakeholder engagement;
- Promote beneficial impacts effectively;
- Manage expectations from the sector;
- Promote Corporate Social Responsibility (CSR) practices in the sector.

If developed and appropriately implemented, it could also become an additional and important pillar of transparency and accountability in the sector.

IV. Implementation of the SEA

Main recommendations for the effective and efficient implementation of this SEA include:

- ✓ Endorsement of the SEA recommendations and policies through integration into regulations and enactment by legal texts, as applicable.
- ✓ Maintain the SEA Task Force for the purpose of coordinating the SEA implementation and the environmental management of the sector (SEA Implementation Committee). Details of proposed requirements/modality for the SEA Implementation Committee are presented below.
- ✓ Proper enforcement of legal requirements and existing control measures.
- ✓ Integration of the SEA framework indicators (state indicators) within the monitoring plans of key performance indicators monitored by authorities, as relevant.
- ✓ Operationalization of the systematic monitoring of indicators through envisioning of resources (qualified human resources, equipment, finances)
- ✓ Operationalization of the environmental database on environmental data associated with the offshore oil and gas sector.
- ✓ Establish a Scientific Committee, particularly on marine related issues, to act as an advisor to the LPA on technical matters.
- ✓ It is recommended that this SEA be updated in 5 years from the date of MoE final approval of this SEA. The scope of the update shall be decided by MoE in coordination with MOEW/LPA.

Requirements for the SEA Implementation Committee and Possible Modalities

There are several options for the future operational model of the implementation committee:

1. It could remain in a similar operational model as the task force today – a technical body for consultation and cross sectorial coordination, with limited decision-making capacities. However, this would mean that individual ministries would be responsible for the implementation of significant parts of the SEA Implementation plan, while MoE and/or LPA would have to oversee overall implementation and progress.
2. It could be officially named by the Lebanese Government – each ministry/responsible authority would have 1 "focal-point" representative, who would take over the responsibility to represent its ministry in the implementation committee. The implementation committee would remain predominantly technical and coordinating body, where representatives would oversee realization of the SEA Implementation Plan, would jointly seek out best solutions and propose them to decision makers.
3. It could be named as a working body of the SDGs committee and would operate in a similar way, as described in the second option.

In either case it is advisable that:

- Implementation Committee takes over the responsibility to oversee operational realization of the SEA Implementation Plan.
- Implementation Committee convenes on regular basis – for example every 3 or every 6 months.
- LPA and/or MoE take over the leading role in the Task force, as majority of tasks falls under their jurisdiction.
- NGOs and/or other relevant actors are invited to oversee the work of the Task force, thus further contributing to transparency and accountability across the sector.

Capacity Building

Capacity building activities to effectively raise the capacity of stakeholders to implement the requirements of this SEA are proposed:

- Training workshops focusing on improving the understanding of stakeholders about the oil and gas industry, its lifecycle and associated hazards and understanding the requirements of this SEA as well as training of concerned authorities on core aspects of the offshore oil and gas industry (technologies and BAT, major accident prevention and related safety studies, emergency preparedness and response, chemical management…etc.)
- Training of concerned authorities on the implementation of Environmental Emergency Response e.g. National Oil Spill Contingency Plan and implementing practice drills to ensure effective operationalization. Response teams of operators and the government should include fisheries scientists and marine wildlife experts to ensure that the necessary data collection methods are used to document the effects of emergencies and to supervise wildlife rescue and early rehabilitation activities.
- Provision of necessary monitoring and inspection equipment to stakeholders depending on their needs and related training
- Capacity building and enabling of concerned national entities for oil spill response and management.
- Support NCMS in the enforcement of ACCOBAMS requirements and guidelines
- Training of concerned authorities on monitoring procedures and requirements as well as reporting requirements and the data needed for reporting on different indicators and monitoring results (more importantly for marine environment parameters, GHG and air pollutants)
- Providing training to concerned authorities who will be conducting missions on-board on safety requirements related to offshore O&G activities.

- Study tours to offshore platforms and oil and gas facilities, so stakeholders acquire practical know-how on how to conduct activities (such as inspections, sampling or audits) at such facilities

V. Conclusions

This SEA study has systematically identified potential positive and negative environmental and socio-economic impacts that could be generated from the development of the offshore oil and gas sector in Lebanon.

Significance of both positive and negative impacts depends on the quantities and types of hydrocarbons that could be found offshore Lebanon and how they are developed. In summary:

- ✓ If no discoveries are made, both negative environmental impacts and positive socio-economic impacts would remain low, except in the case of a major accident during exploration drilling; it is therefore very important that focus be directed by regulators towards the prevention of major accidents
- ✓ If modest discoveries are made or if the government decides to develop discoveries solely for the purposes of power generation, both negative environmental impacts and positive socio-economic impacts would remain moderate; several measures are proposed in this SEA to minimize negative impacts and maximize positive ones
- ✓ If significant discoveries are made, negative environmental impacts could be significant if mitigation measures are not implemented; at the same time, positive socio-economic impacts particularly in terms of GDP contribution, reduced imports and increase exports, as well as potential investment from Sovereign Wealth Funds reserves into productive sectors, infrastructure and social welfare could significantly contribute to enhance socio-economic conditions in Lebanon.

It is therefore crucial to strictly implement recommendations from this SEA to ensure that potential negative impacts are effectively managed and positive impacts are enhanced in case discoveries are made and are developed in Lebanon.

1. INTRODUCTION

1.1 GENERAL

Within the framework of the first offshore oil and gas licensing round in Lebanon, the Minister of Energy and Water (MOEW), following the recommendation of the Lebanese Petroleum Administration (LPA) and in consultation with the Ministry of Environment (MoE), launched the update of the Strategic Environmental Assessment (SEA) for exploration and production activities for offshore petroleum resources in Lebanon. Previously, the first SEA study for the offshore E&P activities in Lebanon was undertaken in early 2012.

The official correspondences related to initiating this SEA update are included in **Appendix A**.

In April 2012, the Lebanese government issued the SEA Decree No. 8213, stipulating the procedures for conducting SEA studies for policies, plans and programmes in Lebanon. According to Article 2 of the decree, "SEA is a planning and management method for avoiding or, at minimum, reducing sources of pollution and depletion of natural resources by way of assessing environmental impacts of policy, program, plan, study, investment or organization proposals that tackle a Lebanese region or an activity sector, identifying necessary mitigation measures and enhancing positive outcomes on the environment and natural resources, prior to their acceptance or refusal". It is important to note that while the definition of the SEA in the SEA Decree focuses on the impacts on the environment and natural resources, the impact assessment also considers social and economic impacts (Refer to Annex 3 of Decree No. 8213/2012). The SEA however does not attempt to assess whether the sector is promising or not from an economic point of view or to demonstrate that negative and positive impacts are balanced, but rather, the SEA aims to ensure that impacts and their sources are identified, and that effective measures to manage these impacts are in place early on prior to the start of petroleum activities.

The SEA Study Update is conducted under the European Union (EU) financed PROMARE Technical Assistance Project ("Technical assistance to support the Government of Lebanon's preparation of exploiting and producing offshore oil and gas resources") and is implemented by the international GFA Consulting Group and its consortium partners, and led by its local partner, Earth Link and Advanced Resources Development (ELARD). The terms of reference for the SEA Study Update are provided in **Appendix B.**

The objectives of this SEA study update are to:

- Inform the exploration activities in the awarded blocks (4 & 9) and subsequent exploration activities arising from future licensing rounds taking into consideration environmental criteria;
- Inform the next licensing rounds with respect to blocks to be opened taking in consideration environmental criteria;

- Inform the Development and Production Plans (PDP) taking into consideration environmental criteria;
- Ensure consistency of E&P activities with other national, regional, sectorial plan/strategies /policies and international commitments;
- Engage stakeholders including interested public in a participatory approach and build trust;
- Advise on the need for transboundary notification and consultation;
- Advise on filling existing gaps in environmental and social requirements;
- Provide environmental management and monitoring frameworks for the sector; and
- Streamline the EIA process for E&P activities that will be subject to an EIA study.

The SEA report is presented in four (4) volumes as follows:

- Volume 1: SEA report
- Volume 2: Baseline Conditions Report
- Volume 3: Legal and Policy Analysis
- Volume 4: Stakeholder Engagement

It also comprises a Non-Technical Summary in both English and Arabic languages.

1.2 PROJECT PROPONENT (THE LEBANESE PETROLEUM ADMINISTRATION)

The Lebanese Petroleum Administration (LPA) was established on the 4th of December 2012, and is an independent public institution mandated to manage the upstream offshore petroleum sector in Lebanon, operating under the tutelage of the Minister of Energy and Water. The principal objective of the LPA is to contribute to creating the greatest possible value for the economy and the society out of the petroleum sector while protecting the environment. More specifically, and in addition to preparing technical studies to support and inform the decision making processes, the LPA actively undertakes planning, regulatory, and supervisory roles across the petroleum industry value chain, namely the LPA plays critical roles during the licensing phase, the exploration phase, the development and production phase and the decommissioning phase.

The Petroleum Administration consists of Six (6) technical departments, namely:

- Strategic Planning Department
- Technical and Engineering Department
- Geology and Geophysics Department
- Legal Affairs Department
- Economics and Financial Department
- Quality, Health, Safety and Environment Department

1.3 SEA PRACTITIONERS

The SEA Study Update is conducted under the European Union (EU) financed PROMARE Technical Assistance Project ("Technical assistance to support the Government of Lebanon's preparation of exploiting and producing offshore oil and gas resources") and is implemented by the international GFA Consulting Group and its consortium partners, and led by its local partner, Earth Link and Advanced Resources Development (ELARD). ELARD has led the SEA study update with support from an international expert from GFA who provided overall guidance and peer review of SEA deliverables.

CVs of Key SEA team members is provided in Appendix C.

1.3.1 PROMARE Technical Assistance Project

E.U.'s technical assistance to support the Government of Lebanon's preparations in exploiting and producing offshore prospective oil and gas resources:

To enhance the protection and sustainable development of Lebanon's maritime resources this partnership will provide a technical assistance (30 months' duration) to the Lebanese Petroleum Administration (LPA) and to the Ministry of Energy and Water (MoEW). The technical assistance will provide the beneficiary institutions with expertise on the following subjects:

1. Organizational and functional capabilities (including technical issues).
2. Strategic, policy and economic capabilities.
3. Governance, transparency and accountability enhancement.

1.3.2 GFA Consulting Group

Based in Hamburg, Germany, GFA Consulting Group is one of the leading European consulting firms active in the development cooperation sector. GFA has a sound track record of providing effective solutions to the challenges in the global consulting market. Since 1982 GFA have implemented complex studies and projects worldwide.

Leading development agencies, ministries and public clients have entrusted GFA with helping them to manage projects financed through bilateral and multilateral funds. Working in cooperation with stakeholders in government, the private sector, NGOs and citizens' groups, GFA balances innovation and reliability to meet local needs.

1.3.3 Earth Link and Advanced Resources Development (ELARD)

ELARD is a regional consulting and engineering firm, specialized in environmental management. ELARD has been offering environment-related services for nearly 20 years in the Middle East, North Africa, Arabian Gulf regions and Asia. With its headquarters located in Beirut, ELARD has permanent offices in Baghdad, Damascus, Abu Dhabi, Dubai, Tripoli and

Maputo. ELARD employs nearly 100 professionals with expertise in numerous fields of environmental engineering and sciences.

ELARD has extensive experience conducting environmental studies in the oil and gas sector, including Strategic Environmental Assessment (SEA), Environmental and Social Impact Assessment (ESIA), Environmental Risk Assessment (ERA), Environmental Baseline Studies (EBS) as well as environmental audits, among other services.

1.3.4 SEA Task Force

A task force was established as part of the SEA process and included:

- Ministry of Energy and Water (MoEW)/LPA
- Ministry of Environment (MoE) – SEA review committee members
- Ministry of Public Works and Transport (MoPWT)
- National Centre for Marine Sciences (NCMS)
- Ministry of Agriculture (MoA)/ Fisheries
- Ministry of Social Affairs (MoSA)
- Ministry of Economy and Trade (MoET)

The SEA team held three meetings with the task force that aimed to discuss the progress, provide data and validate the findings of the SEA process, update and ensure consistency with relevant sectors' strategies, policies and plans.

2. SEA METHODOLOGY

2.1 SEA PROCESS

SEA is "a planning and management method for avoiding or, at minimum, reducing sources of pollution and depletion of natural resources by way of assessing environmental impacts of policy, program, plan, study, investment or organization proposals that tackle a Lebanese region or an activity sector, identifying necessary mitigation measures and enhancing positive outcomes on the environment and natural resources, prior to their acceptance or refusal" (Article 2 of Decree No. 8213/2012). It is important to note that while the definition of the SEA in the SEA Decree focuses on the impacts on the environment and natural resources, the impact assessment does also consider social and economic impacts (Refer to Annex 3 of Decree No. 8213/2012).

Therefore, the SEA as a planning instrument is used to help in the decision-making process and aims to bridge the gap between strategic initiatives and project-level Environmental Impact Assessment (EIA) by providing a systemic analytical approach which provides an opportunity to address impacts of actions at a strategic level and can identify and address issues of resource use, efficiency and sustainability, providing as such a step further towards a fully integrated planning approach promoting sustainable development.

The Update of SEA for Exploration and Production Activities Offshore Lebanon is undertaken in close coordination with the LPA, and particularly the QHSE unit, as well as key stakeholders. The coordination and alignment serves to ensure that:

- Environmental and socio-economic concerns, assets and constraints are properly accounted for in exploration and production activities for offshore petroleum resources in Lebanon;
- Effective measures are identified to mitigate environmental and socio-economic impacts and enhance positive impacts; and
- Proper management of environmental and socio-economic impacts is applied throughout the development and implementation of E&P Activities.

The SEA Study Update meets the requirements of Decree No. 8213/2012 that govern the SEA process in Lebanon. The decree defines the mandatory procedures to be followed for the assessment of potential environmental impacts of any policy, plan, program, study, investment or organization proposal that tackles an entire Lebanese region or an activity sector, in order to ensure that these activities are compliant with conditions related to health, public safety, protection of the environment and the sustainability of natural resources. Annex 3 of Decree No. 8213/2012 lists the necessary information/structure for the SEA study, which are as follows:

1. Executive Summary
2. Proposal (what is the plan/program subject to the SEA study and it characteristics)
3. Baseline data analysis

4. Alternatives
5. Assessment of Potential Impacts (direct, indirect, cumulative, transboundary)
6. Compatibility with the policy, legal and planning framework
7. Choosing the "best proposal formula"
8. Environmental management plan (mitigation and monitoring plans)
9. Amending the proposal formula in accordance with the outcomes associated with the SEA (Integration of results)
10. List of scientific references and reports
    - Technical annexes: Tables of data and detailed technical information; Minutes of meetings with stakeholders and any observations or correspondences in this regard; Report on screening and identifying the scope of the SEA.
    - Administrative annexes
        – A list of the observations submitted by concerned public and private agencies on the proposal
        – The resume of the personnel of the proposal working team and/or the consulting firm that prepared the SEA for the concerned administration.

Figure 2-1 illustrates the SEA process.

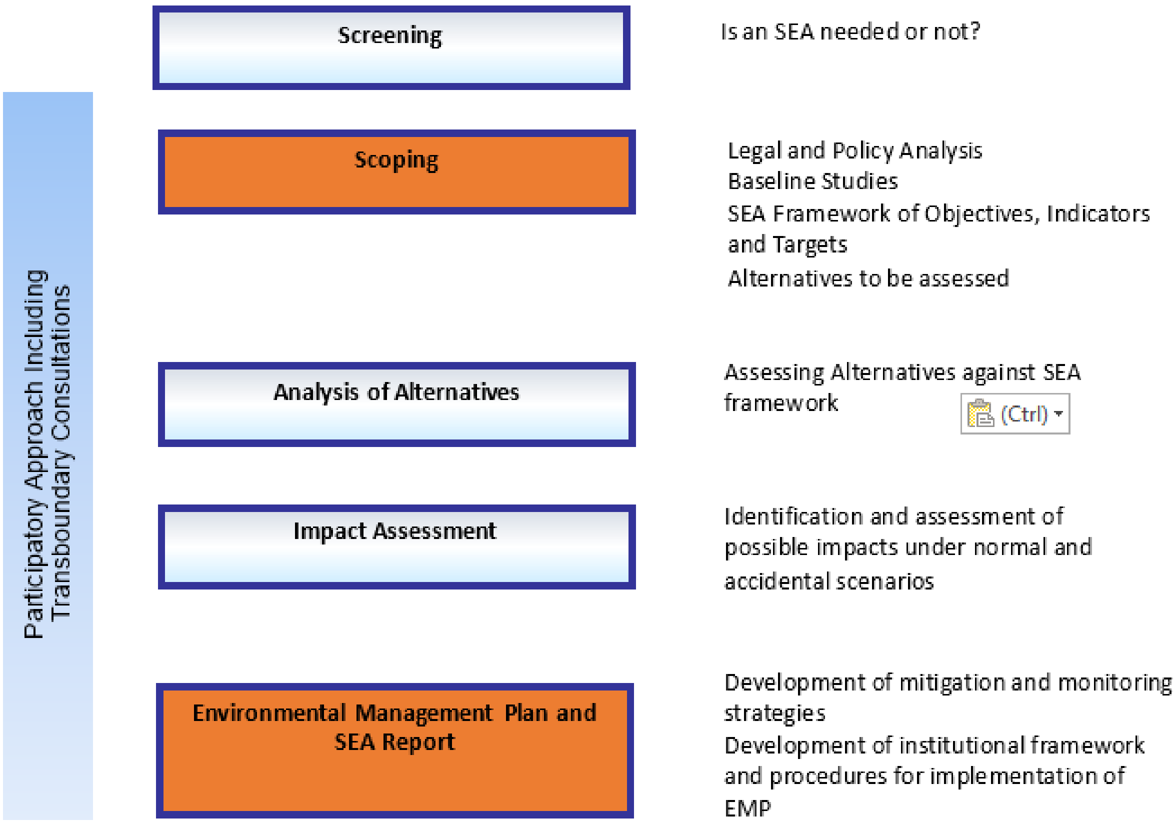


Figure 2-1 SEA Process

2.2 STAKEHOLDER ENGAGEMENT AND PUBLIC CONSULTATION METHODOLOGY

A Stakeholder Engagement Plan (SHEP) has been prepared to secure engagement and participation of relevant stakeholders throughout the process. The main objectives of the Stakeholder Engagement Plan are to:

- Identify and prioritize stakeholders engagement according to their interest and influence in environmental management of the sector;
- Describe the strategy and program for engaging with stakeholders;
- Plan and implement a process that improves communication between the project proponent and the different stakeholders providing opportunities for stakeholders to express their views and concerns, and for the Proponent to respond to them;
- Describe any applicable legal or institutional requirements for consultation and disclosure;
- Provide a strategy and timetable for sharing information and consulting with each of the identified stakeholder groups; and
- Identify the resources required and the responsibilities for implementing stakeholder engagement and consultation activities.

Consultations (e.g. meetings, workshops, etc.) are conducted in accordance with the Stakeholder Engagement and Consultation Plan (Volume 4).

2.3 BASELINE STUDIES METHODOLOGY

Understanding the current state of the environment is necessary to predict the likely future changes resulting from the implementation of the Plan, and to propose the adequate monitoring plans. Baseline conditions also help in the development of the SEA framework, especially in terms of objectives and indicators.

Baseline data related to the environmental, social and economic components with which the E&P activities are expected to interact are collected through the following means:

- All 8 volumes of the SEA for Petroleum Activities in Lebanese Waters (RPS Energy Ltd, 2011/2012);
- Comprehensive literature review of existing documentations, publications and studies;
- Data received from the public agencies and other relevant stakeholders;
- Additional inputs and information received during the Key Issues Identification phase and SEA consultations.

2.4 LEGAL AND POLICY ANALYSIS

Assessment of the implications and compatibility of E&P activities with the legal and policy framework is of particular importance for the SEA Study Update. As such the SEA consultant has reviewed the relevant legislation, standards and international treaties and agreements as well as other strategies, policies and plans of the Government of Lebanon (GoL) to evaluate and assess their implications on the exploration and production (E&P) program for offshore petroleum resources in Lebanon.

2.5 ASSESSMENT APPROACH AND METHODOLOGY

Due to specific characteristics of E&P Activities, which has to take into account many uncontrollable variables (e.g. quantity and type of discovered hydrocarbons, prices in the production phase and subsequent hydrocarbon use alternatives, preferred technologies, etc.), the overall assessment methodology is based on an integrated approach that considers impacts during different phases of the sector (Exploration, Development and Production and Decommissioning) for different scenarios taking into account possible alternatives. The SEA Framework guides the assessment as the evaluation process is based on the potential contribution of each source of impact in meeting the SEA objectives set in the SEA framework.

2.5.1 The SEA framework

Based on the outcomes of the analysis of the legal and policy framework, baseline conditions and stakeholders consultations, the SEA framework of objectives and indicators is developed for sustainability factors relevant to the Plan.

The assessment of impacts of E&P activities for different scenarios and the analysis of alternative (environmental component of the analysis) are compared against the chosen indicators, answering the question: "What contribution will E&P activities make toward maintaining the sustainability factors and meeting the SEA Framework Objectives?"

Most of the used SEA Framework **Objectives** are adapted from the regulatory context including legislations, strategies and plans. Among them are the SDGs released by UN in 2015 and endorsed by Lebanon in 2017. They are part of a plan of action to stimulate all nations to "heal and secure our planet" and "shift the world on to a sustainable and resilient path". 17 goals supported by 169 targets were established in SDGs to be attained by 2030.

Indicators used in the SEA Framework were chosen based on the following criteria:

1- Relevance to the E&P activities and the sustainability factors being discussed

2- Availability of indicator's data

3- Possibility to obtain indicator's data in the future

In order to put the different indicators into context, the Consultant used the DPSIR (driving force –pressure– state – impact – response) framework (refer to Figure 2-2), developed by the EEA (*Smeets and Weterings, 1999*). This causal framework is a widely used tool to describe interactions between society and the environment, such as the environmental impact of human activities, in order to assess appropriate political measures and behaviors. Table 2-1 explains what is meant by the main terms of the framework.

Table 2-1 Main Terms of the DPSIR Framework

Term	Explanation
Driving force	Refers to the driving forces of changes caused by human activities; they put pressure on systems indirectly and can be of demographic, economic, social, political, scientific, technological, or spiritual nature (e.g. the demand for energy, economic growth, the demand for food and housing, population growth).
Pressure	Refers to pressures and stress points that impact systems and manifest themselves as changed environmental conditions (e.g. greenhouse gas emissions, contaminated sites, noise)
State	Refers to the quantitative and qualitative condition of a system (e.g. sea water quality, average global temperature, number of species in a marine ecosystem).
Impact	Refers to the specific effect of a pressure on ecosystems' functioning and thus also on humans and their quality of life (e.g. health problems, species extinction, eutrophication).
Response	Refers to political and societal reactions (e.g. taxes, laws, migration) that reduce the driving

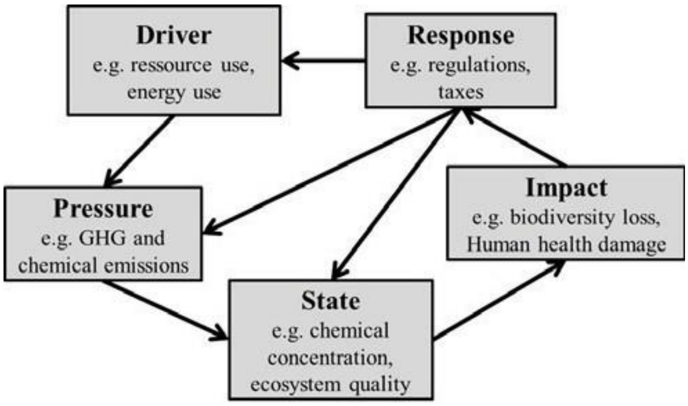


Figure 2-2 The DPSIR Framework, Adapted from EEA

Indicators selected for each SEA objective were chosen to comprise, to the extent possible, at least one (1) State Indicator and one (1) Impact Indicator in addition to other DPSIR framework indicators' types as applicable. State Indicators are used in the SEA monitoring framework to monitor changes in the state of the environment while Impact Indicators are used for the assessment.

The SEA framework was validated during the first consultation workshop with the purpose of strengthening its relevance and credibility, and contributing toward ownership of the results. Stakeholders from the government, local authorities, international organizations, research and academic institutions, civil society and the private sector were divided into six (6) working groups pertaining to six (6) key thematic aspects based on their area of expertise and/or interest, they were asked to validate the selection of sustainability factors, the SEA objectives and the proposed indicators. Stakeholders were asked to rank indicators based on relevance, availability of data and the potential to have data on the indicators in the future. Stakeholders were also asked to suggest new indicators where needed. The outcomes of the first consultation workshop were used to update the SEA framework.

2.5.2 Impact Identification

For each environmental and socio-economic issue of concern, the sources of potential impacts in each phase of E&P activities were identified using impact identification matrices.

2.5.3 Assessment of Impacts

Impacts are assessed for the sources of impacts/activities identified in the impact identification matrices against impact indicators from the SEA framework. Different scenarios and alternatives are considered in the assessment as applicable.

Impacts are assessed during all phases of E&P activities including:

- Reconnaissance Activities
- Exploration and Appraisal Phases
- Development and Production Phases
- Decommissioning phase

The significance level of the impact is assessed on the basis of:

- The severity/consequence of an impact
- The likelihood of occurrence

2.5.3.1 Consequence/Severity of Environmental Impacts

The environmental impacts have their consequence/severity determined, on a one to five tiered scale, using Impact Consequence Criteria. There are a number of considerations that are built into the Impact Consequence Criteria including the impact characteristics: Direction, Magnitude, Geographic Extent, Frequency, Duration and Reversibility, described in Table 2-2. Each criterion is subdivided into sub-criteria which are in turn assigned a score.

The consequence rating criteria is presented in Table 2-3. It shall be noted that these tables were compiled based on expert opinion and as consulted by stakeholders, and are considered sufficient and effective for the purpose of the SEA.

Table 2-2 Criteria for the Characterization of Impacts

Criteria	Options	Score
Direction	N Negative	**-**
	B Beneficial	**+**
Magnitude	L Low: the amount of change in a measurable parameter/ impact indicator relative to existing (baseline) conditions and/or to an applicable standard is small	**1**
	M Moderate: the amount of change in a measurable parameter/ impact indicator relative to existing (baseline) conditions and/or to an applicable standard is moderate	**2**
	H High: the amount of change in a measurable parameter/ impact indicator relative to existing (baseline) conditions and/or to an applicable standard is high	**3**
	VH Very High: the amount of change in a measurable parameter/ impact indicator relative to existing (baseline) conditions and/or to an applicable standard is very high	**4**
Geographic Extent	L Localized: Within the development area	**1**
	N National: Within the EEZ, territorial waters/coastal region or of national importance	**2**
	T Transboundary: affecting neighboring countries	**3**
	G: Global: of global significance	**4**
Frequency	LF low frequency effect: occurs once every six months or less	**1**
	MF Medium frequency effect: occurs once a month	**2**
	HF High frequency effect, occurs weekly	**3**
	C Continuous effect.	**4**
Duration	ST Short-term effect: Measurable effect over a period of weeks	**1**
	MT Medium-term effect: Measurable effect over a period of up to 1 year	**2**
	LT Long-term effect: Measurable effect over a period between 1 and 5 years	**3**
	VLT Very long-term effect: Measurable effect over a period of more than 5 years	**4**
Reversibility	R Reversible	**1**
	I Irreversible	**4**

Table 2-3 Consequence Rating Criteria

Consequence Rating	Score
B. Beneficial	Changes that result in a net positive effect to an ecosystem, environment or population
5. Critical	>17
4. Major	14-16
3. Moderate	11-13
2. Minor	8-10
1. Negligible	5-7

2.5.3.1 *Likelihood*

The criteria for likelihood ranking are shown in Table 2-4.

Table 2-4 Likelihood Evaluation Criteria

Likelihood of Occurrence	Category	Score
Effect is highly likely or certain to occur under normal conditions	Almost Certain	A
Effect is likely to occur	Likely	L
Effect may possibly occur under normal conditions	Possible	P
Effect is unlikely to occur under normal conditions but may occur in exceptional circumstances; Incident could occur in the worldwide oil and gas industry	Unlikely	U
Incident not expected to occur in the worldwide oil and gas industry	Remote	R

2.5.3.2 *Evaluating the Significance of Impact*

The significance rating, as shown in Table 2-5, is obtained by cross-tabulating the consequence rating associated with each impact and its likelihood of occurrence. It shall be noted that this table was compiled based on expert opinion and as consulted by stakeholders, and is considered sufficient and effective for the purpose of the SEA.

The significance of impacts is first determined considering existing control measures and then after additional mitigation measures are in place. The SEA process aims at ensuring that no significant residual impacts remain after implementation of mitigation measures.

Table 2-5 Significance Rating and Acceptability

		Consequence Rating					
		Negligible 1	Minor 2	Moderate 3	Major 4	Critical 5	Beneficial B
Likelihood of Occurrence	Almost Certain A	1A	2A	3A	4A	5A	BA
	Likely (L)	1L	2L	3L	4L	5L	BL
	Possible (P)	1P	2P	3P	4P	5P	BP
	Unlikely (U)	1U	2U	3U	4U	5U	BU
	Remote ®	1R	2R	3R	4R	5R	BR

LEGEND

Consequence Rating	Likelihood	Significance Rating and Acceptability
1- Negligible	A- Almost Certain	Beneficial
2- Minor	L- Likely	Low- Acceptable
3- Moderate	P- Possible	Medium- Acceptable (with EMS in place)[2]
4- Major	U- Unlikely	High- Unacceptable
5- Critical	R- Remote	
B- Beneficial		

[2] Acceptable when the existing control measures and the proposed mitigation measures are implemented.

2.5.4 Mitigation and Monitoring

Mitigation refers to the "elimination, reduction or control of the adverse effects of the policy, plan or program, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means". Priority is given to impact prevention, followed by minimization and then compensation.

For each significant impact, the mitigation measures set by local legislation and international conventions or "Existing Control Measures" are listed. Additional mitigation measures are proposed when needed. Practical and implementable mitigation measures are proposed to the extent possible.

A monitoring framework is proposed comprising pressure, state and response indicators.

Pressure Indicators are used for activity level monitoring, State Indicators are used to monitor changes in the state of the environment and Response Indicators are used to monitor the implementation of the mitigation measures.

2.5.5 Assessment of Scenarios

The extent and types of Exploration and Production (E&P) activities are highly dependent on the size of commercial discoveries (if any), types and quality of hydrocarbons found (e.g. gas and/or liquids), market demand for these hydrocarbons, and their market price (among other factors). Accordingly, Section 3.4 describes various E&P scenarios for the sector. Scenarios evaluation is based on the results of the impact assessment process conducted considering different scenarios, where the SEA team identified all significant impacts linked to individual scenarios and provided recommendations and guidance on a strategic level to mitigate these impacts.

2.5.6 Assessment of Alternatives Methodology

Alternatives are assessed and compared based on their potential technical, environmental and social impacts, costs and institutional feasibility, wherever data is available.

The "environmental and social impacts" component of the analysis of alternatives are obtained by assessment of alternatives against relevant impact indicators in the SEA framework (pertaining to the sustainability factors expected to be affected by each alternative).

Indicators receive a score ranging from -3 to +3 depending on the extent to which the alternative favors (positive score) or disfavors (negative score) reaching the indicator target set in the SEA framework. The analysis of alternatives considers all scenarios relevant to the alternatives in question. The SEA team then provides recommendations on the preferred alternatives ("SEA preferred alternative").

2.6 GAPS AND UNCERTAINTIES

Several data gaps and uncertainties were encountered during the preparation of the SEA, they mainly included:

- The general description available for future petroleum activities and development scenarios and the lack of details related to the technologies to be used. This resulted in the assessment of impacts considering different technologies and development scenarios.
- Gaps in baseline data. Although a relatively large amount of studies exists, there is still a significant amount of baseline information that need to be established in Lebanon. Such gaps are highlighted in Volume 2. The most important gaps are:
    - Lack of information regarding biological environment of the deep sea areas;
    - The absence of water and sediments monitoring in deep sea areas;
    - Large data gaps associated with the understanding of areas and timing of critical lifecycle stages of various species; and
    - Absence of underwater noise monitoring.

In light of these data gaps and uncertainties, a precautionary approach have been adopted for the assessment of impacts significance and in proposing mitigation measures.

3. DESCRIPTION OF OFFSHORE E&P ACTIVITIES AND SCENARIOS

3.1 GEOGRAPHIC LOCATION OF THE PROGRAM

Decree No. 42 dated 19 January 2017 delineates the division of Lebanese maritime waters into blocks. Decree No. 6433/2011 defines the Lebanese maritime waters as comprising regional waters and the Exclusive Economic Zone (22,700 km^2).

The maritime waters are divided into ten blocks, which will be open for bidding in a gradual manner throughout the licensing rounds that the Lebanese State will put in place.

Additionally, the decree accounts for a buffer zone where petroleum activities are not allowed unless the Council of Ministers issues a decree to permit otherwise. The buffer zone extends along the borders of the Lebanese coast for a distance of 3 nautical miles of the territorial waters.

Ten (10) Blocks have been defined within the Lebanon EEZ. The blocks' numbers, locations and main information are presented in Table 3-1 and Figure 3-1.

Table 3-1 Offshore Blocks Overview

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

While most activities are likely to be undertaken offshore, various activities will also be implemented onshore, largely to support the offshore activities. These include onshore support facilities most likely within existing ports mostly for storage of materials and equipment, pre-fabrication works, and inbound and outbound shipping of such materials, equipment and personnel from and to offshore facilities. During production, processing facilities might also be located onshore, depending on final choices made in the Development and Production plans.

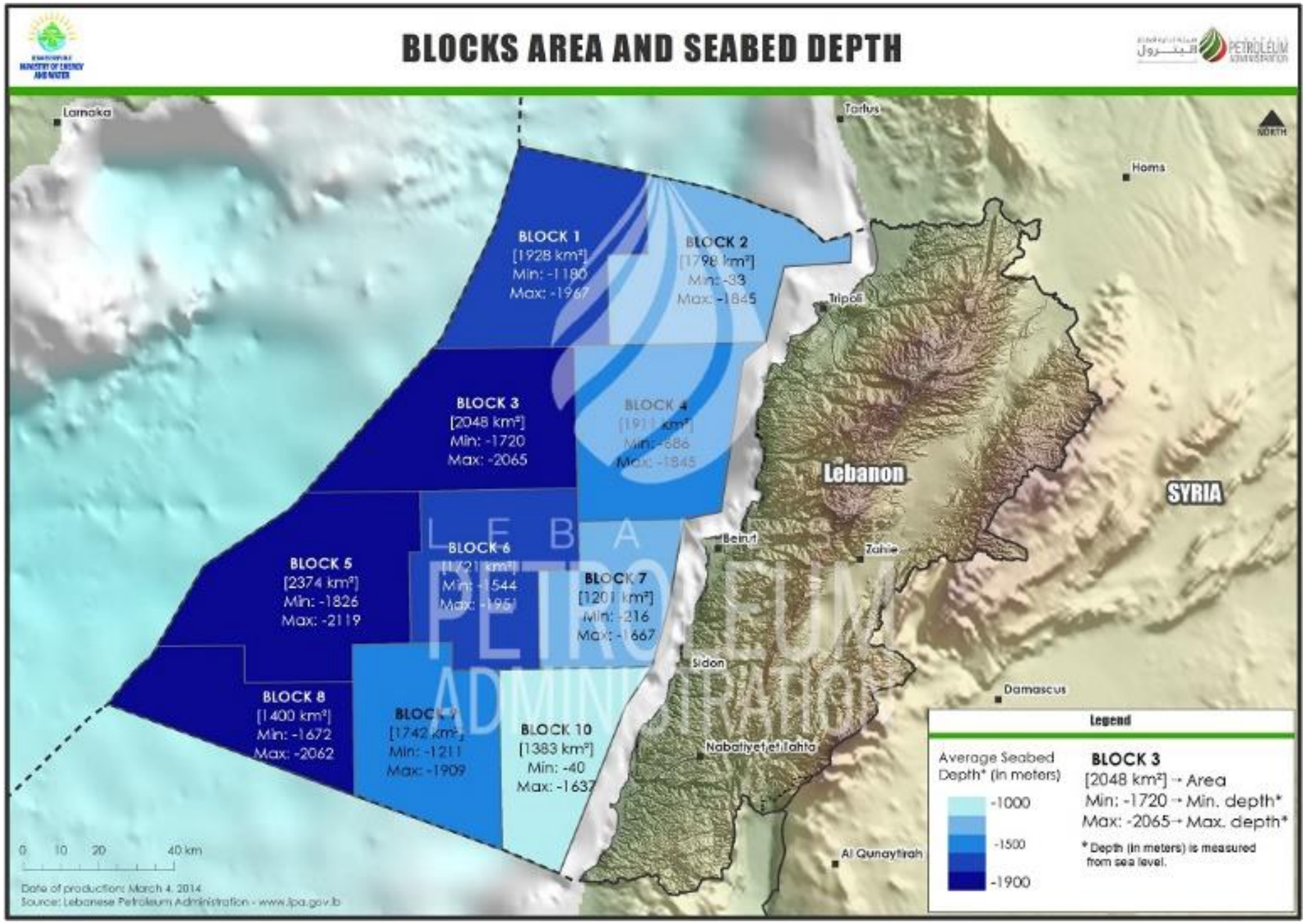


Figure 3-1 Offshore Blocks, Areas and Seabed Depth

(Source: https://www.lpa.gov.lb/mapsgallery.php)

3.2 LICENSING OVERVIEW

Lebanon has successfully completed its first offshore licensing round that resulted in the award of two licenses in blocks 4 and 9 in 2018. This was preluded by a pre-qualification process that thoroughly assessed the eligibility of the applicants against a set of legal, financial, technical and QHSE criteria. As a result, a total of 51 oil and gas companies were eligible to participate in the bid round - 13 as operators and 38 as non-operators.

Based on the recommendation of the Lebanese Petroleum Administration (LPA), 5 out of 10 blocks (Blocks 1, 4, 8, 9 and 10) were open for bidding during the first licensing round that were in line with the objectives that the Lebanese government targeted to achieve during that round: Hitting commercial discoveries that justify the required investments in infrastructure that will lead to the development of petroleum resources and; Safeguarding the rights of Lebanon to benefit from its potential petroleum resources over its complete exclusive economic zone. Accordingly, blocks 1, 4, 8, 9 & 10 were open for bidding in the first licensing round (Figure 3-2).

Blocks 4 and 9 received one offer each from a consortium of 3 companies: Total, Eni and Novatek which were awarded the Blocks. Exploration and Production agreements were signed between the State and the Consortium of TOTAL, ENI and Novatek at the end of January 2018.

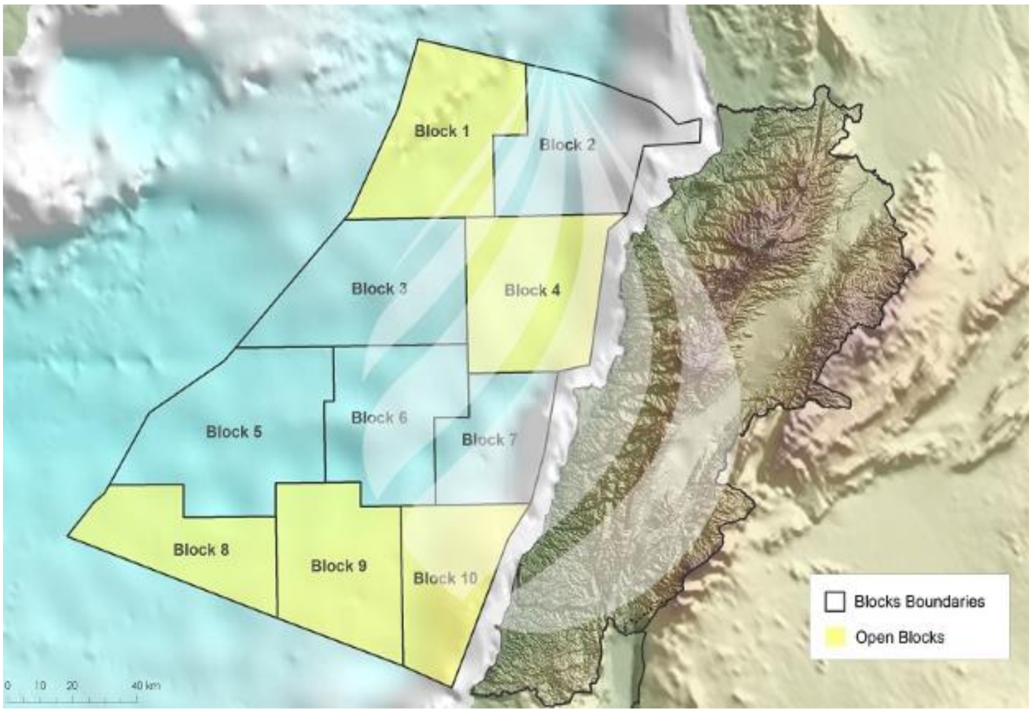


Figure 3-2 Offered Blocks Offshore Lebanon during the First Licensing Round

On the 17th of May 2018, the Council of Ministers (CoM) approved the recommendation of the Minister of Energy and Water and LPA to undertake the preparations for a second offshore licensing round s that was launched on the 5th of April 2019.

The objectives of the 2nd licensing round focus on:

- Accelerating exploration activities in the Lebanese waters, and
- Increasing the attractiveness of the Lebanese waters and promoting competition

3.3 HYDROCARBON EXPLORATION AND PRODUCTION ACTIVITIES OFFSHORE LEBANON

Typical Exploration and Production activities include the following:

- **Reconnaissance activities**: pre-drilling seismic surveys and geological and geophysical investigations to identify drilling targets; such activities can last a few weeks up to 1 months per survey
- **Exploration activities:** drilling of exploration and appraisal / testing wells to confirm the presence of hydrocarbons (in this case named a discovery), and if confirmed, evaluate the size and commerciality of the discovery; drilling of an exploratory well could last a few months (approximately from 2 to 4 months)
- **Development and Production activities:** if a commercial discovery is made, these activities include drilling of production and injection wells and establishment of the necessary infrastructure (such as pipelines and processing facilities) to convey the discovered hydrocarbons to their intended markets along with other required infrastructure (including waste management and utilities) to support the production phase; the development phase typically lasts between 2 years (in mature fields) up to about 5 years in new areas where infrastructure is not available; the production phase is then the longest phase in the lifetime of a discovery (up to 30 years)
- **Decommissioning:** once the quantities of hydrocarbons in place in a reservoir are no longer commercially exploitable, the production facilities are decommissioned including well/platform abandonment and site restoration, as needed..

As the Lebanese government signed Exploration and Production Agreements for Petroleum Activities in Blocks 4 and 9, the agreements provide the companies with the exclusive right to explore for, develop and produce from potential oil and gas reservoirs offshore in Lebanon's Waters as defined by Law No. 163 of 2011. However, specific activities to be conducted in each phase and proposed methods and techniques for conducting them will be provided by the Operators at key stages in line with requirements specified in the Offshore Petroleum Resources Law (Law No. 132/2010), the Petroleum Activities Regulations Decree (PAR Decree No. 10289/2013), Decree No. 43/2017 and the signed Exploration and Production Agreements (EPAs). Petroleum regulations define the documentation and reporting requirements as well as the approvals required whether by the Council of Ministers, the Minister of Energy and Water or the Lebanese Petroleum Administration.

This section provides a description of typical activities, applicable to the Lebanese context, associated with the different phases of Exploration, Development, Production and Decommissioning that will constitute the basis of the assessment in the SEA Study. Subsequent Environmental Impact Assessment (EIA) studies shall be conducted based on activities proposed by the awarded companies and in line with the requirements of the Lebanese legislative framework.

3.3.1 Reconnaissance Activities

Reconnaissance refers to the study of a certain area's geological structures such as faults, folds and anticlines as well as its geophysical and geochemical characteristics in order to determine possible drilling opportunities for the exploration phase. The main aim of this phase is to identify potential prospects before initiating the actual exploration activities using primary technologies such as seismic surveys and other geophysical methods. These investigations are typically carried out before or during the licensing round so that companies interested in exploring and producing hydrocarbons are capable of licensing the data, interpreting it, and studying the associated risks of exploration in relation to the geological properties.

Reconnaissance (Prospecting) activities conducted offshore Lebanon include:

- Geco-Prakla 2D Seismic Survey conducted in 1993 covering 508 km off-Tripoli.
- Spectrum 2D Seismic Surveys: the Spectrum Lebanese Multi-Client seismic datasets includes 2,486.5 km and 1,996.1 km acquired in 2000 and 2002, respectively.
- PGS 2D&3D Seismic Surveys: The Petroleum Geo-Services (PGS) Lebanese Multi-Client seismic data sets include 8637.6 km of 2D seismic data as well as 7,427 km^2 of 3D seismic survey acquired between 2006 and 2012. These surveys provide vital structural insights of the basin and include a detailed grid over Lebanese acreage.
- PGS and Spectrum Offshore 3D Survey in 2013: In 2013 PGS and Spectrum acquired an additional 2,466.6 km^2 and 5,330.2 km^2 of 3D seismic data offshore Lebanon respectively resulting in the coverage of 3D seismic datasets over more than 80% of the 10 blocks area.
- Airborne Geophysical Survey were undertaken by Neos Geosolutions in order to assess the hydrocarbon prospectivity onshore and along the margin area. The survey covered approximately 6000 km^2, of which 2000 km^2 covered the coast of Lebanon and 4000 km^2 onshore. The airborne acquisition surveys provided the ability to

understand the onshore geology with relation to the offshore. This was attained by incorporating geophysical data in the interpretation and integration of the transition zone along the coast of Lebanon providing vital insight into understanding the geology of Lebanon.

The interpretation of these surveys revealed various structural and stratigraphic traps which are considered good candidates for exploration.

Basin Modeling and petroleum system analysis coupled with interpreted geophysical data provided an insight into the maturity of the existing hydrocarbons, the migration pathways, trapping mechanisms and the types of source rocks, demonstrating the prospectivity of offshore Lebanon. Figure 3-3 presents the existing seismic data) for offshore Lebanon as well as the airborne geophysical acquisition onshore Lebanon.

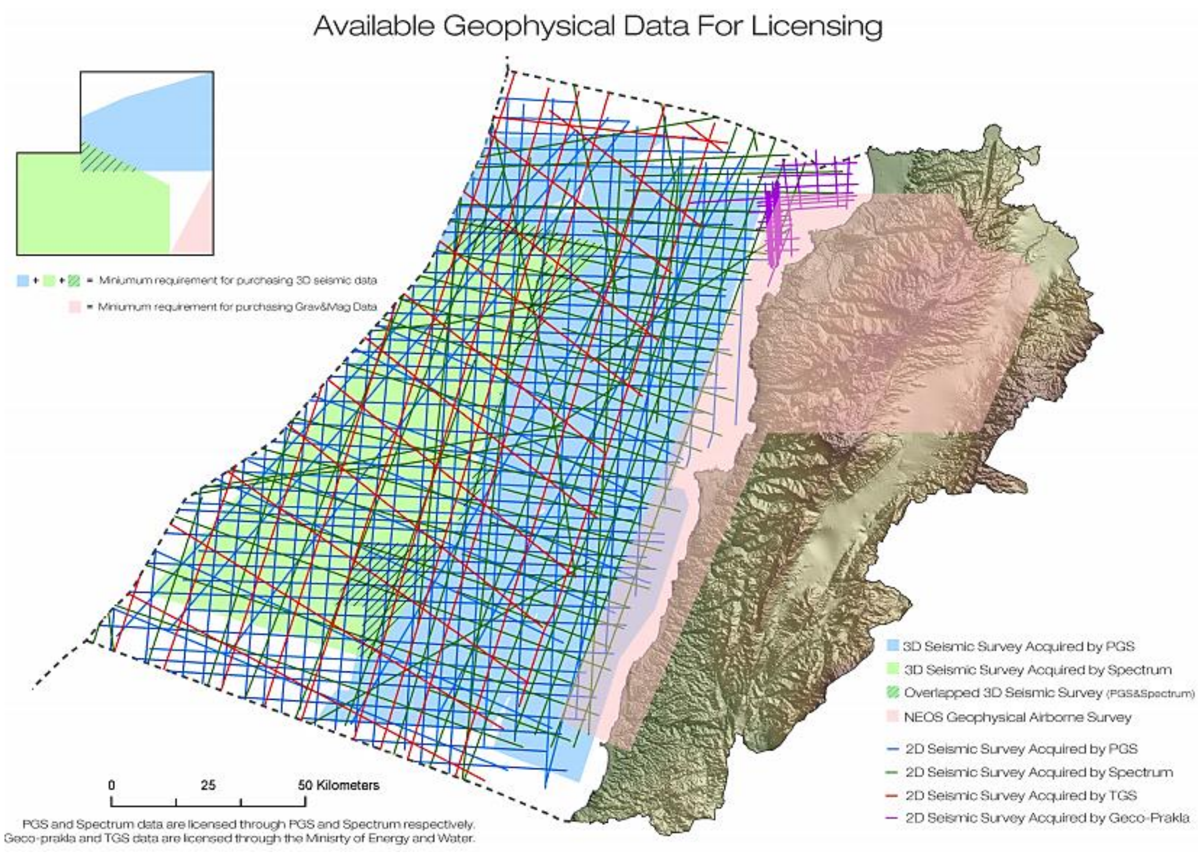


Figure 3-3 Existing Seismic Data

Seismic surveys adopt seismic pulses (sound waves) generated by a combination of air guns, water guns and other acoustic sources that are towed behind a slow-moving survey vessel. The sound waves propagate through the seabed into the subsurface. They reflect off the sea bottom and the geological layers and return back toward the water surface where they are received by an array of hydrophones also known as streamers attached to lines towed behind the ship. A typical vessel possesses around 4 and 20 streamers that are between 3 to 6 Km in length and are towed at a spacing of up to 120 m from one another (Figure 3-4). The seismic readings gathered by the hydrophones are collected into an analog signal and then converted to a digital signal using supercomputers that will translate the information into images of the subsurface environment. The seismic image will then be interpreted by geophysicists and geologists and then combined with other geologic studies to determine the probability of finding hydrocarbons.

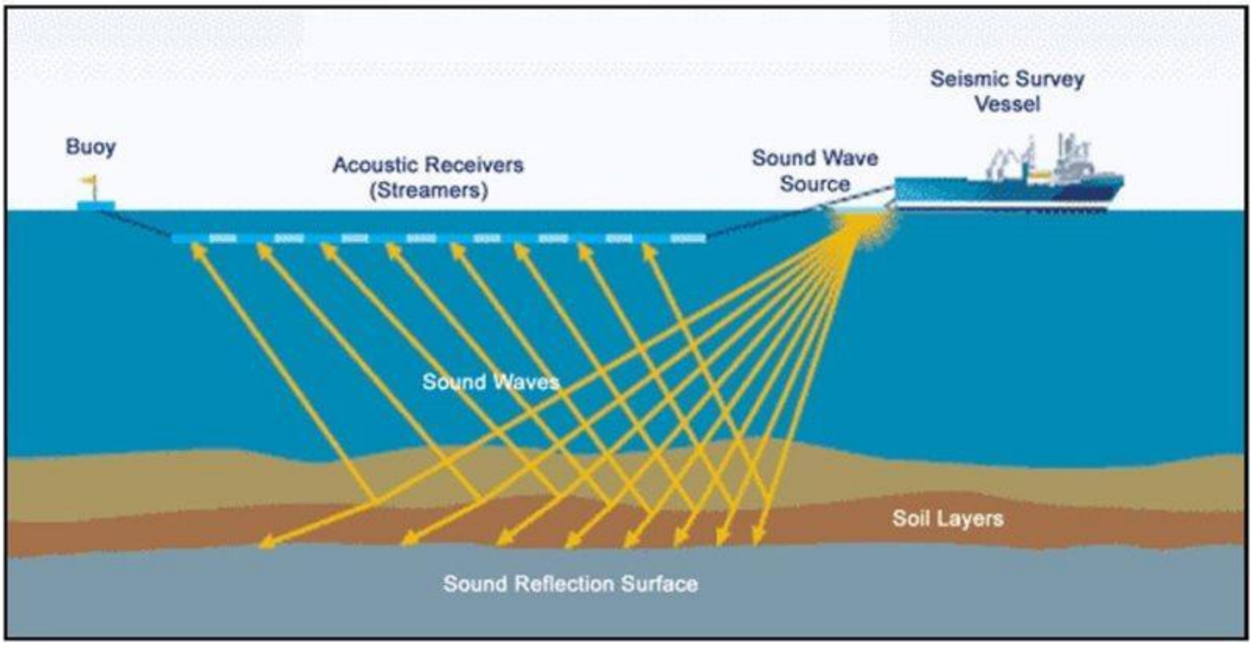


Figure 3-4 Illustration of the Principles of Offshore Seismic Acquisition Surveys

In addition to the acquired data from previous studies, further geophysical investigations using advanced and well-developed technologies yielding high resolution images might be needed to identify potential deeper reservoirs and successfully study offshore faulting and other geologic hazards. Before deciding on the final drilling location, Operators may also carry out additional geological, geophysical and environmental site investigations to better map the prospects and anticipate potential drilling hazards. Such investigations could include:

- **Bathymetric Survey,** to produce a high resolution digital terrain model of the seabed and to determine the underwater depth of the seafloor.
- **Side Scan Sonar,** to determine seabed features across the area of interest and to conduct surveys for marine archaeology by creating an image of large areas of the sea floor. The survey can also assist in investigating debris items and obstructions that may affect future sea floor installations.

- **Sub-bottom Profiling,** to identify and characterize layers of sediment or rock under the seafloor, measure the thickness of dredged material deposits and locate objects buried beneath the seafloor.
- **Magnetometer survey**, to investigate ferrous objects lying on, or buried immediately beneath the seafloor, or to attempt to the position of cables, pipelines or abandoned wells that cannot be identified by acoustic means. A Gradiometer can be used for measuring the magnetic gradient between two or more closely spaced magnetometers for more precise results and surveys close to large structures such as platforms.
- **3D multi-channel high resolution seismic**, designed on a site-specific basis where initial review or offset drilling experience indicates that the shallow section, or the perceived conditions are particularly complex.
- **Seabed sampling**, to ground truth seabed and shallow soil provinces that are defined during site survey, or that have been pre-defined during the desk study. For an anchored rig it may be necessary to acquire shallow seabed soil evaluation data using a suite of tools appropriate to the soil conditions (grab, box corer, piston corer, gravity corer, vibro-corer or CPT). Samples retrieved should be comprehensively logged and may need to be sent ashore for analysis. If sampling is aimed at defining suspected sensitive environments, care should be taken to acquire a control sample away from the suspect target area.
- **Seabed photographs**, to ground truth acoustic data and allow investigation of discrete areas of concern that are identified during a survey.
- **Remote Sensing Radar techniques,** to find indictors of seafloor anomalies without physical contact indicating possible hydrocarbon traps and reservoirs, to detect hydrocarbon leaks and monitor the existing facilities.
- **Electromagnetic (EM) Surveys,** to further de-risk prospects identified through seismic surveys and to identify possible shallow geo-hazards such as gas hydrates and gas pockets.

Many factors can affect the aerial extent of investigations such as the type and quality of existing data, water depth, expected subsurface lithology, and type of rig to be used.

3.3.2 Exploration & Appraisal Phase

Depending on the need to further de-risk the identified prospects or for purpose of site preparation, the exploration phase may include in addition to drilling exploratory wells, some of the surveys listed within the reconnaissance activities subsection above.

Once the drilling locations have been identified, exploratory wells are drilled within the boundaries of the awarded block in order to physically confirm the presence of hydrocarbon resources within a targeted geological structure and assess their commerciality.

This requires the use of exploration drilling rigs, usually referred to as Mobile Offshore Drilling Units (MODUs). Rig selection criteria depends on several aspects, namely:

- Operational (water depth, met-ocean, BHP and BHT of formation, etc.)
- Technical (Variable deck load (CDL), derrick capacity, equipment specifications, fluid and bulk capacity, etc.)
- Logistics (well location relative to the nearest supply base)
- Contractual (Availability, commercial rates, operating history, etc.)

Different rig types can be deployed in offshore exploration and production activities ranging from bottom founded and platform-based rigs, to anchored and dynamically positioned rigs (Figure 3-5).

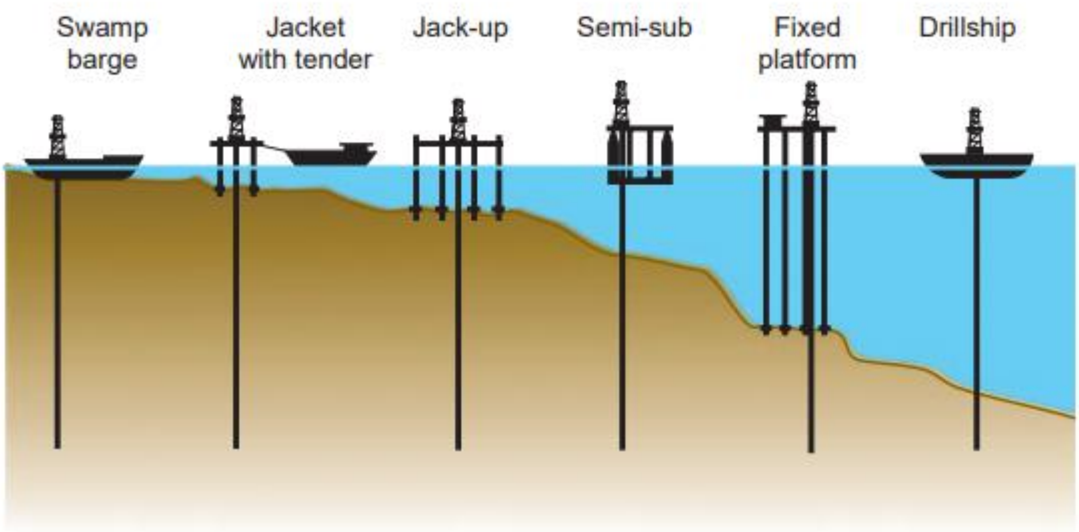


Figure 3-5 Offshore Drilling Units (Jahn et. al., 2008)

Swamp barges: These are used in shallow swamp areas (less than 6 m). They can be towed to the location of interest then ballasted such that they rest on the seabed.

Drilling jackets: These are used in shallow and calm waters. A number of wells can be drilled from the same jacket. A jack-up rig can be cantilevered over the jacket if found to be too small and the operation would be carried from it. This type was found to be cost-effective especially when adopting a progressive/phased approach in the upcoming development. Their use was very common in coastal areas, such in South China Sea and in the North Sea (Jahn et. al., 2008).

Jack-up rigs: These are the mostly used globally. They can operate in areas with water depth ranging between 4.5 m up to 150 m depending on operating conditions. They can be either towed to the drilling location (alongside a jacket) or are equipped with a thrust system. The overall structure integrates all drilling and supporting equipment. The three or four legs of the rig are lowered onto the seabed the rig will lift itself to a determined operating height above the sea level (Jahn et. al., 2008).

Semi-submersibles: These are used in water depths exceeding the range within the capacity of a jack-up. They consist of a large deck area built on columns of steel. Attached to these heavy-duty columns are at least two barge-shaped hulls called pontoons which are partially filled with water before start of operations ensuring stability by being submersed for about 50 ft. in water. Semi-submersibles can be moved around and relocated using tugboats and/or propulsion systems. During operation they maintain their position using a combination of several anchors and dynamic positioning (DP) equipment. Some heavy-duty types can handle high reservoir pressures (up to 15,000 psi) and can operate in water depths down to 3000 m.

Drill ships: These are used for deep and very deep waters (up to 3000 m). Modern high-specification drill ships can remain stable, and on target during 100 knot winds using powerful thrusters controlled by a DP system (Jahn et. al., 2008). The thrusters counter the forces of currents, wind and waves keeping vessel exactly on target, averaging less than 2 m off its mark, without an anchor.

Since the water depth in some of the blocks offshore Lebanon reaches 2,000 m, semi-submersibles and drill ships (anchored and dynamically positioned rigs) are deemed the better option for exploration drilling. They also provide:

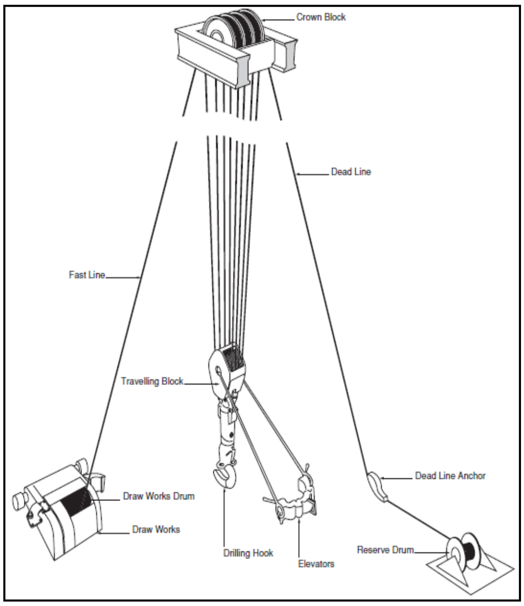
- High Variable Deck load, this will minimize the resupply, in addition, the vessel can carry significant amount of materials on board during mobilization;
- Large personnel capacity; and
- Self-propelled boat, therefore much faster to mobilization and demobilization

3.3.2.1 Drilling Rig Description

Regardless on which structure, platform, barge or ship it is installed, the rig consists of a minimum set of systems required for performing the drilling activities, these are the power system, hoisting system, circulating system, rotary system and well control system. These are further elaborated below.

Power System: this consists mainly of generators that supply power to all electrical motors including drawworks, rotary table and the mud pumps.

Hoisting System: this is a large pulley system used to lower and raise the drill string and casing in and out of the well. It is composed of drawworks, drilling line, crown block, traveling block, hook and elevators (Figure 3-6). The whole hoisting system is encompassed within a derrick, which is a vertical steel structure allowing vertical clearance and providing strength for raising and lowering the drill string (Figure 3-7)



(source: IADC)

Figure 3-6 Hoisting System

Figure 3-7 The Derrick (source: IADC)

The drawworks' function is to convert the power source into a hoisting operation and allow braking capacity to stop and sustain the weight of the drill string.

The drilling line is a multi-thread, twisted wire rope that is spooled through the traveling block and crown block to facilitate the lowering and lifting of the drill string into and out of the well. The crown block series of sheaves fixed at the top of the derrick used to change the direction of pull from the drawworks to the traveling block which is rigged with the crown block by multiple drilling lines strung between them. The hook is a J-shaped equipment with high capacity to hang other items such as the swivel, kelly, elevator bails and top drive units. The elevator is a latching tool for lowering the pipe joints or collars and is connoted to the traveling block through bailers.

Circulating System: consists of a range of equipment through which the drilling fluid is circulated. The drilling fluids' main functions are to exert a hydrostatic pressure within the well countering the pore pressure of the formation, cool and clean the drilling bit as well as lift the drill cuttings. The circulating system is comprised of mud pits/tanks, mud pumps, standpipe, kelly Hose, drilling string/annulus, bell nipple/flow line as well as solid removal equipment (Figure 3-8).

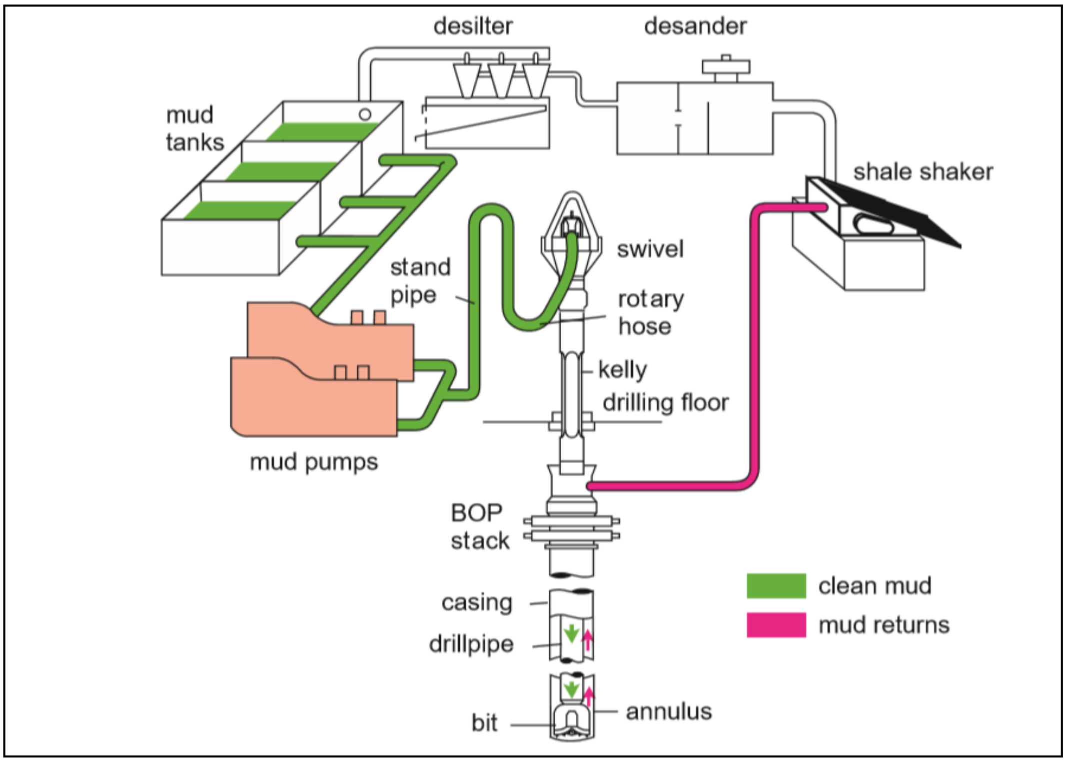


Figure 3-8 Circulation System (Jahn et. al., 2008).

Mud pits/tanks are large tanks that hold the drilling fluid on the rig, most are made of steel, rectangular in shape and hold about 200 barrels each. The mud pumps are of high-pressure and high-volume and are used for circulating the drilling fluid down through the drill pipe, out from the drill bit nozzles and up through the annular space. The standpipe is a rigid metal rod that serves as conduit for the high pressure pathway up to the derrick level where it is connected to a kelly/rotary hose which is a high-pressure flexible line permits the raise and lowering of the drill string. The Bell Nipple is a pipe located at the top of a casing string and serves as a funnel guiding the drilling tools into the top of a well. It is installed with side outlet to permit drilling fluids to flow back to the surface mud treating equipment through another inclined pipe called a flow line (mud return line). The solid removal (mud treatment) equipment consists of a shale shaker, a desander and a desilter. The shale shaker removes the cuttings for disposal and is also the place where a sample is collected for cutting description to be made by the well site geologist and mud loggers. The fine particles are then removed by desanders and desilters such that clean mud is transferred again into the mud tanks where it resumes its circulation through the system described above.

Rotary System: consists of swivel, Kelly, kelly bushing and rotary table (Figure 3-9). The swivel is the part which connects the kelly/rotary hose to the drill string (i.e. the circulation system to the rotary system). The kelly is a square/hexagonal member at the uppermost part of the drill string right below the swivel and in turn passes through a fitting knows as kelly bushing. The rotary table/bushing transmits rotational motion to the kelly through the kelly bushing. Nowadays, Instead of having a rotary table in the rig floor the drive mechanism for the drill string is mounted on guide rails and moves up and down inside the derrick, known as top drive system (Figure 3-10). This allows drilling in segments of 30 m of pre-assembled pipe, significantly reducing connection time and resulting in better hole conditions (Jahn et. al., 2008).

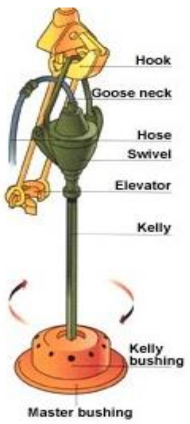


Figure 3-9 Rotary System

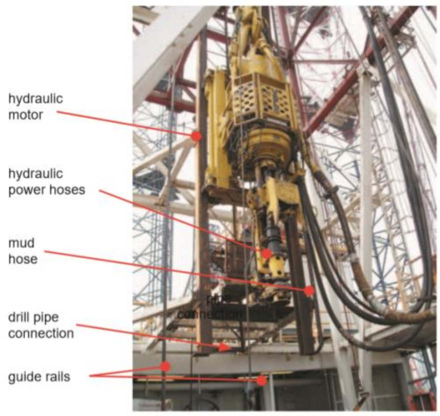


Figure 3-10 Top Drive System

Well Control System: An important safety equipment deployed on every modern rig is the Blow Out Preventer (BOP). The BOP is normally installed during drilling operations on top of the wellhead which provides suspension means to the casing and tubing. As discussed earlier, one of the functions of the drilling mud is to counterbalance the pore pressure of fluids in permeable formations. Yet the formation fluid might still enter wellbore creating what is termed a 'kick' which if not controlled would expose the upper part of the hole and equipment to the higher pressures of the deep subsurface and can eventually lead to a blowout. The BOPs are a series of powerful sealing elements designed to close off the annular space between the pipe and the hole through which the mud normally returns and by doing so the well will be 'shut in' and the mud and/or formation fluids forced to flow through a controllable choke, or adjustable valve. This choke allows the drilling crew to control the pressure to restore the balance of the system, a process also known as 'killing the well'. The BOPs are opened and closed by hydraulic fluid stored in accumulators typically under a pressure between 3000 and 5000 psi. Certain hydraulic systems may be designed to operate in excess of 5000 psi. Figure 3-11 shows a typical set of BOPs.

The annular preventer consists of a rubber sealing element that fits tightly around any size of pipe in the hole after being hydraulically inflated. The Ram type preventers either grip the pipe with rubber-lined steel pipe rams, blocking the hole with blind rams when no pipe is in place or cut the pipe with powerful hydraulic shear rams to seal off the hole (Jahn et. al., 2008).

BOP ram configurations are interchangeable depending on operational considerations.

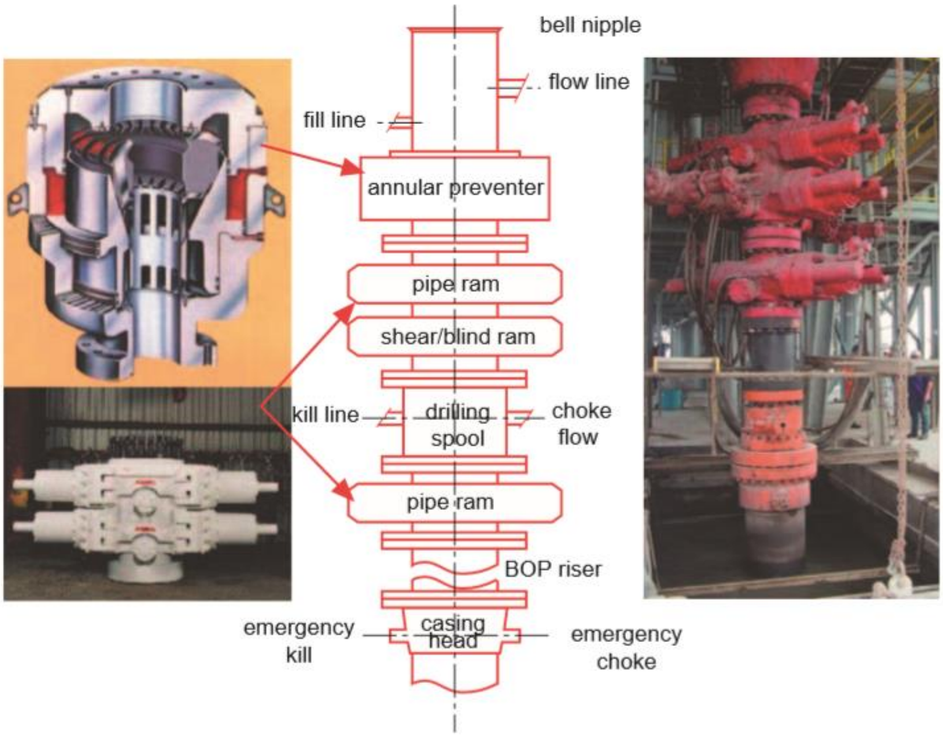
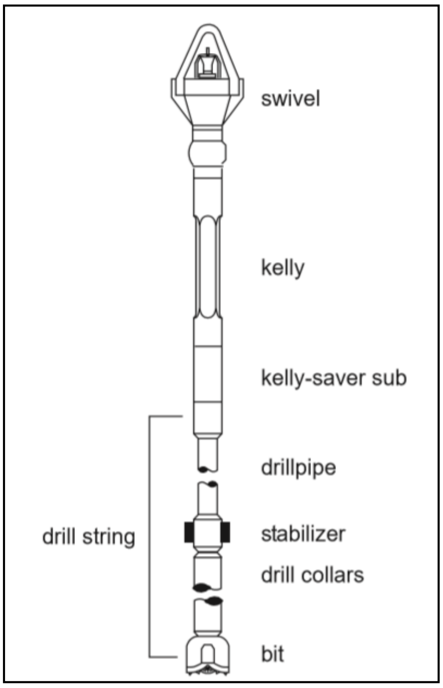


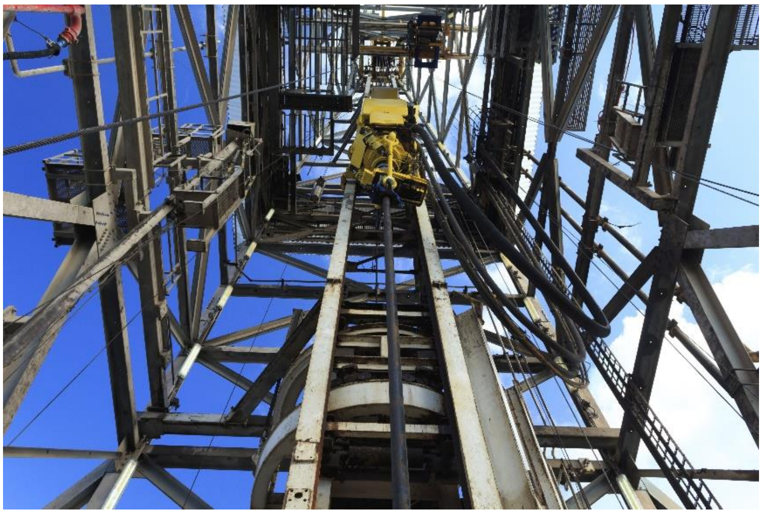
Figure 3-11 Blow Out Preventer (BOP)

3.3.2.2 *Drill String Description*

The drill string (Figure 3-12) is the physical equipment that advances into the sub-surface in order to create the bore. Its main functions are to suspend the bit, transmit the rotary torque to the bit and provide a conduit for the drilling fluid until reaching the bit. It consists of a drill pipe, a bottom hole assembly (BHA) and a drill bit. The BHA could be made up of drilling collars, stabilizers, reamers, tool subs and jars. Recently, it became more complex and accommodates additionally a down hole motor or a Rotary Steerable System (RSS) as well as Measurement While Drilling (MWD) and Logging While Drilling (LWD) Tools.



Source: Jahn et. al., 2008



Source: IADC

Figure 3-12 Drilling String

The drill pipe is the major component of a drill string. It constitutes generally 90 to 95% of the drill string length. It is a seamless pipe with threaded connections known as tool joints. Heavy weight drill pipes (HWDP) are similar to drill pipes except that they have a larger wall thickness. They are deployed at the base of the string where stress is higher and are able to absorb the stress from stiff drill collars to a relatively more flexible drill pipe.

Drill collars are pipes with larger outer diameters and smaller inner diameters thus significantly larger wall thickness. They provide enough weight on bit (WOB) for efficient drilling and help keeping the string in tension in order to reduce bending stresses. They provide also in general stiffness to the BHA for better directional control. Various types of drill collars are available based on the shape of the grooves, these include spiral and square. Special collars called Monel are used too, these ensure isolation of the directional survey tools (MWD) from magnetic distortion pertaining to the steel drill string.

The stabilizers consist of a length of pipe with blades on the external surfaces. The blades can be either straight or spiral and can be either mounted on the body of the pipe or on a rubber sleeve. The stabilizers are used to reduce buckling and bending stress on drill collar, allow higher WOB, increase bit life by reducing wobble, help to prevent wall sticking and wipe key seats (small-diameter channels worn into the side of larger diameter wellbore) when placed at top of collars.

Roller Reamers consist of stabilizer blades with rollers embedded into the surface of the blade. The rollers act as stabilizers too and are used for maintaining gauge hole (well rounded with a diameter close to that of the drilling bit). They are deemed very efficient in reaming out potential hole problems such as dog legs and key seats.

Substitutes (subs) are short joints for connecting components that cannot be screwed initial to each others. Shock subs are tools used for minimizing stress resulting from bouncing when drilling through hard rock.

Jars are specialized tools installed above the drill collars, meant to deliver sharp blows in order to free the pipes in case they get stuck.

Measurement While Drilling (MWD) tools consist of sondes that are inserted close to the bit providing directional data. These have been improved to the point of allowing acquisition of geophysical logs whilst drilling, i.e. Logging While Drilling (LWD).

The Drilling bit is the cutting tool used for creating the hole. The two most frequently used bit types are the roller cone bits and the polycrystalline diamond compact bits (Figure 3-13).

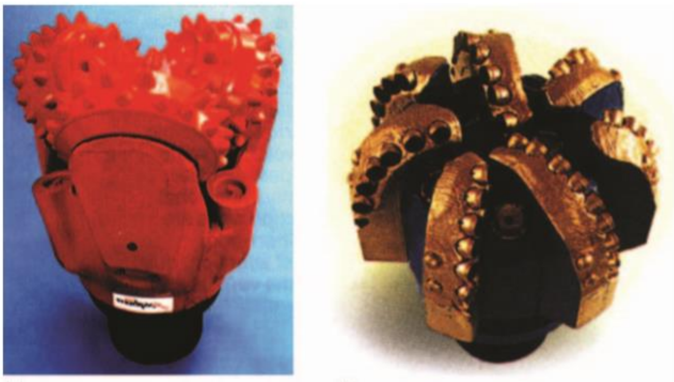


Figure 3-13 Roller Cone Bit (Left) and PDC bit (Right)

Rotary steerable systems (RSS) and downhole turbines/motors are special units used for directional drilling and are installed near the bit. In RSS (Figure 3-14), small electronically controlled rotating stabilizer pads (actuators) exert a continuous directional force onto a drive shaft which orients the drill bit into the desired direction. The drill string is rotated at the same time, allowing hole cleaning. The rotary steerable system is combined with logging tools in the drill string close to the bit, allowing a continuous optimization of the well trajectory (Jahn et. al., 2008).

In mud turbines and mud motors (Figure 3-15) rotational movement of the drill string is restricted to the motor or turbine section, while the rest of the drill string moves by 'sliding' or being rotated at a lower speed to ensure hole cleaning. The mud is pumped between the rotor and the stator section, inducing a rotational movement which is transmitted onto the drill bit. Motors and turbines are being replaced by the rotary steerable system for cost and operational reasons. They are mostly used for kicking off a sidetrack or where a sharp change in angle is needed in a short-radius horizontal well (Jahn et. al., 2008).

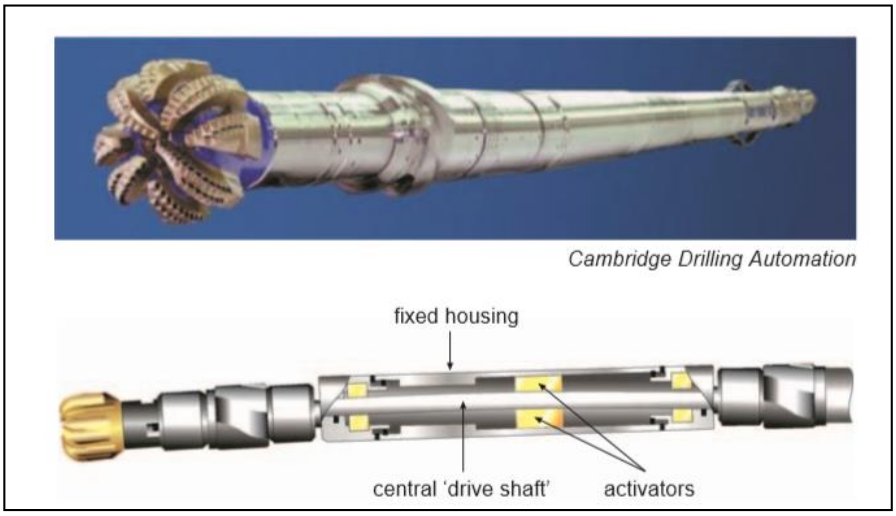


Figure 3-14 Rotary Steerable System (RSS)

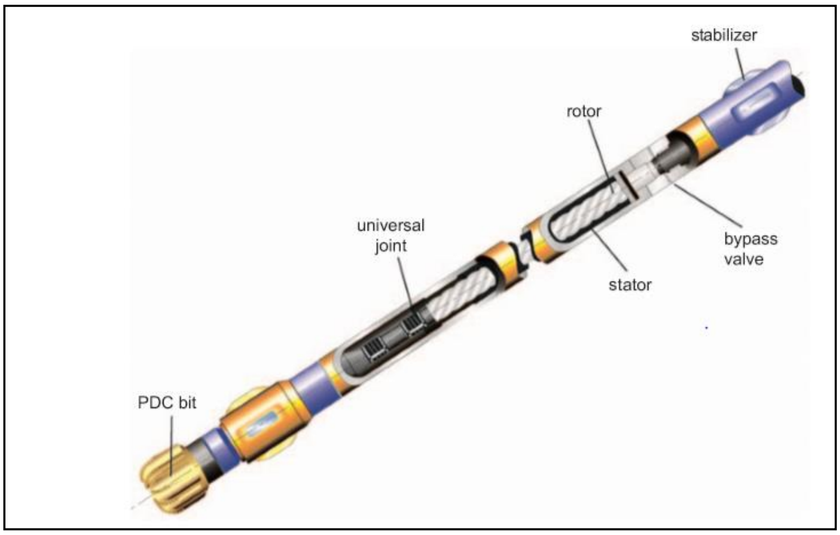


Figure 3-15 Mud Turbine

3.3.2.3 *Drilling and Completion Process*

The first step in drilling involves driving of a conductor pipe into the ground or sea bed. A drill bit is then lowered, connected to a BHA and the drill string, all of which suspended by the hoisting system. The rotational torque is supplied either by the rotary table or the top drive system to the bit, which drills through the rock layers cutting them into fragments (drill cuttings). These are circulated to the surface by the drilling fluid which is pumped at high pressure into the drill pipe and out of the bit nozzles and all the way through the annular space between the pipes and borehole wall as explained in the circulation system above. As the bit advances deeper, more pipes are added to the string by connecting their joints. The pipes are added in stands of 10, 20 or 30 m. Modern derricks with high capacity can accommodate stands of 120 ft. The hole is drilled and completed in intervals, from wider to narrower. In addition to the conductor pipe, a surface, intermediate and production casing are installed (Figure 3-16). The whole drilling process is monitored through recording of specific drilling and mud parameters by sensors installed on the rig. The parameters include hookload, string torque, Weight on Bit (WOB), rotary speed, pump pressure and rate, Rate of Penetration (ROP), the mud weight and the volume of mud in the tanks. In addition to these, directional data and geophysical logs are acquired in real time by the MWD and LWD tools using mud pulse telemetry technology.

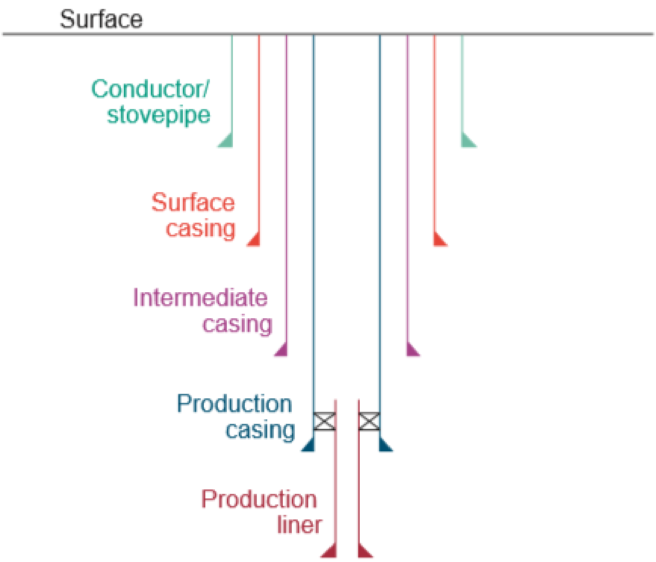


Figure 3-16 Typical Casing Scheme (Jahn et. al., 2008).

Once an interval is drilled, it is cased and cemented before proceeding to the next interval. This is to avoid hole collapse, ensure well integrity and sometimes used for isolating specific zones. The process entails lowering a casing and injecting a cement slurry in the annular space between the casing and the borehole wall (Figure 3-17). An open hole Wireline logging is carried before installation of the casing, with the aim of acquiring geophysical logs that help in inferring the formation lithology and petro-physical parameters, such as porosity and saturation while a cased hole logging is ran after the installation of casing and cementing to evaluate the cement job (This is referred to as Cement Bond Log).

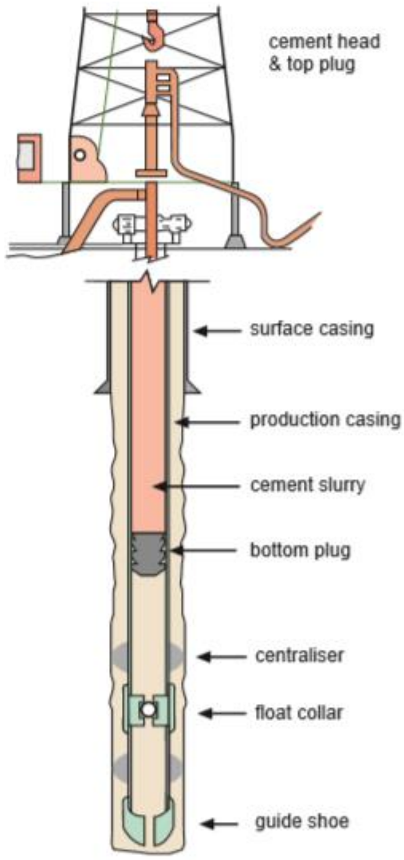


Figure 3-17 Principle of Casing Cementation (Jahn et. al., 2008).

Some sections that are of interest for specific analysis could be cored rather than drilled using the conventional way. This is achieved by replacing the roller/PDC bit by a special coring bit and barrel that allow retrieval of a cylindrical core sample rather than breaking the rock into cuttings. Smaller horizontal or vertical plugs are extracted from the core and are sent to laboratories for analysis and testing.

For completing the bottom hole section, several options are available; the last drilled section (one that is penetrating the reservoir) could left open (without no casing, neither liner), or could be lined (using a slotted liner/screen) or cased and cemented and later on perforated in specific producing zones to allow the hydrocarbon into the well. The perforation activity involves lowering a perforation gun/tool on Wireline to a certain depth against a producing zone of interest and actuating it such that holes are created in the casing, cement and into the rock formation allowing communication between the reservoir and the well. The hydrocarbon is conveyed up to the surface through a production tubing that is installed in the well with the use of specific packers. Other completion equipment are installed in the well including wireline entry guide, surface controlled safety valves for well control, sliding side door for fluid circulation control as well as side pocket mandrels which can accommodate different types of valves such as water injection control valve, gas lift valves and others. The selection of the completion equipment is made by the production engineer based on many factors such the well type, fluid nature, purpose of the well and the economics.

3.3.2.4 Deepwater Drilling Considerations

The standard drilling process described above will differ when working in deepwater environment where a drilling ship or a semi-submersible is deployed. A conductor is advanced below seabed using a special jet bit which is replaced by a normal roller cone drill bit when the refusal point is reached. At this stage the cuttings are simply washed out to the top of the well using high pressure seawater. Once the conductor section is completed it is cemented in place. After the second section is drilled, the wellhead system is run while attached to the first string of casing inside the conductor and then cemented. A subsea BOP stack follows and shall be installed on top of the wellhead which is connected to drilling ship by a large diameter pipe known as the riser. The riser will serve as a conduit for the subsequent drilling string and casings and will be used to circulate the drilling fluid up to the surface for removing the cuttings.

3.3.2.5 Appraisal

After a discovery, the project moves from the Exploration to the Appraisal phase where the commerciality of the discovery is evaluated. In this phase, additional wells (appraisal wells) are drilled and several activities are conducted to assess the extent and productivity of the discovery. .Such activities include well testing which help assess the productivity of the field as well as the faults location, coring and logging to better understand the depositional environment, reservoir extent and reservoir properties, and may include more refined 3D seismic acquisition for better assessment of the gross rock volume If the appraisal wells confirm that field development is commercially viable, the field will pass into the development phase. Potential exploratory wells will be temporarily plugged for re-entry at a later stage or for use in production.

If, however, the discovered reservoir is deemed non-commercial, the drilled wells would be permanently plugged with cement or mechanical plugs and abandoned. A site clearance survey would be conducted to ensure that any debris from drilling activities is removed from the sea floor around each drilling site.

3.3.3 Development and Production Phase

Based on the geophysical, geological and reservoir information obtained during the reconnaissance and exploration phases, a Plan for Development and Production is prepared. This plan usually comprises activities and processes required to develop the field which could include the number of wells, drilling and production systems, processing, subsurface and surface facilities, risk assessment and maintenance systems all dependent on water depth, reservoir type, and infrastructure and support operations. Once the plan is completed, a sequence of activities will follow: FEED and detailed design, procurement of construction material, fabrication and installation of facilities, commissioning of all equipment and the production startup.

In general, a production profile controlled by the drive mechanism, prices, cost, regulations, reserves and well geometry, can be split into three main periods:

Build-up period: during which new producing wells shall be drilled;

Plateau period: during which new producing wells may still be brought on stream while existing ones exhibit decline in production. In this period the production facilities will be operating at full capacity and rate of production would be maintained constant.

Decline period: during which production will decline in all wells.

Enhanced Oil Recovery (EoR): during which the lifetime of the field is extended by using EoR techniques.

The following sub-sections describe development and production activities that could be applicable to different E&P scenarios offshore Lebanon. The Scenarios are presented in section 3.4.

3.3.3.1 Offshore Production Facilities

An offshore production platform is rather like a gathering station where the produced hydrocarbons are collected, processed and transported for further treatment or storage. The platform holds all necessary equipment and facilities with a specific design and layout that suits offshore operations which are different from those on land for the following reasons:

- A platform has to be installed above sea level before drilling and process facilities can be placed offshore
- There are no utilities offshore, so all light, water, power and living quarters, etc. also have to be installed to support operations
- Weight and space restrictions make platform-based storage tanks non-viable, so alternative storage methods have to be employed

As for the types of platforms, two broad categories can be distinguished: fixed platforms and floating platforms. Since the choice of the platform is influenced by water depth, environmental conditions and logistical matters, fixed platforms are not considered as a viable and possible option offshore Lebanon given the deep and ultra-deep waters in most blocks. Floating platforms on the other hand, can be categorized into three main types: Semi-Submersible vessels, Floating Production Storage and Offloading Platforms (FPSO) and SPAR platforms. They are illustrated in Figure 3-18 and described in the following sub-sections.

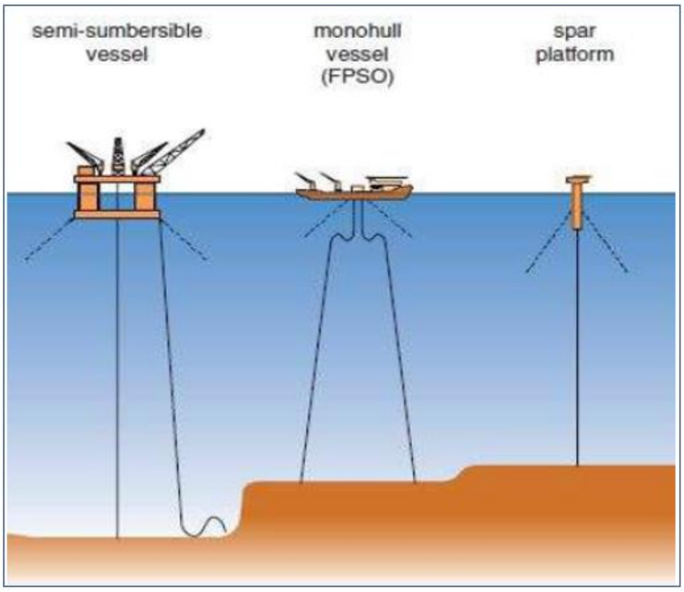


Figure 3-18 Floating Production Systems

3.3.3.1.1 Semi-Submersible Vessels

Semi-submersible platforms are marine vessels used as offshore drilling rigs, safety vessels and production platforms. This type of vessels is typically adopted because of its capability to withstand harsh conditions and its efficiency in deep waters (Figure 3-19). Before production semi-submersible platforms were designed for drilling, semi-submersibles were previously converted to very stable and cost-effective production platforms the first of which was the Argyll FPF in 1975 in the North Sea.

Figure 3-19 Examples of Semi-Submersible Vessels

3.3.3.1.2 Floating Production Storage and Offloading Platforms (FPSO)

FPSO (Figure 3-20) is a floating vessel used to store and offload produced hydrocarbon with variable production streams until it can be transported and refined. It can also provide processing of the hydrocarbon including three-phase separation, gas lift, water treatment and injection. A main reason for which this type of platform became more adopted is because of their low cost in comparison with traditional platforms.

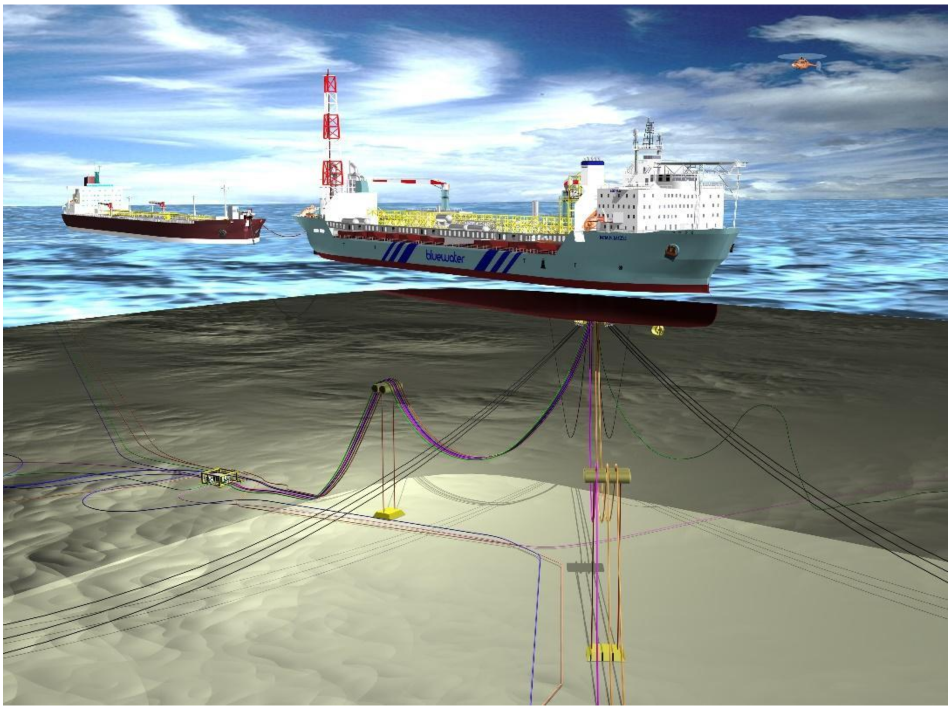


Figure 3-20 Illustration of a Floating Production Storage and Offloading Vessel

Ship-shaped **FPSOs** must be designed to 'weather vane', meaning it must have the ability to rotate in the direction of wind or current. This requires complex mooring systems and the connections with the wellheads must be able to accommodate the movement. The mooring systems can be via a single buoy or, in newer vessels designed for the harsh environments, via an internal or external turret.

The typical process capability for FPSOs is around 100,000 barrels per day, with storage capacity up to 800,000 bbls. However, in the recent deep-water developments in West Africa some FPSOs exist which are over double this capacity. FPSOs can also be used for gas production fields whereby gas can be processed (multi-phase separation) before it is piped to further treatment and market.

3.3.3.1.3 SPAR platforms

SPAR Platforms are floating platform typically applied in deep waters and moored vertically in place. Although originally designed as a floating buoy to acquire oceanographic information, this type has been developed to substitute conventional platforms. The design of the platform makes it less affected by oceanic and weather conditions and allows for the use of dry tree and subsea production (Figure 3-21). The first SPAR ever adopted was the Brent SPAR specifically designed for storage and offloading of products in the North Sea, whereas the more recent structures have incorporated drilling, production, storage and offshore loading facilities as an integrated development option.

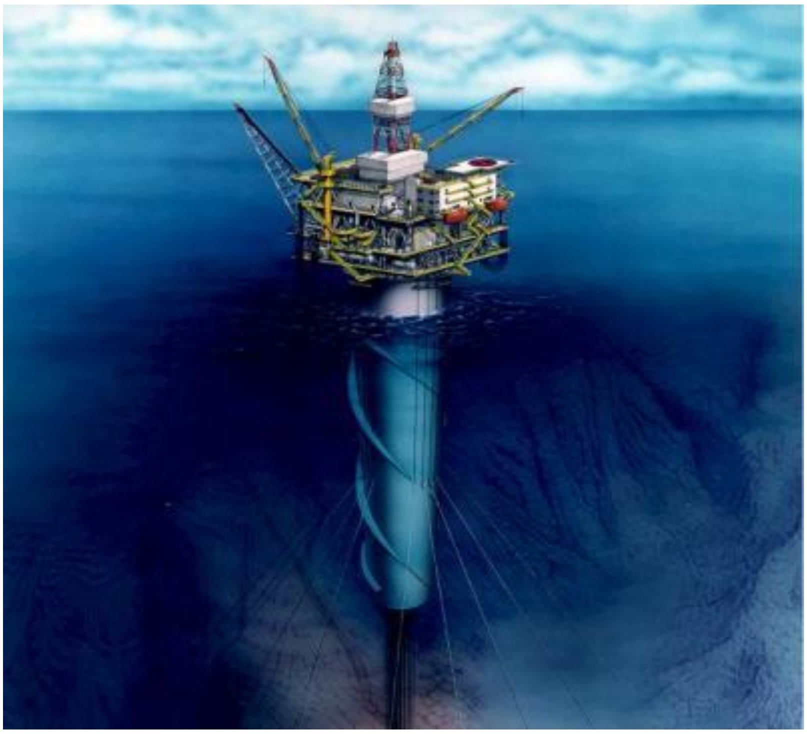


Figure 3-21 Illustration of a SPAR Platform

3.3.3.1.4 Subsea Production Systems

Subsea Production systems provide an alternative offshore development option with wells located on the sea floor where the petroleum is extracted and then tied back to an already existing platform. The produced hydrocarbons can reach the nearby production platform by a riser or an undersea pipeline allowing one production platform to service a large number of wells spread over a relatively large area. This type of systems serves as one of most economic and practical solutions for developing small fields near a pre-existing infrastructure such as platforms or pipelines in deep waters. Subsea systems have been proven to be efficient and cost-effective when adopted in combination with floating production systems.

Subsea production systems also create large savings in manpower as they are unmanned facilities. However, these systems can be subject to very high operating expense from the well servicing and subsea intervention point of view as expensive vessels have to be mobilized to perform the work. As subsea systems become more reliable, this OPEX will be reduced.

As shown in Figure 3-22, a subsea field development or subsea satellite development would consist of a cluster arrangement of special subsea trees positioned on the seabed tied-in to a manifold. The produced fluids are piped from the manifold to the host facility. Control of subsea facilities is maintained from the host facility via control umbilicals and subsea control modules.

The most basic subsea satellite is a single subsea wellhead with subsea tree, connected to a production facility by a series of pipelines. A control module usually situated on the subsea tree allows the production platform to remotely operate the subsea facility via its valves and chokes.

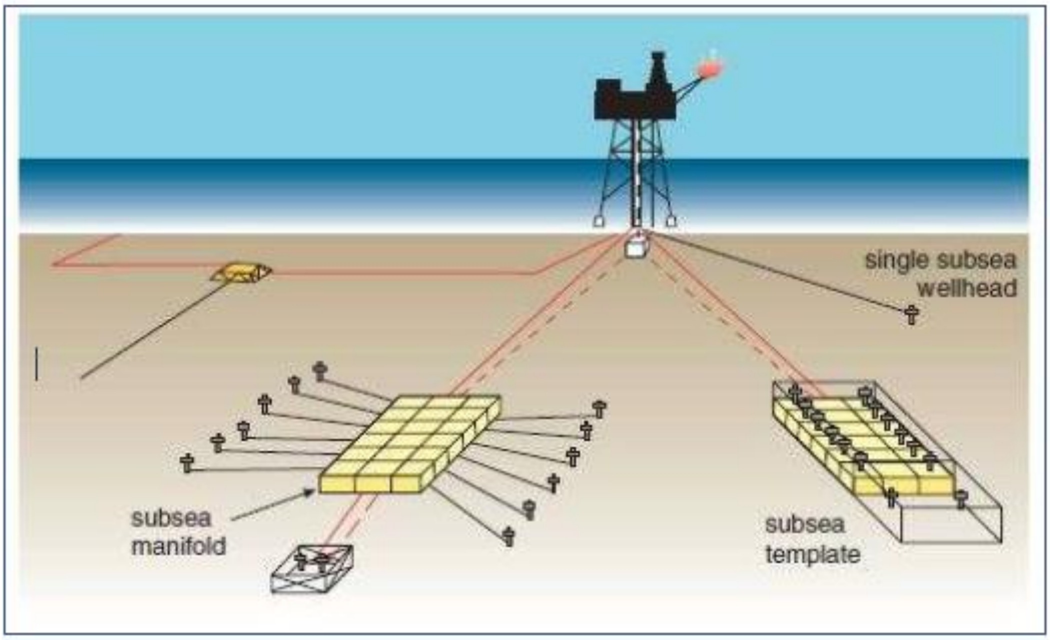


Figure 3-22 Typical Subsea Field Development Options- Tied Back to a Host Facility

3.3.3.2 Oil and Gas Transportation Systems

Once the produced hydrocarbon is gathered at the production platform, it will be transported by pipeline in the case of gas and oil, or tankers in the case of oil. Pipeline transport is the most common mean of transporting hydrocarbons, particularly when handling large volumes. Although a pipeline may seem a fairly basic piece of equipment, failure to design a line for the appropriate capacity that can withstand operating conditions over the field lifetime, can prove very costly in terms of deferred hydrocarbon production.

In areas where seabed relief makes pipelines vulnerable or where pipelines cannot be justified on economic grounds, tankers are used to store and transport crude from production centers.

The simplest method for transportation is to pump stabilized crude from a processing facility directly to a tanker.

3.3.3.3 Processing Systems

Processing of hydrocarbons usually occurs offshore on platforms unlike refining that is done onshore. The produced hydrocarbons generally have a high volatility and contain a significant number and concentration of contaminants such as water and sand that can damage and block pipelines and process equipment during transportation from the platform to the shore, whether by ship or by subsea pipeline. To avoid flow assurance issues, such as the creation of waxes or hydrates, petroleum processing is much viable and safer to take place offshore before transportation occurs.

The processing process includes flow separation and treatment after production, gas compression, liquefaction (if applicable) and metering.

3.3.3.4 Utility Systems

Utility systems are systems which do not handle the hydrocarbon process flow, but provide some service to the main process safety or residents. They are required to support process system and are essential for the day-to-day operation of the facility as well as its safety. In general, an offshore platform utility system comprises power generation and distribution systems, Instrumentation systems, fire water systems, emergency shutdown systems, cooling and heating systems and holds Instrument air, utility air, gas fuel and diesel fuel.

Other installations and plants might also be installed including gas plants, gas compressors in addition to pipelines export systems based on the approved Plan for Development and Production (PDP).

3.3.3.5 Onshore Facilities

During different phases of the Plan, there will be a need for on-shore support facilities to provide logistics support to the oil and gas operations. The total area of on-shore support facilities including fabrication yards and logistics bases could range from 5 ha (50,000 m^2) in early stages of exploration up to 100 ha (1,000,000 m^2) in the case of multiple platforms operating in the sea. The location of such facilities shall be in line with the National Land Use Master Plan and the facilities shall be subject to EIA studies including analysis of alternatives prior to their deployment.

3.3.4 Decommissioning Phase

When economical reserves are depleted, the field should be decommissioned in a way that ensures minimal environmental disruption according to a decommissioning plan that shall be approved by the Minister of Energy and Water and shall include an EIA Study. The decommissioning plan should consider well abandonment, the removal of production facilities and equipment, decommissioning of pipelines and flowlines, restoration of oil and gas sites that are no longer profitable to environmentally-sound conditions, disposal and reuse options for materials and site clearance. After bringing the platform and all facilities onshore for dismantling and disposal, the materials used for their construction can be reclaimed and reused. To ensure proper site clearance, operators need to conduct post decommissioning surveys to identify and remove debris left behind during the removal process, especially those that could interfere with other uses of the area, and note and manage any environmental damage.

Operators usually try to defer this phase by either reducing operating costs or increasing hydrocarbon throughput. For such purpose, enhanced recovery techniques to recover a proportion of the hydrocarbons that remains after primary and secondary production using unusual methods such as thermal recovery and chemical injection. However, given that the economic viability of such techniques is very sensitive to oil price, they are more often justified for onshore development rather than offshore ones.

3.4 SCENARIOS FOR THE OFFSHORE PETROLEUM E&P ACTIVITIES

The extent and types of Exploration and Production (E&P) activities are highly dependent on the size of commercial discoveries (if any), types and quality of hydrocarbons found (e.g. gas and/or liquids), market demand for these hydrocarbons, and their market price (among other factors). Therefore even though Lebanon has awarded exclusive petroleum licenses for Blocks 4 and 9, and has initiated the exploration phase for these blocks, it is practically impossible to anticipate how the sector will evolve and accordingly what would the associated benefits and impacts be.

Accordingly various assumptions have been made to develop hypothetical scenarios that would cover a wide range of activities, and can therefore be used to assess the potential and significance of impacts under each scenario and develop mitigation and monitoring strategies to be adopted by oil companies and the government as the sector develops further.

The following scenarios are considered in this SEA update:

- **Scenario 0: "Do Nothing" Scenario**

Scenario Description	Relevant Assumptions and Variables
This scenario is hypothetical and considers Business as Usual (BAU) (reference scenario) without E&P activities. Analysis of this scenario provides understanding of what is likely to happen to the selected environmental and socio-economic indicators should there be no development of the hydrocarbon sector in Lebanon.	✓ There are no E&P activities, thus no discoveries are made. ✓ Gasification of the energy sector continues. However, it is based on imported oil and gas products - Lebanon remains an oil and gas importer. ✓ Oil and gas import infrastructure is built in order to ensure sufficient and stable import. ✓ There is no significant impact of the sector on job creation, development of oil and gas related economy or on further sustainable development of Lebanon.

- **Scenario 1: "No Commercial Deposits" Scenario**

Scenario Description	Relevant Assumptions and Variables
Exploration activities will result in finding no commercial deposits - this is a minimalistic scenario whereby activities are limited to exploratory activities and there is no production and development phase. This basically means that the environmental conditions will be subject to some pressure from exploration activities but without significant socio-economic benefits.	✓ 0 commercial[3] discoveries are made ✓ It is assumed that during 6-8 years, a maximum of 8 wells are drilled, at an average of 2 exploration wells drilled every 2 years, and then activities will cease ✓ Supply base infrastructure remains limited to the needs of servicing exploration activities ✓ Gasification of the energy sector continues. However, it is based on imported oil and gas products - Lebanon remains oil and gas importer. ✓ Oil and gas import infrastructure is built in order to ensure sufficient and stable import. ✓ There is no significant impact of the sector on job creation, development of oil and gas related economy or on further sustainable development of Lebanon.

[3] Commercial means adequate to develop reservoir for production.

- **Scenario 2: "Low Development" Scenario**

Scenario Description	Relevant Assumptions and Variables
A single discovery is put into production to feed the local market. Lebanon satisfies its demand for Natural Gas at production start however cannot sustain the growth in demand and becomes net importer of Natural Gas with demand growth. Production is assumed to cease starting from 2048.	✓ Only 1 commercial discovery is made and it is Natural Gas only. ✓ First 2 blocks to be explored are blocks 4 and 9 – prioritization of other blocks is currently unknown. ✓ Up to 10 wells will be drilled; 1 commercial discovery; 2 appraisal wells for the discovery. (*1st or 2nd well consists the discovery)* ✓ Production starts in 2029 up till 2048. ✓ It is assumed that 5 production wells will be operational at any given time in the 20-year production period at a production rate to satisfy the local demand of approximately 0.2 tcf/year. ✓ Lebanon satisfies its demand for Natural Gas at production start however cannot sustain the growth in demand and becomes net importer of Natural Gas with demand growth. ✓ Oil and gas transport infrastructure is built in order to ensure delivery of local gas to power plants, and to ensure sufficient and stable import.

- **Scenario 3: "High Development" Scenario**

Scenario Description	Relevant Assumptions and Variables
The high resources result in a high emphasis placed on exports. There is also potential for use of the resources for value-addition.	✓ Multiple commercial discoveries (5) are made: - Liquid Hydrocarbons & Natural Gas in shallow areas of blocks; - Natural Gas in Deep-water area. ✓ First 2 blocks to become operational will be blocks 4 and 9 – prioritization of other blocks is currently unknown. ✓ 12 exploration wells are drilled in total; 5 commercial discoveries; 2 appraisal wells per discovery (total of 10 appraisal wells in addition to the exploration wells) ✓ First production of natural gas starts in 2029 at a production rate to satisfy the local demand of approximately 0.2 tcf/year and production gradually increases for export purposes to reach an approximate rate of 1.1 tcf/year by 2040 ✓ Some production of liquids approximately estimated at 7 – 13 MMbbl ✓ It is assumed that up to 30 production wells could be operational by 2040. ✓ Lebanon meets its domestic demand and is a net exporter of Natural Gas. ✓ Hydrocarbon use options and infrastructure are: - Natural Gas – domestic use (gas-to-power will be the main use; additional usages include gas-to-industry and gas-to-product in case these options prove to be economic and feasible); - Natural Gas – export through 1- The Arab Gas Pipeline or 2- Onshore pipeline to Turkey and/or 3-LNG export infrastructure; - Liquid Hydrocarbons – exported by sea through oil tankers.

4. BASELINE CONDITIONS

To be able to assess the possible environmental and socio-economic impacts from offshore E&P activities in Lebanon, it is important to first understand their existing conditions and their likely evolution without any E&P activities. It is then possible, provided there is sufficient information available, to assess whether such conditions will be improved (positive impacts) or deteriorated (negative impacts) due to E&P activities and to propose measures to enhance positive and avoid/minimize negative impacts.

This section provides a summary of the analysis of existing conditions in Lebanon. Detailed description of baseline conditions is available in Volume 2 of the SEA study.

4.1 GEOGRAPHIC FEATURES OF THE MEDITERRANEAN BASIN OFF THE LEBANESE COAST

On the margins of land masses, marine waters are very shallow and overlay an underwater extension of continental lands called the continental shelf. On global scale, this area covers only 7-8% of total marine waters and slopes gently from 0 m depth from the shore to depth ranging between 100-200 m (Figure 4-1). At the outer edge of the shelf, there is an abrupt steeping of the sea floor to become the continental slope with different depth ranges for different parts of the world. The continental slope then descends precipitously until the bottom becomes the flat, extensive sediment covered plain. According to some geologists, the Mediterranean Sea has no abyssal plains (usually deeper than 4000m), and hence all the deep Mediterranean basins form part of the continental margin. For the purposes of this report, the area beyond the continental slope will therefore be referred to as the deep-sea plain. In Lebanon, the continental slope reaches a depth of approximately 1600-1700m before the sea floor stretches into the deep-sea plain with approximate depth ranges from 1600m to 2100m (Figure 4-2).

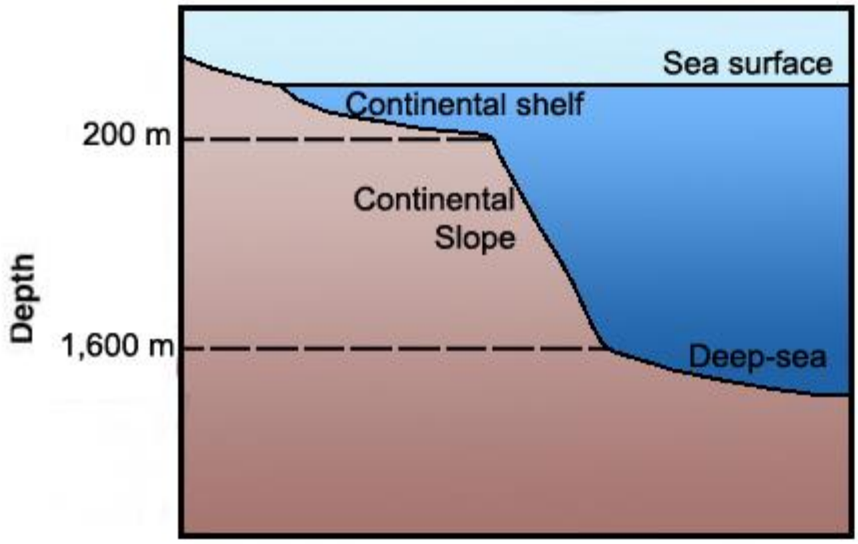


Figure 4-1 Diagrammatic cross section of the sea basin off the coast of Lebanon (Not to scale; large vertical exaggeration and approximation of depth values)

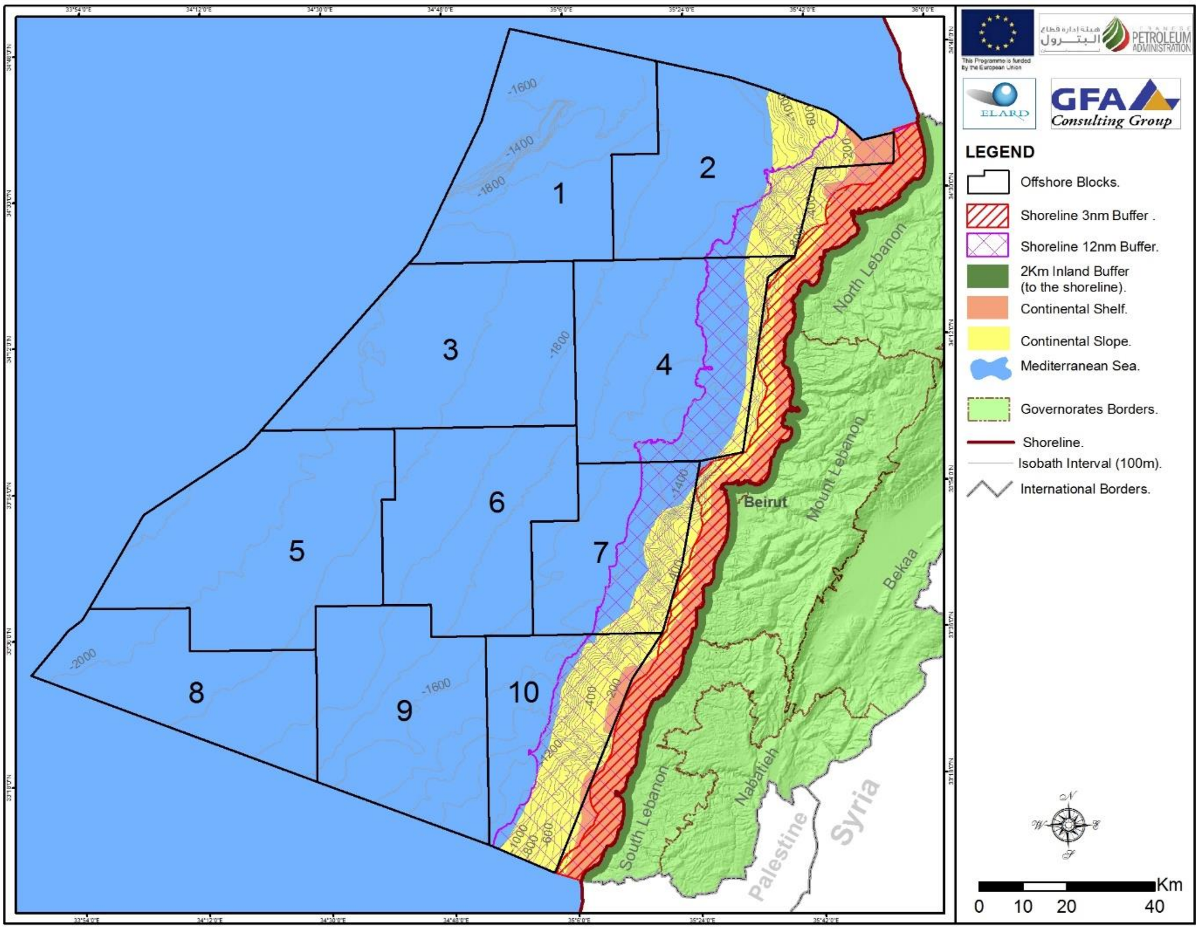


Figure 4-2 Geographic features of the sea basin off the coast of Lebanon

Continental shelves are <u>one of the most productive parts of marine environments</u>. Although they comprise only 7-8% of the surface area of the world oceans and seas, they provide 15-30% of marine primary production. From a biological standpoint, continental shelves are extremely important because they are much shallower than the rest of the ocean/sea basins. This allows enough light to penetrate in the water column for primary production and to reach the sea floor further allowing plant growth. This is indispensable for many animals, including most fishery species, since bottom habitats are generally safer than open water habitats due to the complexity of the shallow natural environment. Any habitat that combines food availability with safety attracts the majority of life forms. In addition to increasing light availability and the resultant increase in fish abundance, the shallowness of shelves also makes fishing more accessible to humans leading to better food security for coastal and other communities. A huge proportion of the fish landed for human consumption either comes directly from continental shelves, or spend at least part of their life cycle on such shelves. As much as 90% of the global catch of shellfish and finfish comes from this specific natural environment. This also applies to most marine organisms. Many seabirds and marine mammals also depend on such shelves for sustenance. In this area, nutrients supporting the rich and diverse marine life come from both the land and the sea where river and stream runoff is an extremely important source of nutrients and sediments. Wind, tides, and waves serve to keep nutrients in the euphotic layer of the water column while the continental slopes, through their canyons and general geo-morphology return nutrients that had settled into the deep-sea plains.

Given the extensive anthropogenic pressures exerted on the Lebanese coastal zone (due to urbanization, industrial activities, shipping, fishing, tourism, etc.) including the continental shelve, it is imperative that all precautionary measures be taken to protect and conserve this biome due to its importance to human food security and overall marine ecosystem productivity and equilibrium.

Furthermore, and until recently, **continental slopes** were perceived as monotonous, muddy environments of limited ecological and environmental importance. Progress in seafloor mapping and direct observation revealed unexpected and extremely heterogeneous habitats and ecosystems that influence biological diversity. Interactions among water masses, terrestrial inputs, sediment diagenesis (changing of sediments into rocks), and tectonic activity create ecological settings that support distinct communities. Such special communities have the resilience to populate canyons and seamounts, high-stress oxygen minimum zones, as well as vast reefs of cold corals and sponges. This high localized biodiversity (localized on the slopes) is fundamental to the production of valuable fisheries, energy, and mineral resources, and performs critical ecological services (nutrient cycling, carbon sequestration, nursery and habitat support). Continental slopes worldwide are today under significant threat from climate change and human resource extraction activities.

Even though minimal research activities have taken place on the continental slope and its canyons off the Lebanese coast, serious conservation actions are required to preserve the functions and services provided by these deep-sea environments that science is just starting to understand. Recent surveys in Lebanese Canyons down to a depth of 1,000 m undertaken by IUCN and partners through the OCEANA project with the Ministry of Environment and CNRS confirm the ecological importance of these habitats.

As for the **deep-sea plains**, they represent the globe's largest biome, but our knowledge of their biodiversity is extremely low. They are characterized by the absence of light (absence of photosynthesis), mild to non-existent currents and very specialized biodiversity that can survive in dark, cold, high-pressure environments. In the last decades, an increasing number of studies investigated their biodiversity in several regions of the world. Even though more research is being carried out in the Mediterranean, there is no total biodiversity census (i.e., the biodiversity of all forms of life) of any deep-sea region. Scientists nevertheless highlight the presence of clear differences in knowledge of the deep-sea Mediterranean biota. This is related to the fragmented spatial coverage of investigations, and it is clear that after 20 years of intensive deep-sea research "*the relative species richness of … faunas of the different sectors of Mediterranean is better correlated with the level of research effort than the true species richness*" (Danovaro et al., 2010).

In addition, and as shallow fishery resources are being depleted all around the Mediterranean, increasing commercial fishing activities are entering deeper waters. For example and to date, little is known about the effects of deep-water trawling on benthic habitats and associated life forms. Pioneer studies have shown that intense deep-sea commercial trawling may trigger sediment gravity flows with an increase in near-bottom turbidity (Palanques et al., 2006; Martin et al., 2008). The effects of such sediment gravity flows on deep-sea life are unknown and need further investigation. Joint efforts of the World Wildlife Fund and the International Union for Conservation of Nature have led to the ban on trawling below 1,000 m (WWF/IUCN, 2004), making the deep benthic Mediterranean environment the largest protected area in the world. Such precaution is not only of major importance but also essential as it protects a widely unknown ecosystem.

Future research is therefore crucial before anthropogenic activities are introduced in such areas. Advancing our understanding of the biodiversity and ecosystem function of the deep-sea off the Lebanese coast will provide sound scientific data to enable policy makers and stakeholders to develop conservation and management options regardless of the commercial/industrial activities taking, or that will take, place in these areas.

The Lebanese continental shelf, slope and deep sea areas currently face significant pressures from various economic activities that may increase in the future due to increased urbanization, tourism, and fisheries (planned to shift from artisanal fisheries to a more industrial fisheries sector with the adoption of the new Fisheries Law in parliament, which extends allowable fishing zone to the entire Lebanese EEZ).

4.2 GEOLOGY

Interpretations of the 2D and 3D seismic data acquired within the Levant Basin led to a better understanding of geological domains and structural features onshore and offshore Lebanon.

Based on a recent publication (Ghalayini et al., 2018), Lebanon was subdivided into four domains: the distal Levant Basin, the Lattakia Ridge, the Levant margin, and the onshore (Figure 4-3).

A number of geohazards are associated with offshore exploration activities; these include seismicity, gas hydrates, over pressured zones and submarine landslides.

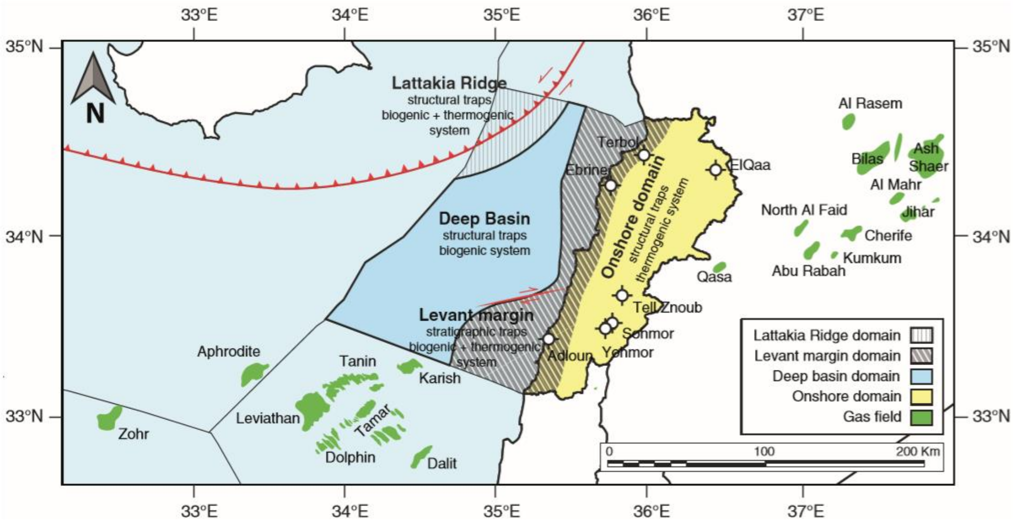


Figure 4-3 Geological Domains of Lebanon (Ghalayini et al., 2018)

4.3 BATHYMETRY

Further to the above description of the geographical features off the Lebanese coast and their ecological and socio-economic importance, this section further describes bathymetric features of these areas and their relevance to environmental and socio-economic conditions of the Lebanese EEZ.

A bathymetric survey of the Lebanese Exclusive Economic Zone (EEZ) was conducted in 2003 by the SHALIMAR bathymetric cruise (MOPWT – DGLMT, 2017).

According to the survey, the water depth off the coast increases westward to 2000 m in the abyssal plain (deep-sea plain) of the Levant basin.

The Lebanese continental shelf itself is relatively narrow, and is considered, as for all continental shelves around the world, the most productive part of Lebanese waters where most fishing activities are concentrated. It can be divided into 3 main parts:

- ✓ the widest part (18 Km) between Enfeh and Akkar;
- ✓ between Enfeh and Ras Beirut where the coastal plain is very narrow or almost non-existent (in this part, the continental shelf does not extend to more than 3 Km; and
- ✓ from Ras Beirut till Naquoura where the continental shelf widens up again reaching 7 Km.

Between Beirut and Batroun, the shelf is extremely narrow and the margin exhibits its steepest slope, with the water depth dropping from 100 to 1500 m in less than 5 km in some areas.

The bathymetry of shallower waters (0-200 meters depth) between the coast and up to 10 km seaward is in the surveying process. Once complete this will connect the inland geomorphology with the seabed relief already mapped during the bathymetric cruise SHALIMAR survey.

Deep canyons characterize the continental slope of the Lebanese coast. Almost 518 large submarine canyons have been identified in the Mediterranean Sea and are considered as key structures for its ecosystem functioning.

Submarine canyons are steep-walled, sinuous valleys, with V-shaped cross sections and relief comparable even to the largest of land canyons. Tributaries are found in most of the canyons and rock outcrops abound on their walls. Because they play a fundamental role in "Deep Oceans-Shelf Exchanges", submarine canyons can be defined as "super highways", allowing the energy turnover to speed up by reducing the time and the distances covered by water masses, organic and inorganic sediments, benthonic and nektonic organisms during their active or passive movements from shallow to deeper waters and vice-versa.

Recent interest has focused on the role of submarine canyons in the exchanges between the deep ocean and continental shelf, as well as in the functioning of the benthic and pelagic ecosystems. Mixing rates inside canyons could be as much as 1000 times greater than rates measured in the open ocean, and upwelling associated with canyons enhances local primary productivity with the effects extending up the food chain to include birds and marine mammals. Consequently, commercially important pelagic and demersal fisheries as well as cetacean feeding grounds are commonly located at the heads of submarine canyons. In addition, unique benthic habitats are associated with submarine canyons, particularly the heads of shelf-incising canyons that are characterized by steep bedrock exposures upon which biologically diverse communities may occur. Submarine canyons that extend across the continental shelf and approach the coast are known to intercept organic-matter-rich sediments being transported along the inner shelf zone. This process causes organic-rich material to be supplied and transported down-slope, where it provides nourishment to feed a diverse and abundant macro fauna.

4.4 ECOSYSTEMS AND BIODIVERSITY

4.4.1 Phytoplanktons and Zooplanktons

Due to the physical characteristics of the Lebanese coast, the seawater shows a highly diversified plankton community contrasting with poor plankton biomass. Special attention has been given lately to toxic and alien species and their relationships with environmental conditions. Every year, new alien species are recorded in the Mediterranean and the introduction rate is expected to increase in the future due to factors such as the enlargement of the Suez Canal, increased maritime transport (ballast water, fouling organisms), climate change, and aquarium pet trade.

Zooplanktons comprise most of marine zoological groups like protozoans and chordates. It is the most studied group of plankton in Lebanese waters where they have been monitored for the last 35 years. Their ecology is affected by the hydrological, hydro-biological and physical/chemical characteristics of the water they inhabit. Certain species are considered as biological indicator species and are therefore of particular ecological importance.

In total more than 780 species are reported in the Lebanese waters, 220 of those being Microzooplankton and 563 Macrozooplankton. Special attention has been given to alien species and their relationships with the surrounding environment.

Every year, new alien species are recorded in the Mediterranean and the introduction rate is expected to increase in the future due to factors such as the enlargement of the Suez Canal, increased maritime transport (ballast water, fouling organisms), climate change, aquarium pet trade.

4.4.2 Benthos

Lebanon's varied benthic biodiversity allows it to allocate habitats to many groups of phytobenthos and zoobenthos. Many of the species though are unknown with some attention being paid to few groups like Sponges, Cnidaria, Nemerta, Polychaetes, Sipunculiens, Mollusks, Brachiopoda, Crustacea, Echinoderma, Asidies. Nevertheless, the Mediterranean Sea accounts for 18% of the world's benthic biodiversity.

For a sea that encompasses only 0.32% in volume of the world ocean, there are various reasons why the species biodiversity is high:

- ✓ The Mediterranean Sea has been more intensively studied than almost any other sea;
- ✓ Its tormented geological history that led to a rate of environmental change and species occurrence; and
- ✓ The current variety of climatic and hydrological situations that are found in the Mediterranean yield temperate and subtropical biota (Marine biodiversity in the med sea).

Macroalgae:

Studies on macroalgae along the Lebanese coast are fairly limited. Many studies reported on the biodiversity of macroalgae from 1976 up to this day

In the earlier years, around 200 species were described, followed by more than 230 species in more recent studies. All studies agreed on the fact that the impact of pollution on their abundance created a negative outcome. At present, certain alien species forming permanent populations are competing with native species and colonizing their habitats

Angiosperm /Phanerogames:

Marine seagrasses form a unique ecological entity; however, they encompass various taxonomic groups.

In coastal waters, the occurrence of Monocotyledone is a rare scarcity. Among the marine flora, three species of Phanerogams (*Cymodocea nodosa*, *Halophila stipulacea* and *Zostera* *nana*) occupy Lebanese coastal waters, especially sandy bottoms, particularly in the Chekka area

They provide keyforming meadows. These meadows are considered of great importance as breeding and feeding grounds for an array of marine species

***Meiofauna**:*

Meiofauna are described as motile organisms that can move within sediments. Their presence is an indicator of the health or pollution of its respective environment

The CNRS conducted a study in 2011 on meiofaunal communities in Antelias looking at physicochemical and biological parameters within the study group. The study shows a significant difference in the number of diversity of the meiofaunal taxa. The count of nematodes, surpassing 1000 individuals/cm², in a polluted station in Antelias contradicts the results found in Ramle al Bayda and Sidon at 60 individuals/10cm² and 128 individuals/cm² respectively

These results are great indicators of the water quality of the studied environment with respect to the species abundance of nematodes. Meiofauna and the quality of the water column are directly correlated

Macrofauna:

Throughout a campaign done between 2012 and 2016 using a Remotely Operated Underwater Vehicle (ROV) on the CANA research boat with the collaboration of the CNRS, the biodiversity of macrobenthos was mapped. The findings report 430 different species of which 75 flora counts, 14 fauna of invertebrates, 99 species of molluscs, 82 species of polychaetes, 45 species of crustaceans, 44 species of sponges and 22 species of cnidarians

4.4.3 Marine Ichtyofauna

Ichtyofauna in Lebanon and Eastern Mediterranean is constantly changing due to Lessepsian migration. Every year, new species are recorded in the Mediterranean and the migration rate is expected to increase with the new expansion of the Suez Canal. Lebanese Ichtyofauna includes 357 species comprising 44 Chondrichthyes. Nevertheless, a recent study on Chondrichthyian along the Lebanese coast narrowed down the list from 44 to 25 species. It is believed that at present, this is the most comprehensive and realistic list of Chondrichthyes. On the other hand, for Osteichthyes, no revised checklist is currently available.

Every year, new alien species are recorded in the Mediterranean and the introduction rate is expected to increase in the future due to factors such as increased maritime transport (ballast water, fouling organism), climate change, aquarium pet trade.

4.4.4 Sea mammals

Among the three orders of marine mammals, studies have shown that dolphins are the most represented with 7 species recorded in the country: Short-beaked common dolphin (*Delphinus delphis*), Common bottlenose dolphin (*Tursiops truncates*), fin whale (*Balaenoptera physalus*), Cuvier's beaked whale (*Ziphius cavirostris*), Risso's dolphin (*Grampus griseus*), Striped dolphin (*Stenella coeruleoalba*).

The only species of seals present in Lebanon is the Mediterranean monk seal (*Monachus monachus*).

Several scientific records and confirmed sightings (n = 25, from 2003 to 2016), corroborated by photos and videos, have been reported from the Lebanese coastline and have led to the re-evaluation of the status of *Monachus* in the country (Mytilineou *et al.*, 2016).

4.4.5 Marine Herpetofauna

There are relatively few reptiles that are apt to life in a marine environment. Three species of marine turtles are found in Lebanese waters: the Loggerhead turtle (*Caretta caretta*), the Green turtle (*Chelonia mydas*) and the Leatherback turtle (*Dermochelys coriacea*).

The Loggerhead and Green sea turtles nest on Lebanese sandy shores while the Leatherback turtle is just a visitor to the Mediterranean Sea. In addition, the Hawksbill Sea turtle (*Eretmochelys imbricate*) is considered as vagrant and is very rarely recorded in the Eastern Mediterranean; also another species of turtles, the Nile softshell turtle (*Trionyx triunguis*) is also recorded in Lebanese waters. Even though it is a large fresh water turtle, it has been found in saline coastal waters at the mouth of rivers.

These reptiles are under severe pressure due to mortality by catch in fishing nets, floating solid waste, and/or by the destruction of their nesting habitats on sandy beaches.

4.4.6 Marine Ornithofauna (Seabirds)

Lebanon is considered as a bottle-neck along a major flyway route for birds twice per year and is located on one of the world's key migratory bird corridors.

According to a study conducted by Ramadan-Jaradi *et al.* (2008), 395 species in total have been recorded in the Country including 186 coastal and marine species observed near the coast of which 144 have marine affinity.

According to the IUCN Red List, Lebanon hosts bird species of international significance, with 2 being endangered, 8 vulnerable, and 17 near threatened.

Numbers of coastal and marine bird species were not reported to have changed between 2002 and 2016.

4.4.7 Important Biodiversity Areas and Cultural Sites

Important Biodiversity Areas and cultural sites including existing Marine Protected Areas (MPAs), proposed MPAs based on Lebanon's Marine Protected Areas Strategy prepared by the Ministry of Environment and IUCN, OCEANA's deepwater survey studies and sites prioritization conducted by the Environmental Resources Monitoring (ERML) project[4] are (Figure 4-4):

1. Palm Islands Nature Reserve (PINR) (Law No. 121 of 9/3/1992)
2. Tyre Coast Nature Reserve (TCNR) (Law No. 708 of 5/11/1998) (which extends to the entire territorial waters facing its coastal limits)
3. Nakoura (proposed MPA)
4. Sidon Rocks (proposed MPA)
5. Raoucheh cliffs and caves (proposed MPA)
6. Beirut port outer platform (proposed MPA)
7. Byblos (proposed MPA)
8. Medfoun Rocky Area (proposed MPA)
9. Batroun Phoenician Wall (proposed MPA)
10. Ras El Chekaa Cliffs (proposed MPA)
11. Enfeh Peninsula (proposed MPA)
12. Litani Estuary (proposed MPA)
13. Awally Estuary (proposed MPA)
14. Damour Estuary (proposed MPA)
15. Nahr Ibrahim Estuary (proposed MPA)
16. Areeda Estuary (proposed MPA)
17. Beirut Escarpment (OCEANA proposed deep sea site for conservation)
18. Saint Georges Canyon (OCEANA proposed deep sea site for conservation)
19. Jounieh Canyon (OCEANA proposed deep sea site for conservation)
20. Tyre Canyon (OCEANA proposed deep sea site for conservation)

[4] The "Environmental Resources Monitoring in Lebanon" project (ERML) aims at improving environmental monitoring in Lebanon in key sectors, namely on coastal and marine resources and on urban air quality, by implementing appropriate management programmes and providing policy guidance. The project addresses environmental priorities defined by the Ministry of Environment (MoE), namely the sustainable management of the coastal area and the improvement of urban air quality.

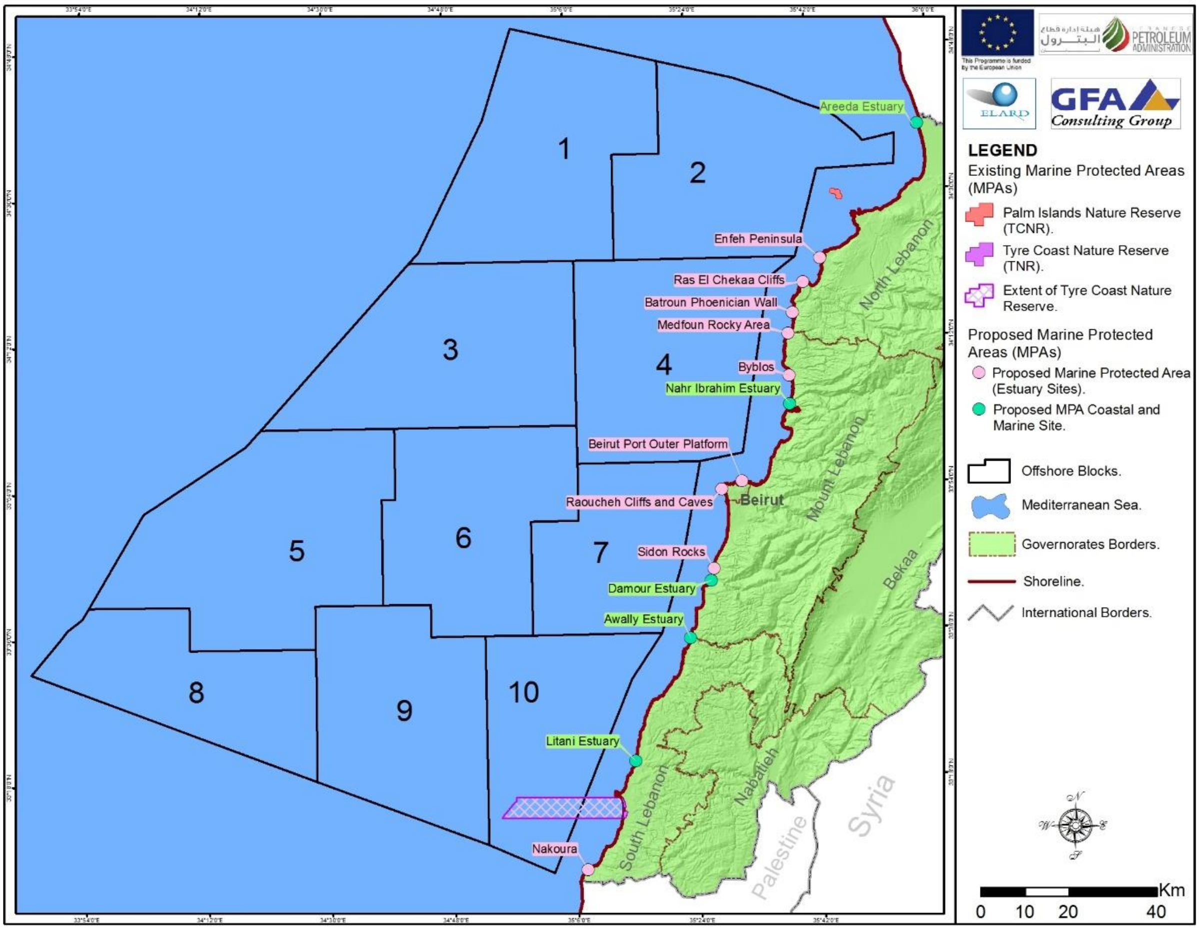


Figure 4-4 Existing and Proposed Marine Protected Areas in Lebanon

High priority coastal sites as proposed by the ERML project are shown in Figure 4-5.

Coastal sites of special significance and protected by national legislation are:

- ✓ Aarqa river estuary (MOE, Decision no. 188/1998)
- ✓ Terraces and Beach of southern Tripoli towards Qalamoun (Decree No. 3362/1972)
- ✓ El Jawz River estuary (MOE, Decision no. 22/1998)
- ✓ Batroun National Marine Hima at the National Centre for Marine Sciences (MOA, Decision no. 129 of 1991)
- ✓ Ibrahim River estuary (and archaeological sites) (MOE, Decision no. 34/1997)
- ✓ Coastal Front Rocks and terraces of Wata Slim (Tabarja)(MOE, Decision no. 200/1997)
- ✓ El Kelb River estuary and historical site (MOE, Decision no. 97/1998)
- ✓ Beirut River estuary (MOE, Decision no. 130/1998)
- ✓ Awally river estuary (MOE, Decision no. 131/1998; CDR/DAR/IAURIF, 2005)

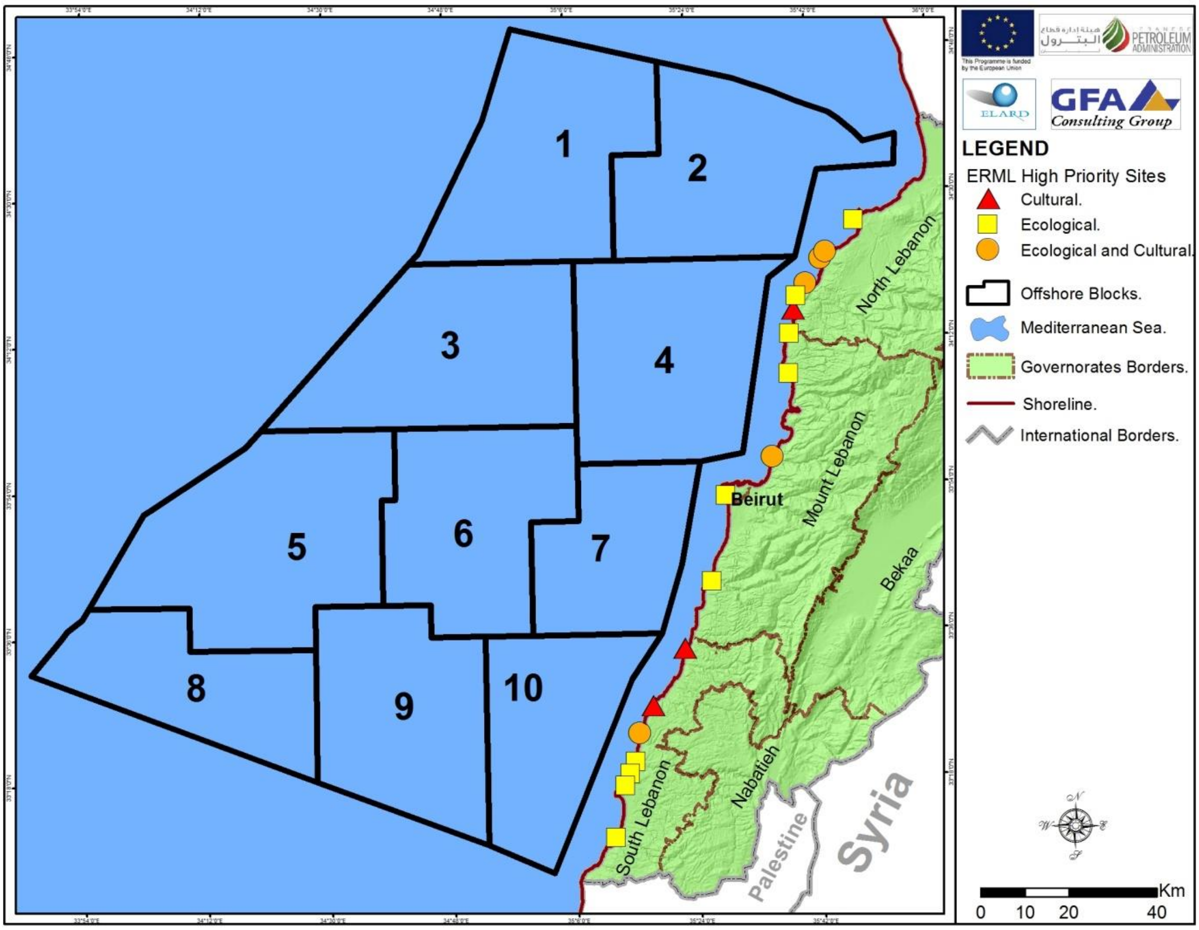


Figure 4-5 ERML High Priority Sites Map

The report "The Mediterranean deep-sea: highly valuable ecosystems in need of protection" published in 2005 by the IUCN and WWF, led the Members of the General Fisheries Commission for the Mediterranean (GFCM) to prohibit the use of towed dredges and trawl net fisheries at depths beyond 1000 m and in areas called "Deep Sea Fisheries Restricted Areas", such as the Lophelia reef off Capo Santa Maria di Leuca, the Nile delta area cold hydrocarbon seeps, and the Eratosthenes Seamount (South of Cyprus). Conservation of deep-sea features, such as canyons, requires improving understanding of the biological and ecological role of these ecosystems, threats and conservation issues, limits and chances of national and international jurisdictions.

Ecologically and Biologically Significant Areas (EBSAs)

Within this context, The Convention of Biological Diversity (CBD) organized an expert meeting in April 2014 in Malaga, Spain to define **Ecologically and Biologically Significant Areas (EBSAs)** for the Mediterranean. The representative of Lebanon, recognizing the importance of such ecosystems to sustain marine life and the socio-economic sectors that depend on it, suggested an EBSA for the East Mediterranean under the title of East Levantine Canyons Area - ELCA (Figure 4-6, https://www.cbd.int/meetings/EBSAWS-2014-03).

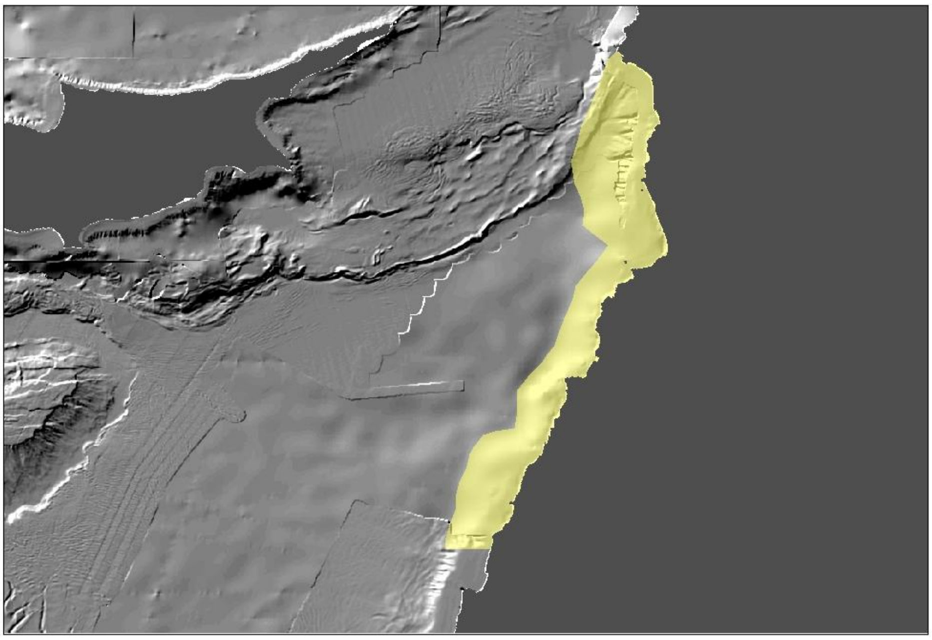


Figure 4-6 Proposed East Levantine Canyons Area (yellow; Source: CBD/UNEP – EBSA Workshop, Malaga Spain, April 2014)

The ELCA is featured by its deep canyons all along the Lebanese and Syrian coasts, several hydrothermal vents, submarine freshwater springs in addition to its being of particular importance biologically.

The coast of Lebanon: harbors and trade routes.

Some 15 harbors or maritime installations can be asserted on the Lebanese coast that operated starting the Bronze Age Period, till recently.

- The oldest structure of the port of Byblos is roughly dated ca. 2570 B.C.
- Anchorages of the Middle Bronze Age (2100-1550 B.C.) sheltered by offshore ridges were used in Beirut, Sidon, Sarepta (Sarafand) and Tyre.
- The Sidonian North breakwater (230 m long) is dated ca. 1700-1500 B.C.

The connections between the different cities in the Mediterranean Sea based on the written texts of geographers during antiquity (first - third c. Anno Domini) reported by P. Arnaud, 2005 are shown in Figure 4-7. It shall be noted that these connections do not present the exact navigation routes.

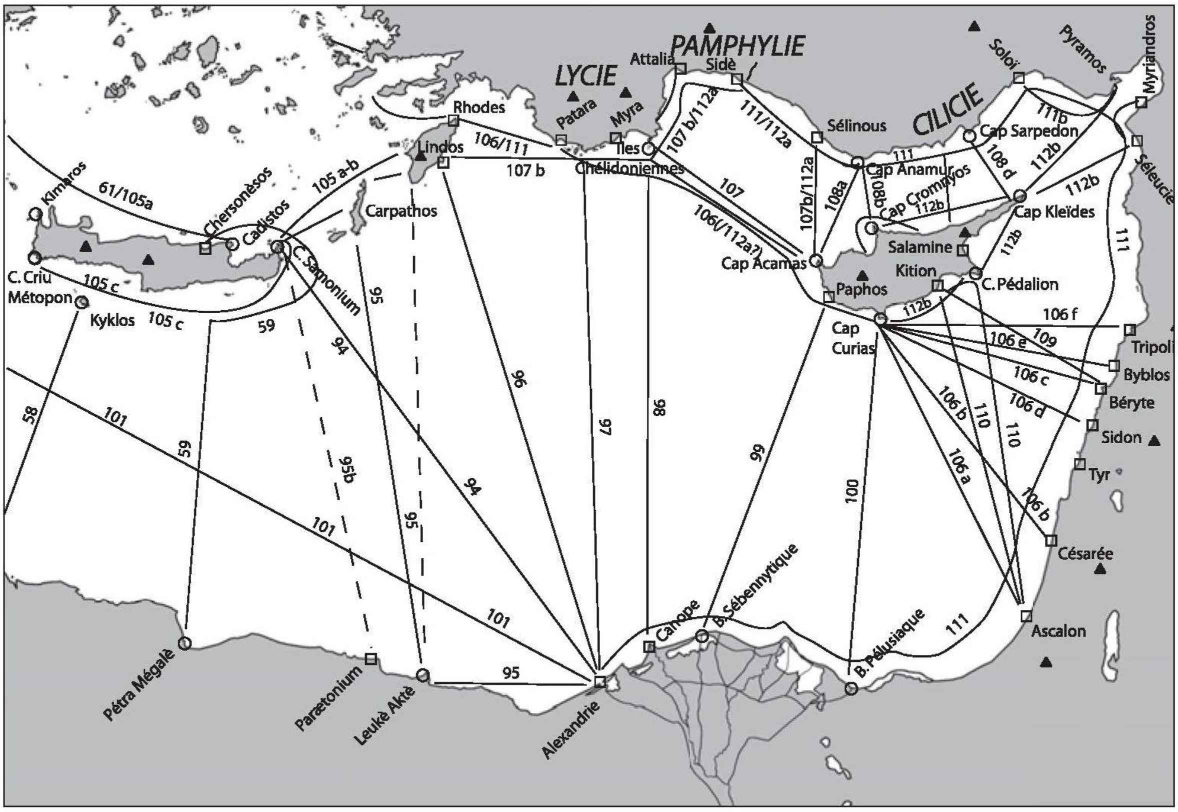


Figure 4-7 Connections between Different Cities in the Mediterranean during Antiquity (P. Arnaud, 2005)

Shipwrecks:

The studied shipwrecks discovered on many maritime sites on the Levantine coast raises the possibility of unearthing Bronze Age to Islamic wrecks off the shore of Lebanon.

One shipwreck off the coast of Tyre was investigated between 2006 and 2010, at a depth of 34 meters, 4.5 Km North-West from Tyre, allowing the recovery and study of the artefact that constituted the cargo: a large amount of clay statues, both of female and male figures, dated between the 6th and 4th c. B.C.

The main shipwreck discoveries of interest in the vicinity of the Lebanese coast are:

- In 1997: The shipwrecks of Tanit and Elissa were discovered at a depth of 400 m, 33 miles off the shore of the Ashkelon coast. The cargo of Tanit consisted of some 385 amphorae, while Elissa carried some 396 amphorae. Both ships yielded amphorae produced on the Levantine coastal cities, around 750 – 700 B.C.
- In 1999: two ships dated to 750 B.C. that had set sail from Tyre were found at a depth of 1,500 feet about 30 miles off the coast to the south of Tyre. The ships were "almost perfectly preserved – a result of the bitterly cold deep-sea waters, where sunlight cannot reach, pressure is intense and sediment scarcely accumulates".

- In 2014: Phoenician shipwreck dated to 700 B.C. was discovered 1 mile off the coast of Malta, at a depth of 400 feet.

As of the 1990s, studies on the Lebanese coast have gained in significance, consolidating both the ancient texts and land archaeological evidence.

The prominence of the Phoenician's skills in terms of navigation and trade, the results of coastal investigations and the historical records lead to the expectation of significant discoveries off the shore of the Lebanon.

4.5 SEA WATER QUALITY

4.5.1 *Physical characteristics of seawater*

Lebanese waters have a salinity that fluctuates between 39.25 PSU in April and 39.75 PSU in September. Averages of sea water surface temperature vary from a minimum of 17 °C in February to a maximum of 30°C in August.

The Levantine Basin is known to be oligotrophic and is characterized by the succession of two annual thermal phases: cold phase in winter and warm phase in summer, separated by two short inter-seasonal periods in spring and autumn.

4.5.2 *Chemical characteristics of seawater*

Several sources of pollution affect water quality in the Eastern Mediterranean Sea including Lebanon, ranging from river discharge, to industrial effluent, to untreated wastewater and presence of coastal dumps and landfills, amongst others. Increasing values of pollution in seawater over the years was reported especially in front of major coastal cities of Lebanon, thus reflecting the negative impact of anthropogenic sources (discharge of untreated sewage, solid waste, port activities, etc.).

There are however important gaps in data related to the chemicals characteristics of seawater in Lebanon due to insufficient long-term monitoring data. Pollution of seawater is expected to further deteriorate if land-based sources of pollution are not effectively controlled.

4.6 SEDIMENTS QUALITY

There is a general lack in the availability of long-term monitoring data on sediments quality.

4.7 AIR QUALITY AND CLIMATE CHANGE

Ambient air quality can be characterized through the monitoring of various pollutants including ground level ozone (O_3), Nitrogen dioxide (NO_2), particulate matters (PM_{10} and $PM_{2.5}$), Sulfur dioxide (SO_2), carbon monoxide (CO) and benzene. Available monitoring data, mainly from studies and from results of the government's Air Quality Monitoring Network (AQMN), indicate the following:

- ✓ O_3: exceedences from allowable levels have been observed with higher values in Baalbeck (Bekaa plain) than in Beirut (coastal); highest values are observed in the summer as meteorological conditions are more favorable for the formation of ozone; these results need to be confirmed by more recent ambient air quality monitoring data.
- ✓ NO_2: levels monitored throughout different field campaigns and studies at various stages since 2004 before it was consistently monitored as of 2013 (Phase I AQMN) were higher than WHO guidelines of 40 µg/m³ but were compliant with NAAQS (Decision 52/1) at 100 µg/m³. It is important to note that with the adoption of the new Air Quality Law in Lebanon, national ambient standards should meet at least WHO values, in which case compliance status with standards will change.
- ✓ PM_{10} and $PM_{2.5}$: PM measurements comprise many years of observation from short to medium term field campaigns in different locations of Greater Beirut Area. PM values always exceeded annual WHO guidelines for PM_{10} and $PM_{2.5}$, set at 20 and 10 µg/m³ respectively, but showed some exceedance in PM_{10} levels of the Lebanese NAAQS set at 80 µg/m³. PM_{10} and $PM_{2.5}$ levels recorded in Tripoli Urban Center since 2000 showed values of PM always above WHO guidelines. PM_{10} levels exceeded the Lebanese NAAQS (Decision 52/1) in several cases.
- ✓ SO_2: levels measured from December 2004 till July 2006 within Beirut showed low SO_2 concentrations of 8 $\mu g.m^{-3}$ compliant with NAAQS (80 µg/m³) (Decision 52/1); Observed values in 2014 were all compliant with the Lebanese standards for the different averaging periods.
- ✓ CO: levels measured from December 2004 till July 2006 and since 2013 do not indicate any important concentrations in Beirut background even at peak hours hence always being compliant with NAAQS (Decision 52/1).
- ✓ Benzene: Measurements of benzene conducted in suburban Beirut in summer 2011 and winter 2012 showed average levels of benzene of 2 µg/m³. While this is compliant with NAAQS (16.2 µg/m³), it is associated with an excess lifetime risk of leukemia according to WHO standards (less than 1/100,000).

The relatively limited monitoring data indicate that certain contaminants, particularly NO_2, particulate matters and ozone are already subject to exceedences to standards. Main contributors to air pollution in Lebanon are electricity generation, transport, and industry. A large fraction of these emissions are concentrated in main coastal cities including Beirut, Zouk Mikael, Jiyeh, and Chekka.

On-going plans to avail imported natural gas to coastal power plants in Lebanon could significantly reduce sources of air pollution and help improve air quality in coastal cities. Further enforcement of environmental compliance would also contribute to reducing air pollution from the industrial sector. Major public transport infrastructure and initiatives to promote hybrid and electric cars in Lebanon would further reduce emissions from transport sector.

In terms of Greenhouse Gas (GHG) emissions, it was estimated that in 2013, Lebanon emitted around 26,285 Gg $CO_{2equivalent}$ with the most significant GHG being carbon dioxide, primarily produced from the burning of fossil fuels. CO_2 removals from the land use, land use change and forestry category amounted to 3,518.80 Gg CO_2, bringing Lebanon's net emissions down to 22,766 Gg $CO_{2equivalent}$. It was also perceived that the main contributor to GHG emissions is the energy sector with 56% of GHG emissions, followed by transport (23%), industrial processes (10%) and waste sector (7%).

Lebanon aims to reduce them by 15% as an unconditional target and 30% as a target conditional to financial and technical support. The GoL is committed to this under the Nationally Determined Contributions (NDC) submitted under Paris Agreement which Lebanon signed in 2016. Total cumulative **unconditional** reduction in 2030 compared to the BAU scenario is **1,511,675 Gg** while **conditional** reductions amount to **3,616,075 Gg**. This reduction will originate from the implementation of policies and activities for the power, transport, waste and forestry sectors.

4.8 NOISE

No measurements of underwater noise currently exist in Lebanon. Gaps in such data should be filled by future environmental monitoring campaigns.

With respect to ambient noise levels in coastal cities, and although there is no systematic monitoring of ambient noise, a review of ambient noise levels at a total of 33 coastal locations were retrieved from previous studies and environmental surveys conducted by ELARD as part of EIA studies.

Exceedences in noise levels with respect to national standards (MoE Decision No. 52/1/1996) were witnessed in 17 points out of 33 monitoring points. Noise levels exceeding the national standards in North Lebanon occur in the city of Tripoli only, whereas the bulk of noise levels exceedences occur along the coastal areas in central Lebanon, whereby noise levels varied between 66 and 76.8 db(A) depending on site characteristics such as proximity to major roadways like Charles Helou Highway, other noise sources, and the relative elevation of roadways and receptors.

4.9 SOCIO-ECONOMICS

4.9.1 Economy

The Lebanese economy has been witnessing a reduction in growth since 2004 due to local and regional political and security uncertainties. In more recent years, this has been accelerated by the Syrian crisis which increased the pressure on Lebanese resources. GDP growth dropped to 0.9% in 2011. It increased to 2.8% in 2012, slowed again in 2013 with a drop to 2.6% and 2% in 2014 to reach 0.8% in 2015 before increasing again as of 2016. Some key facts are presented below based on the draft Economic Vision Report published by the Ministry of Economy and Trade late 2018.

Overall, real GDP growth between 2010 and 2017 is reported to be 1.3%. GDP in 2016 is reported at 51 Billion USD of which contribution from Agriculture/ Forestry and Fisheries (3% GDP), Manufacturing (10% GDP) and Hotels & restaurants (representing tourism sector) (3%) is only 16%. These sectors employ only 26% of labor force (total labor force in 2016 estimated at 1,977,000 persons).

Inflation in 2016 is reported to about 2.6%.cDeficit in National Budget in 2016 was 4.9 billion USD.

Based on the economic vision (not yet endorsed by the Lebanese government), if implemented (it does not consider the impacts from the oil and gas sector), economic growth would improve by primarily investing into agriculture, industry, tourism, knowledge economy, financial services and diaspora support. Targets for the year 2025 are to reach 5 to 6 % real GDP growth, 80 billion USD GDP, and an additional 370,000 jobs.

4.9.2 Population, Demographics and Living Conditions

The total Lebanese population estimate is 4.3 Million. The total displaced persons from Syria are around 1.5 Million. Total of Palestine displaced persons in around 495,985. Some additional baseline metrics cover (2017):

- ✓ Average population growth rate is 1.5%
- ✓ Age segregation: 27.4% of Lebanon's resident population is youth; aged between 15-29 years
- ✓ Life expectancy at Birth: 81.2 years
- ✓ 2,871 schools, one public university and 47 private universities in addition to vocational schools
- ✓ Unemployment rate: 15 to 25% of active population (according to the Economic Vision baseline values); 21.6% are youth
- ✓ Unemployment rates are particularly high for women (18 %) and youth (21.6%)
- ✓ Around 27 to 28.5% of the population were considered poor and were living below 3.884 USD per person per day between 2008 and 2011 with 10% of the population were extremely poor. This has risen by 6% between 2011 and 2015, after the Syrian crisis erupted in 2011.
- ✓ According to the National Poverty Targeting Program (NPTP), every household living below 3.84$/capita/day is classified as an extreme poor Lebanese household. Until December 2013, a total of 42,703 households were classified as extremely poor.

According to the draft Economic Vision, unemployment rates could decrease to 8% by 2025 and 6% by 2035.

4.9.3 Fisheries Sector

Lebanese fisheries are artisanal or traditional in nature, with the country's coastal waters containing more than 80 fish species being of commercial importance.

Fishing usually occurs to a maximum depth of up to 200 m, while most activities take place at an average depth of 50 m.

The main gears include trammel nets, gill nets, long lines, purse seine nets (lampara) and beach seines.

The number of licensed fishing vessels in 2015 stood at 2193 boats operating from 44 fishing harbors and landing sites along the entire Lebanese coastline.

Lebanon also relies heavily on imported fish with around 20,100 tons/ year of demand with an average of 6.03 kg per capita/year.

Fisheries data obtained from the Ministry of Agriculture (MoA) for the year 2017 reveal that the total catch in 2017 was about 3,536 tons**.** The highest catch was recorded for 2 species: *Etrumeus teres* (640.8 tons per year) and *Engraulis encrasicolus* (548.1 tons per year), followed by 242.7 tons and 219.2 tons per year for *Boops* and *Pagellus acarn* species. Significantly lower catch for other species (less than 200 tons per year) were observed.

Due the importance of the fisheries sector and in order to improve the fishermen's wellbeing, several initiatives were launched addressing the problems plaguing the sector:

- Catch/Effort initiatives
- Biological parameters and stock assessment initiatives
- Socio-Economic initiatives
- Capacity building and Awareness initiatives
- Management initiative

As indicated in the Economy section above, the entire agriculture sector (including fisheries) contributes to a modest 3% to the Lebanese GDP. If the new draft Fisheries Law is approved by the Lebanese parliament, it shall enable fisheries to be extended to the entire Lebanese EEZ. This means that the Lebanese fisheries sector would eventually shift from an artisanal sector to a more industrial one, eventually leading to an increase in the sector's contribution to the Lebanese GDP.

4.9.4 Tourism Sector

Tourism is a priority industry for economic development in the country. Around 1.9 million tourist arrivals to Lebanon were recorded in 2017 which increased since 2012. Tourists originate mostly from Europe (34.5%), Arab countries (30%) and Americas (17.5%).

Tourism infrastructure in terms of accommodation is considered sufficient with an average occupancy rate of Beirut Hotels in 2016 was 59%.

Tourism currently contributes 1.6 billion USD to the national GDP (roughly 3% of total GDP) and according to the Economic Vision, tourism contribution to GDP could increase to 3.7 billion USD in 2025 and 5.4 billion USD in 2035. Number of jobs offered by the sector and the total number of tourists could also increase.

4.9.5 Industry

The industrial sector in Lebanon suffers from a lack of competitiveness due to sub-optimal infrastructure and a relatively high cost of energy. There is also a general lack of industrial zones to provide an adequate environment for industries to operate from. GDP contribution from the industrial sector stands at 4.6 billion USD in 2017 (around 10% of GDP) and could increase to 8 billion USD by 2025 and 11.7 billion USD by 2035 should the economic vision be implemented. In terms of jobs it currently employs around 185,000 persons, and number of jobs could increase to 240,000 in 2025 and 250,000 in 2035.

4.9.6 Transport Infrastructure

Lebanon suffers from a very poor infrastructure ranking 113th out of 137 countries in terms of quality of infrastructure (WEF, Global competitiveness report, 2017-2018). Only 15% roads are considered to be in good condition, with high traffic congestion on main highways and a general lack of public transportation. Demand exceeds capacity at the Beirut International Airport with a 6 million traveler's capacity versus an 8 million travelers demand. Ports face a high dwell time with dwell time at Beirut Port being 13 days and an inefficient integration between different ports and roads.

However plans to improve infrastructure are currently underway. These include the expansion of Beirut International Airport and the Khalde – Okaybe expressway, public transport infrastructure (Bus Rapid Transit (BRT), feeder buses project, the coastal railway between Beirut and Tripoli, and Tripoli and the Syrian border). If implemented, these projects could significantly alleviate traffic on main roads and enhance overall Lebanese competitiveness and trading ability with neighboring countries.

4.9.7 Electricity

The electricity sector in Lebanon relies mainly on thermal power plants, with limited contributions from renewable sources of energy (mainly from hydropower and solar). However contribution from renewable sources of energy is targeted to reach 12% by 2020 and 30% of the energy mix by 2030. Thermal power plants rely primarily on imported liquid fuels to generate electricity. Due to shortages in supply, diesel generators are widely used in Lebanon to fill the supply gap, imposing additional costs to the population and further pressure on air quality.

The Lebanese Oil Installations (LoI) have launched a tender to procure three (3) offshore LNG terminals with Floating Storage and Regasification Units (FSRUs) to import Natural Gas as LNG (import capacity of up to 3.5 million tons of LNG) to be able to gasify the existing and planned power plants. If the project is implemented, natural gas will start feeding power plants in Lebanon. If natural gas discoveries are made in the future in Lebanon, it could then replace imported natural gas with cheaper gas and hence contribute to economic development as well as energy security in the country.

4.9.8 Waste Management

Lebanon suffers from a general lack of adequate waste management infrastructure. Non-hazardous wastes, with a generation rate estimated at 2,263,000 tons per year, are still largely landfilled with a relatively low percentage of waste recovery or recycling (only 15% of generated waste). Hazardous wastes yearly generation is estimated at 50,000 tons. These types of wastes are either stored by waste generators or exported via the Basel Convention, or inadequately disposed of in the environment.

With the recent adoption of the Integrated Solid Waste Management Law by the parliament (Law No. 80/2018), some improvements in the sector are expected to be achieved. The Ministry of Environment plans to establish three interim storage facilities for hazardous wastes with the support of the private sector.

4.9.9 Water Supply

According to the State and Trends of the Lebanese Environment Report of 2010, the available water exceeds projected water demand for 2035; however, these resources are under stress due to pollution, overexploitation of groundwater, and poor water infrastructure which limits the ability to meet future water demands. The average rate of the Lebanese population connected to the public water network does not exceed 80%, varying from 96% in Beirut to only 55% in North Lebanon. Most of the existing networks are aging, poorly maintained, and losing large quantities of non-revenue water (FRANSABANK, 2018).

4.9.10 Health

The bulk of morbidity and health care costs are burdened by Non-Communicable Diseases (NCDs), namely cardiovascular diseases (CVDs), cancers, respiratory conditions and diabetes. Occurrence of NCDs among males is more than females, which has been increasing over the past years.

In terms of mental health, 25.8% of the population experiences at least one mental disorder at some point in their lives while 10.5% experienced more than one.

4.9.11 Education

While Lebanon has a reputation of having a rather good education system, recent statistics indicate that quality of education is low compared to peers. It suffers from an outdated curriculum with latest updated from 1997, and a skill gap between the labor force demand and supply. Total number of higher education students enrolled in 2016-2017 included 85,244 students in vocational and technical education, 75,956 students in the Lebanese Public University, and 124,851 students in private universities.

Since the adoption of the Offshore Petroleum Resources Law in 2010, various universities have initiated programs related to petroleum engineering and related studies and have attracted a significant number of students. However graduates of such programs are finding difficulties in obtaining jobs.

5. LEGAL AND POLICY ANALYSIS AND COMPATIBILITY

The analysis of the main relevant legislation, standards, international treaties and agreements and national plans and strategies, their key requirements and implications to E&P activities in addition to roles and responsibilities of the various stakeholders are presented in **Volume 3 of the SEA report**; while the sub-sections below list the main legislations with relevance to E&P Activities. Operators and future service providers should be aware of such legal requirements and demonstrate compliance in subsequent environmental studies that shall be conducted for the different activities of the Plan.

In addition to the legal requirements presented in this section and in Volume 3, the competent authorities are preparing guidelines complementary to the regulations including, but not limited to, EIA Guideline, Exploration Plan Guideline and Technical Drilling Guideline. These guidelines should be followed by operators.

It is to be noted that the listed regulations are the ones known, available and accessible to the consultant at time of preparation and that it might not be inclusive and that it might be updated/amended.

5.1 RELEVANT LEBANESE REGULATIONS AND STANDARDS

5.1.1 Synopsis of the Petroleum Legislations

The main petroleum legislations including environmental requirements are presented below.

1. **Law No. 132/2010 (Offshore Petroleum Resources Law):** The law sets the principles and procedures for the management of offshore petroleum operations.

   It requires an SEA study prior to awarding any petroleum rights or allowing any petroleum activities and requires EIA studies for any plan for development, production, transportation, storage, utilization, cessation of petroleum activities and decommissioning. It requires a permit for venting and flaring. Article 60 stipulates that Lebanese laws for the protection of the environment shall apply to Petroleum Activities in any location to the extent such Petroleum Activities are conducted in Waters, and the MoE, in coordination with the Minister of EW, shall be in charge of supervising and controlling environmental matters related to Petroleum Activities and shall coordinate with other concerned authorities, take initiatives or measures deemed necessary to minimize negative impact that Petroleum Activities may have on local communities and the environment. Article 74 provides that a competent authority has the right to inspect an area subject to a petroleum right and any facility used for petroleum activities to monitor and verify the consistency of information and reports relating to petroleum activities or performance of petroleum activities. Article 57 requires the establishment of a safety zone[5] surrounding a Facility unless otherwise

[5] A safety zone is an area extending 500 m from any part of offshore oil and gas installations (except when within territorial waters where it could be more if warranted by risk assessments) and is established automatically around all installations which project above the sea. Vessels are required to respect the safety zones.

stipulated by a justified decision by the CoM. It includes other provisions related to safety zones.

2. **Decree No. 10289/2013 (Petroleum Activities Regulations (PAR)):** It is the main decree governing offshore petroleum activities. It details different phases licensing conditions and requirements, in addition to HSE requirements.

   Among many other environmental provisions, it sets requirements for the SEA study and requires environmental studies/ requirements to be submitted along with different plans. It requires a flaring or venting permit to be awarded by the Minister of Energy and Water. Article 141 on Environment requires the right holder to: a) Use modern technologies and practices, and operation methods that guarantee protection from environmental damage and control of wastes and avoidance of unnecessary losses and damages to the natural resources; b) Comply with Lebanese environment protection laws and regulations; c) Comply with the obligations enforced by any agreement of exploration and production or by any development plan. The Right Holder has to provide protection from: accidents and physical damage due to his activities; damage or risk of damage to workers; damage to fauna, flora, marine biodiversity and archaeology; marine pollution and pollution to springs that will be discovered during the course of petroleum activities; air pollution; damage to hydrocarbon bearing formations. The Right Holder has to assure the monitoring and implementation of mitigation measures for the impacts from all operational and accidental discharges, handling of wastes and pollutant emissions to air, sea, lakes, rivers and soil. Article 143 on Protected Areas stipulates that: if petroleum activities are to be carried out within the boundaries of a protected area within the area of the development and production agreement; the Right Holder has to acquire additional related permits from the state pursuant to the laws in force. It includes provisions related to training and employment of Lebanese and local content requirements.

3. **Decree No. 7968/ 2012 (Lebanese Petroleum Administration (LPA))**: It is related to the establishment of the Lebanese Petroleum Administration (LPA) and it sets the roles of each department.

   The QHSE department of the LPA handles all issues related to the quality of operators' systems and their compliance with the health, safety and environmental standards, particularly: review of plans related to quality of performance, health, safety and environment and emergency plans; monitoring the readiness of operators to handle accidents and emergencies; examining the extent of safety zones; coordination with the competent departments with regard to environmental matters; review of EIA studies in coordination with the competent departments; monitoring of facilities and ensuring their compliance with environmental standards.

4. **Decree No. 43- Annex 2/2017 (The Exploration and Production Agreement (EPA))**: It includes the provisions of the agreement between the Republic of Lebanon and the

Right Holder. It regulates the legal and contractual relationship between the State and the Right Holders. Article 17 is related to health, safety and environmental requirements. Among other HSE requirements, it requires the right holders and operators to comply with: (i) Best International Petroleum Industry Standards relating to the protection of health, safety and the environment; (ii) applicable Lebanese laws relating to health, safety and the environment; and (iii) the reasonable requirements of the Petroleum Administration or any other competent authority relating to the protection of health, safety and the environment. EIA studies are required in connection with: (α) a Development and Production Plan (β) the construction, placement and operation of a Transportation or storage Facility; and (γ) a plan for cessation of Petroleum Activities and decommissioning of Facilities. Section 17.2 is related Block-Specific Environmental Requirements. Article 28 related to Changes in Laws and Regulations stipulates that petroleum activities shall be conducted in accordance with all applicable Lebanese laws, as they may be amended or modified from time to time during the term of this EPA. Nothing in this EPA shall be interpreted so as to exempt the Right Holders or the Operator from the obligation to comply fully with all applicable Lebanese laws, or as modifying any applicable Lebanese laws.

5.1.2 Synopsis of the Legislative Framework for Environmental Protection

An overview of the main environmental legislations in Lebanon applicable to the offshore petroleum activities is presented below.

1. Law No. 444/2002, Environmental Protection Law: It is the environmental protection framework law. Includes the general provisions for the protection of the environment.

   Article 30 stipulates that it is strictly forbidden all discharges, immersions or burning in the Lebanese territorial waters of every material that may directly or indirectly: (i) Affect the health of human beings or natural marine resources; (ii) Harm the activities and marine creatures, including shipping, fishing, flora and seaweed; (iii) Negatively affect the quality of marine water; (iv) Reduce the entertainment value and tourism possibilities of the sea and the Lebanese coast. Article 31 requires a permit for discharge to sea (application decree not issued yet). Article 44 requires a permit for the import, handling or disposal of dangerous/ hazardous chemicals (application decree not issued). In the absence of the detailed procedures for obtaining such permits, MoE provides these approvals through the EIA process. According to the law, MOE has the powers for monitoring inspection and enforcement.

2. Decree No. 8213/ 2012, Strategic Environmental Assessment in the public sector: This Decree aims at determining mandatory procedures to be followed for the assessment of potential environmental impacts of any policy, plan, program, study, investment or organization proposal that tackles an entire Lebanese region or an activity sector, in order to ensure that these activities are compliant with conditions

related to health, public safety, the protection of the environment and the sustainability of natural resources.

3. MOE Decision No 589/2015, related to defining the procedure for the review of Strategic Environmental Assessment scoping reports (SEA scoping) and Strategic Environmental Assessment reports (SEA)

4. Decree No. 8633 /2012, Environmental Impact Assessment: This decree aims at setting forth the rules that shall be considered in the EIA of public and private projects to avoid potential environmental impacts during construction, operation and decommissioning of these projects. Annex 1 includes the list of projects that duly require an EIA study: including item #9 Oil and gas:
   - Installation of pipelines on/off the beaches
   - Excavation and extraction of oil and gas,
   - Refineries
   - Platforms
   - Tanks

   Article 5 on Project Classification stipulates that: Based on an informed review during the period mentioned above, the Minister of Environment may request an initial environmental report or an EIA report on the project regardless of its classification in accordance with paragraphs 1 and 2 of this article.
5. MoE Decision 261/1/2015: related to defining the procedures for the review of Scoping Reports (SRs) and EIA Reports.

6. MoE Decision 260/1/2015: related to defining the procedures for the review IEE Reports.

7. MoE Decision 262/1/2015: related to defining the procedures for filing and review of an objection on MoE Decisions related to EIAs.

8. Decree No. 2275/2009, Organization and mandates of the MoE, its divisions and departments.

9. Law No. 690/2005, Organization of the Ministry of Environment: The Ministry of Environment is responsible for all matters related to the environment sector.

10. MOE Decision No 189/2016, Review procedure for environmental audit studies.

11. Law 130/2019, Protected Areas Law: The Law classifies the types of protected areas, sets the requirements for their establishment, includes supervision and management requirements and sets the conditions for allowing certain activities within protected areas.

12. Law 115/2019: Paris Agreement ratification that mandates countries to submit Nationally Determined Contributions (NDCs) that reduces greenhouse gas emissions and increase resilience in order to fulfill the goal of the Agreement which is to keep a

global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

13. Law No. 78/ 2018, Law for the Protection of Air Quality: The law aims to protect ambient air quality by identifying, monitoring and assessing, preventing and controlling air pollution resulting from anthropogenic activities. This excludes air pollution caused by physical hazards, natural disasters, and occupational and indoor air pollution.

14. Law No. 77/2018, Water Resources Law: The law aims to organize, develop, and protect water resources. It also aims to promote sustainability by strengthening water establishments.

15. Law No. 80/2018, Integrated Solid Waste Management: the law sets integrated solid waste management principles. It provides guidelines for the management of non-hazardous waste and hazardous waste.

16. Decree No. 5606/ 2019, Management Procedure of Hazardous waste: The decree provides the procedure for the integrated management of hazardous waste including requirements related to generation, sorting, storage, transport and disposal. Related application decisions include:

    - Decision 59/1 dated 21/1/2020 related to hazardous waste storage facilities;
    - Decision 999/1 dated 24/12/2019 related to the transporters of hazardous waste;
    - Decision 998/1 dated 24/12/2019 related to the Generators of hazardous waste.

17. Decree No. 5605/ 2019, Waste Sorting at Source: It includes the requirements for sorting of municipal wastes at source.

18. MoE Decision No. 8/1/2001: National Standards for Environmental Quality (NSEQ) related to air contaminants and liquid waste emitted from classified establishments into receiving water bodies. Amends Decision 52-1/1996 The decisions sets the following standards: 1) Maximum emission limits of air contaminants (Annex 2/1 of this decision applied to power sector according to capacity in MW; 2) Maximum limits for wastewater discharge into the receiving water bodies and public sewers and 3) Maximum limits for wastewater discharge into sewer networks. Sector-specific standards are yet to be issued by MoE.

19. MoE Decision No. 20/1/ 2011 amends two specifications of liquid waste generated by chemical companies' to be discharged into the sea.

20. MoE Decision No. 52/1/1996,National standards for environmental quality and environmental limit values for air, noise, water and soil, Amended by MoE Decision 8/1/2001.The following standards are still applicable: 1) guide values and maximum

admissible limit values for aquatic life; 2) water quality specifications for swimming (pools, rivers, lakes, seas); 3) urban wastewater specifications; 4) national maximum allowable noise levels and the permissible noise exposure standards; 5) maximum allowable concentrations of ambient air contaminants.

21. Decree No. 3989/2016, Environmental Police: Designation of an Environmental Police Department within the Ministry of Environment to regulate environmental crimes and enforce penalties; and specification of their organization and mandates.

22. Law No.121/1992, Establishment of two nature reserves in some of the islands in front of Tripoli Beach.

23. Law No. 708/1998, Establishment of Tyr Coast Nature Reserve in Jaftlak Ras Al Ain – Tyr Real Estate Zone.

24. Decree No. 2366 /2009, National Land Use Master Plan: It classifies lands and organizes the territory.

5.2 INTERNATIONAL CONVENTIONS, TREATIES AND AGREEMENTS

Lebanon has ratified several conventions related to the protection of the environment and marine environmental resources. The conventions that are of most relevance to the offshore petroleum activities are:

- The United Nations Convention on the Law of the Sea (UNCLOS)
- Barcelona Convention and its following protocols:
  a) 1976 Dumping Protocol.
  b) 1976 Emergency Protocol.
  c) 1980 Land-Based Sources Protocol.
  d) 1982 Specially Protected Areas Protocol.
  e) 2002 Emergency Protocol.
  f) 1995 Integrated Coastal Zone Management in the Mediterranean.
- IMO MARPOL 73/78 and its annexes:
  - Annex I: Regulations for the Prevention of Pollution by Oil.
  - Annex II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk.
  - Annex III: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form.
  - Annex IV: Prevention of Pollution by Sewage from Ships.
  - Annex V: Prevention of Pollution by Garbage from Ships.
- The Convention of the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic-ACCOBAMS;

- The Agreement on the conservation of African-Eurasian Migratory Water Birds (AEWA);
- The International Convention on the control of harmful anti-fouling systems on ships, 2001
- IMO Ballast Water Management Convention;
- Basel Convention on the control of transboundary movements of hazardous wastes and their disposal;
- Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (not including NORM)
- Paris Agreement - Paris Climate Conference (COP21), part of the UNFCCC – 2015
- United Nations Framework Convention on Climate Change (UNFCCC) treaty and the Kyoto Protocol
- Vienna Convention for the protection of the ozone layer
- Montreal Protocol on substances that deplete the ozone layer and Copenhagen amendment
- UNESCO Convention on the Protection of Cultural & Natural Heritage, 1972
- Convention on the Protection of the Underwater Cultural Heritage, 2001
- The Convention on wetlands of international importance – (Ramsar)
- Convention on Biological Diversity (CBD)
- Cartagena Protocol on biosafety
- Stockholm Convention on Persistent Organic Pollutants
- Sendai Framework of Action for Disaster Risk Reduction
- Minamata Convention on Mercury
- IMO International Convention on Civil Liability for oil pollution damage (CLC) (1969)
- IMO International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC)
- IMO International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKER)
- The International Convention relating to the Limitation of the Liability of Owners of Sea-Going Ships, and Protocol (Brussels, 1957); this convention was replaced by The IMO Convention on Limitation of Liability for Maritime Claims (LLMC),1976, but the LLMC has not been ratified by Lebanon.

5.3 PLANS, PROGRAMS AND STRATEGIES

Main national plans, programs or strategies that could have implications on E&P activities are presented in Table 5-1 including a compatibility analysis of E&P activities with them.

Table 5-1 National Plans, Programs and Strategies[6]

#	Title	Year	Key Requirements	Implications to E&P activities and compatibility
1.	Lebanon's commitment to the UN sustainable development goals, 2030	2017	In September 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development that includes 17 Sustainable Development Goals (SDGs). Building on the principle of "leaving no one behind", the new Agenda emphasizes a holistic approach to achieving sustainable development for all.	E&P activities shall consider the SDGs and contribute to the extent possible to the related goals. The SDGs are used for developing the SEA framework, as applicable, to ensure alignment of E&P activities with the SDGs. E&P activities are expected to contribute towards achieving the SDGs related to social and economic conditions due to revenues and job creation. Compatibility with environmental and health related goals and targets is subject to adherence to standards and regulatory requirements.
2.	Sustainable Consumption and Production National Action Plan/ MoI	2015	SCP-NAP is a first step in response to the 2015 adopted SDGs and in particular Goal 12: Ensure Sustainable Consumption and Production patterns. In a multi-stakeholder and inclusive process Lebanon developed a national SCP Action Plan for the Industrial Sector to promote Sustainable Consumption and Production patterns, with a special focus on the Litani Basin and Qaraoun Lake. It identified 3 operational objectives:	The objectives of the action plan shall be followed by the petroleum activities. No incompatibility is identified.

[6] The table is not exhaustive. It includes most relevant plans, programs and strategies to E&P activities.

#	Title	Year	Key Requirements	Implications to E&P activities and compatibility
			- Adopt Best Available Techniques to promote SCP in the industrial sector; - Introduce SCP approaches related to the industrial sector in the policy and institutional frameworks; - Educate and raise awareness of consumers on SCP in the industrial sector;	
3.	The Integrated Vision for Lebanese Industrial Sector for 2025/ MoI		The plan of the MoI sets the operational objectives: - Expansion of domestic market - Increase of industrial exports - Increase of the competitiveness capacity of the national industry, internally and externally with consistency and steadiness. - Increase of investment and financing in the industrial sector - Encouragement of green industries - Encouragement of new knowledge Industries - Media for the industry	The E&P activities can contribute to achieve some of the objectives of the plan of the MoI, specifically: - Increase industrial exports - Increase competitiveness of the national industry No incompatibility with E&P activities is identified.
4.	Policy Paper for the Electricity Sector (Electricity Reform Paper), MoEW	2010 Prepared by the MoEW in June 2010, and adopted by GoL in 2011	An Integrated Electricity Strategy was set within the Electricity Reform Paper. It addressed the following areas: I. Infrastructure: 1. Generation, 2. Transmission, 3. Distribution II. Supply and demand: 4. Fuel Sourcing, 5. Renewable Energy, 6. Demand Side Management / Energy Efficiency, 7. Tariffs III. Legal Framework The Policy Paper constitutes a global framework for the power sector in Lebanon, and constitutes 10 strategic initiatives. According to the Policy, the power sector will have more than 4,000 MW generation capacity in 2014 and 5,000 MW after 2015, in addition to reliable transmission and distribution networks. The Policy calls for resources diversification such that natural gas will constitute 2/3 of the fuel mix with multiple sources of supply; more than 12% of energy used for power generation will be renewable energies by 2020.	E&P Activities could provide gas sources which would help achieve the set fuel sourcing policy. No incompatibility with E&P activities is foreseen.

#	Title	Year	Key Requirements	Implications to E&P activities and compatibility
5.	Second National Energy Efficiency Action Plan	2016	The Second National Energy Efficiency Action Plan for the republic of Lebanon, NEEAP 2016-2020, continues and builds on the initiatives proposed in the first NEEAP 2011-2015. The NEEAP 2016-2020 is divided into two main section: - The power sector measures: which tackle energy efficiency in electricity generation, transmission and distribution. - The end-use measures: which tackle Horizontal End-Use measures, End-Use measures in the Building Sector, End-Use measures in the Industry and Agriculture, Measures in Mobility and Transport and End-use measures in The Public Sector.	The Second National Energy Efficiency Action Plan guides national plans for oil and gas utilization. No incompatibility with E&P activities is foreseen.
6.	Land Transport Sector Strategy	2016 -2017	• Greater Beirut Urban Transport Project • Rehabilitation of the Coastal Railway between Beirut and Tripoli • Rehabilitation of the Coastal Railway between Tripoli and the Syrian Border	Potential onshore facilities and pipelines shall consider the railway corridors. No incompatibility with E&P activities is foreseen.
7.	The National Renewable Energy Action Plan for the Republic of Lebanon- 2016-2020/ MoEW	2016	The NREAP 2016-2020 is the main national document that will lead the way for Lebanon to develop the different RE technologies needed to reach the 12% target by the year 2020. It offers a detailed description of the different RE technologies to be used in Lebanon to meet the 2020 objective, including the target for each technology, the financial appraisal of the technology, the needed budget, and the way forward. It discusses the policies and tools that Lebanon needs to follow and use to reach the set objectives including legal issues and legislation, awareness raising, capacity building, quality control, financing mechanisms, and grid code.	Petroleum sector development and the potential energy supply from petroleum sources shall not contradict with the renewable Energy target set in the action plan (12%). No incompatibility with E&P activities is foreseen as long as national efforts to develop RE technologies are continued.
8.	Lebanon's National Strategy for Air Quality Management for	2017	The strategy is composed of 6 strategic goals and allows the GoL to identify the needed outputs and activities to meet the vision set forth in the strategy by 2030 at the level of each goal. The strategic goals together with their outputs and activities provide a framework for action	The sector to consider the strategic goals and take the required measure. E&P activities will not improve air quality

#	Title	Year	Key Requirements	Implications to E&P activities and compatibility
	2030/ MoE		at short-, medium- and long-term level and allow the concerned stakeholders to use the strategy as a basis for identification of needed interventions. The goals identified in the strategy are: - Strengthening the Legal & Institutional Framework - Improving AQ Assessment Throughout the Territory - Solving AQ Problems Due to Stationary Sources in Degraded Airsheds - Solving AQ Problems from Mobile Sources - Mainstreaming AQ Management in Priority Sectors - Communication & Outreach on AQ	nor solve air quality problems, however, air quality management within the offshore petroleum sector is considered.
9.	Lebanon's Nationally Determined Contribution under the UNFCCC / MoE	2015	Lebanon's mitigation included: <u>Unconditional Target:</u> - GHG emission reduction of 15% compared to the Business- As-Usual (BAU) (2011) scenario in 2030. - 15% of the power and heat demand in 2030 is generated by renewable energy sources. - 3% reduction in power demand through energy-efficiency measures in 2030 compared to the demand under BAU scenario. <u>Conditional Target:</u> - A GHG emission reduction of 30% compared to the BAU scenario (2011) in 2030. - 20% of the power and heat demand in 2030 is generated by renewable energy sources. - A 10% reduction in power demand through energy-efficiency in 2030 compared to the demand under the BAU scenario. The conditional mitigation scenario covers the mitigation actions under the unconditional scenario, as well as further mitigation actions which can be implemented upon the provision of additional international support. The NDC covers the sectors of: Energy, industrial processes and other	GHGs from the petroleum sector shall be controlled to achieve the targeted GHGs emissions reduction from the energy sector. E&P activities are not compatible with the NDC as it will increase GHGs in the energy sector; this adds additional pressure on other components of the energy sector to achieve the committed reduction rates in GHGs.

#	Title	Year	Key Requirements	Implications to E&P activities and compatibility
			product use, agriculture, land-use, land-use change and forestry, and waste.	
10.	Lebanon's Marine Protected Area Strategy/ MoE	2012	The document proposes new MPAs in addition to the two existing sites and sets the MPAs management strategy which aims to fulfil the following objectives: - To establish a more systematic approach to marine protected areas planning and establishment; - To enhance collaboration for management and monitoring of marine protected areas; - To increase awareness, understanding and participation of the local community in the marine protected areas network; and - To link Lebanon's network of marine protected areas to Mediterranean networks.	During offshore petroleum activities, it is necessary to adhere to the requirements of the strategy and set measures to protect MPAs and proposed sites. Compatibility is subject to adherence to the requirements of the strategy and applicable standards and regulations.
11.	Lebanon's 5th National Report to the Convention on Biological Diversity/ MoE	2015	It provides an update on biodiversity status, trends, and threats and implications for human well-being and provides the national biodiversity strategy and action plan.	National targets and national actions relevant to the program shall be adhered to, especially targets related to preserving threatened species, control the introduction and diffusion of IAS into the environment and sustainable management of natural ecosystems. Compatibility is subject to adherence to the requirements including national targets and actions.
12.	Lebanon's National Biodiversity Strategy and Action Plan/ MoE	2016	It addresses Lebanon's obligations under Article 6a of the Convention on Biological Diversity (CBD) and is an update of the country's first NBSAP issued in 1998. The revised NBSAP was aligned with the new CBD strategic goals and integrated the 2020 Aichi Biodiversity Targets while taking into consideration both global and local needs and aspirations, as well as reflecting Lebanon's specific realm and the current existing professional capacities and awareness levels. One of the main	National targets and national actions relevant to the program shall be adhered to, especially targets related to preserving threatened species, control the introduction and diffusion of IAS into the environment and sustainable management of natural ecosystems.

#	Title	Year	Key Requirements	Implications to E&P activities and compatibility
			objectives of the NBSAP is to mainstream biodiversity into sectorial and cross-sectorial strategies, plans and programmes.	Compatibility is subject to adherence to the requirements of the strategy and action plan.
13.	Palm Islands nature reserve management plan 2000-2005	2000	Management plan for Palm Islands nature reserve	Requirements of the management plan shall be adhered to. Compatibility is subject to adherence to the requirements of the management plan.
14.	Ministry of Agriculture strategy 2015-2019/MoA	2014	The strategy sets three objectives, eight main courses of action including 30 components and 104 areas of intervention. Fisheries related actions include: - Improve the contribution of agriculture to the economic and social development of the country - Support investment in the fisheries and aquaculture and improving sustainable management of the sector	Petroleum activities shall not negatively affect the requirements of the strategy. Compatibility is subject to adherence to the requirements of the strategy.
15.	National Oil Spill Contingency Plan in the Lebanese Waters/ MoEW	2017	The objectives of the NOSCP match and amplify the International Maritime Organization (IMO) objectives for a NOSCP, and as such it: - Establishes a viable operational organization with representation from all concerned agencies. - Identifies the national high risk areas. - Identifies priority coastal areas for protection and clean-up. - Provides a minimum level and appropriate types of pre-positioned pollution response equipment in accordance with article 6(2) of the OPRC Convention. - Prevents the spread of further pollution from identified oil spills. - Controls the spill source and clean-up existing pollution. - Employs Net Environmental Benefit Analysis (NEBA) to ensure that the chosen recovery strategies do not cause further damage to the	Procedure and requirements of the plan shall be followed in case on oil spills of all tiers. Compatibility is subject to adherence to the requirements of the plan.

#	Title	Year	Key Requirements	Implications to E&P activities and compatibility
			environment.	
16.	Integrated Solid Waste Management Policy	2018	Sets the overall guiding principles and requirements for solid waste management in Lebanon. Regarding hazardous wastes, MoE shall prepare a feasibility study and shall take the necessary steps to build there interim hazardous wastes storage sites and build needed treatment facilities.	Management and disposal of wastes generated by petroleum activities and establishment of waste management infrastructure shall be in line with the requirements of the policy. Compatibility is subject to adherence to the requirements of the policy.
17.	Lebanon SME Strategy: A Roadmap to 2020	2014	Initiated by the Ministry of Economy and Trade to ensure the long term planning and support for a key sector of the Lebanese economy. The study proposes a national strategy for Lebanon's entrepreneurs and SMES with the ambitious vision of: SMEs as Key Economic Engine for Growth and Job Creation Achieving the vision is incumbent upon all stakeholders to execute the mission: Foster the Creation of Vibrant and Globally Competitive SMEs that Contribute to Employment Opportunities and High Value-Added Economy.	The petroleum sector will provide opportunities for SME in fields related to the petroleum sector. No incompatibility is identified.

5.4 ENVIRONMENTAL GOVERNANCE

Sound environmental governance and regulation of the offshore Oil & Gas sector shall give assurance to:

- Prevent and reduce as far as possible the occurrence of major accidents and limit their consequences on people, environment and assets;
- Preserve and protect the environment and communities, in particular the marine environment and coastal economies against pollution;
- Conservation of Lebanon's natural resources;

Lebanon has a unique opportunity to create a fit for purpose HSE governance system for a nascent industry in Lebanon. In order to achieve this, the HSE Governance Framework shall:

1. Ensure the establishment of a well-defined mandate for regulating, monitoring and enforcing the HSE matters throughout the sector's life cycle
2. Clearly define the roles and responsibilities, commitments and liabilities of all involved stakeholders in the sector.
3. Integrate Health, Safety and Environmental aspects within the sector's management, including Major Accident to the Environment, rather than adopt an aspect approach.
4. Ensure that the HSE regulator is independent from economic regulator (resources management). This can be achieved through structural or functional arrangements.

The petroleum regulations clearly identify MOEW-LPA as the main regulator of the sector, where the integrated approach to HSE is, to a great extent, achieved in the mandated role of the Quality, Health, Safety and Environment (QHSE) department within LPA which supervises and oversees the implementation and compliance of HSE aspects, while also recognizing the need for coordination with other relevant entities at multiple instances. Meanwhile, the independence between HSE and economic management and regulations is not assured in the current governance arrangements.

It is of utmost importance to emphasize the need of independence of the HSE and economic management and regulations where following every major accident in the world where a credible investigation has been made, a lack of independence of the HSE regulator(s) from economic regulation was found to be at issue. In its main study preceding EU-wide legislation in 2013, the European Commission found the independence factor a cornerstone of best regulatory practice.

It is not always practicable to ensure complete separation of the HSE regulator from the officials exercising economic regulation. One reason may be that the scale of the sector does not warrant or fund a regulator of sufficient size to stand alone from the licensing authority of the country. The HSE EU Directive have recognized that the ambition is to achieve independence between HSE and economic regulations however it has recognized that for emerging oil and gas countries (similar to Lebanon), this independence can be waived for early stages (first couple wells) as investment in independent regulators might not be justified as well as pooling of capacities, competences and resources would be helpful at these early stages.

6. STAKEHOLDERS ENGAGEMENT AND CONSULTATION ACTIVITIES

Stakeholder engagement activities conducted as part of the SEA process included:

1. Establishment of a task force that includes:
   - Ministry of Energy and Water (MoEW)/LPA
   - Ministry of Environment (MoE) – SEA review committee members
   - Ministry of Public Works and Transport (MoPWT)
   - National Centre for Marine Sciences (NCMS)
   - Ministry of Agriculture (MoA)/ Fisheries
   - Ministry of Social Affairs (MoSA)
   - Ministry of Economy and Trade (MoET)

   The SEA team held three meetings with the task force that aimed to discuss the progress, provide data and validate the findings of the SEA process, update and ensure consistency with relevant sectors' strategies, policies and plans.

2. Bilateral meetings with several stakeholders for data collection.

3. The First Consultation Workshop: This workshop was held on April 26, 2018 and was organized in such a way as to facilitate and maximize the participation of stakeholders from government, local authorities, international organizations, research and academic institutions, civil society and the private sector. The workshop brought together governmental and non-governmental stakeholders including private associations, experts, academics, researchers as well as civil society representing 38 different entities.

   Participants were distributed in six (6) thematic working groups based on their area of expertise and/or interest. Each participant was given a working booklet in order to facilitate their participation and validate aspects relevant to their field of work/ expertise/ interest. The working groups were divided as follows:

   - Working Group 1: Stakeholders related to the use of Hydrocarbons and Infrastructure;
   - Working Group 2: Affected Stakeholders;
   - Working Group 3: Marine Ecology;
   - Working Group 4: Air Quality and Climate Change;
   - Working Group 5: Emergency Preparedness and Response; and
   - Working Group 6: Waste and Chemicals.

   The discussion among the groups revolved around: 1) Regulatory and Policy Analysis; 2) Baseline Data; 3) Environmental and Socio-Economic Issues and Alternatives and 4) SEA Framework and Indicators.

Findings of the consultation workshop were integrated as applicable into the SEA study.

4. Public Consultation Process

The Draft SEA Report was published on LPA website, and written comments were accepted over a period of 7 weeks. In addition, five public consultation sessions were undertaken along the coastal towns in Beirut, Tripoli, Byblos, Saida and Naqoura between April 23rd and 25th, where discussions were undertaken and comments collected from the general public.

Feedback and comments were received from multiple entities including the general public, environmental consultancies, international organizations, NGOs, international oil companies in addition to governmental entities.

Feedback and comments from the public consultation process were integrated as applicable into the SEA study.

Volume 4 of the SEA report includes: 1) the stakeholder engagement plan; 2) a register of meetings held; 3) the minutes of meetings and 4) the first consultation workshop report, 5) proceedings of the public sessions and 6) the register of received comments during the public consultation process and the Consultants response.

7. SEA FRAMEWORK

Based on the outcomes of the analysis of the legal and policy framework, baseline conditions and stakeholders consultations, the SEA framework of objectives and indicators is developed for sustainability factors relevant to the Plan.

The assessment of impacts of the E&P activities for different scenarios and the analysis of alternative (environmental component of the analysis) are compared against the chosen indicators, answering the question: "What contribution will E&P activities make toward maintaining the sustainability factors and meeting the SEA objectives?"

The SEA framework presented in Table 7-1 has been used in the assessment of impacts of E&P activities for different scenarios and the analysis of alternative and it provides the basis of monitoring of E&P activities environmental and socio-economic impacts.

It is important to note that some targets in the SEA framework need to be achieved from the onset of petroleum activities and maintained throughout its lifetime, however, there are targets that can only be achieve with time.

Table 7-1 SEA Framework

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
1.	**Ecosystem Protection (Air)**	Sector complies with air quality national (or international in the absence of national) standards and does not significantly affect air-quality in coastal cities	Indicator 1.1: Ambient concentrations of criteria air contaminants (CO, NOx, SO_2, NMVOC, PM) in coastal cities	State	Comply with standards
			Indicator 1.2: Emissions of CO, NOx, SO_2, NMVOC, PM from the offshore petroleum sector	Pressure	Comply with standards and BAT
			Indicator 1.3: Change in concentrations of criteria air contaminants (CO, NOx, SO_2, NMVOC, PM) in coastal cities due to offshore petroleum activities	Impact	No significant [7] increase
2.	**Climate Change**	Reduce GHG Emissions from Thermal Energy	Indicator 2.1: Change in emissions of GHGs from the petroleum sector	Impact	Do not compromise national commitments to UNFCCC
			Indicator 2.2: Emissions of CO_2-e from the energy sector	Pressure	Unconditional cumulative emission reductions from energy sector by 2030(Gg):CO_2eq.:1,508,797 (Ref: NAQMS for 2030)
			Indicator 2.3: Emissions of CO2-e during exploration activities	Pressure	Minimize as per Best Available Technologies
			Indicator 2.4: Emissions of CO2-e per production unit	Pressure	Minimize as per Best Available Technologies
3.	**Acoustic**	Keep noise level below harmful	Indicator 3.1: Ambient noise levels measured in the vicinity of	State	Comply with

[7] Significant according to impact assessment criteria.

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
	Environment	standards according to national standards	petroleum facilities/ support activities in the coastal area		standards
			Indicator 3.2: Increase in ambient noise levels measured in the vicinity of petroleum facilities/ support activities in the coastal area	Impact	Do not significantly increase
		Noise levels below intervals that affect mammals	Indicator 3.3: Number of Marine Mammals affected from underwater noise from the petroleum sector	Impact	0
			Indicator 3.4: Zone of influence on marine fauna	Pressure	Minimise
4.	**Ecosystem Protection (Marine Environment)**	Prevent marine pollution of all kinds and ensure proper implementation of applicable standards within the sector	Indicator 4.1: Percent of deviation from national and international requirements of discharges to the sea from offshore petroleum activities	Pressure	0%
			Indicator 4.2: Heavy metals in sediments along the Lebanese coast and from different depth ranges	State	Comply with standards
			Indicator 4.3: Pollutants' concentrations in sediments attributed to petroleum activities	Impact	Do not increase
			Indicator 4.4: Impacts related to sedimentation on the sea bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.) due to offshore petroleum activities	Impact	Do not increase
			Indicator 4.5: Seawater chemical characteristics along the Lebanese coast across the water column	State	Do not affect negatively
			Indicator 4.6: Change in chemical characteristics of seawater attributed to petroleum activities	Impact	Do not affect negatively
			Indicator 4.7: Number of spills reaching the coast	Impact	0
			Indicator 4.8: Occurrence of submarine landslides and related impacts (Tsunamis, change of sediments particle size) due to petroleum activities	Impact	0

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
		Sector development does not affect marine and coastal protected areas and ecosystems or areas planned for protection	Indicator 4.9: Percent area of sensitive/ protected marine habitats affected by petroleum activities	Impact	0
		Sector development contribute to the management of marine and coastal ecosystems	Indicator 4.10: **Phyto and zoo benthos** (monitoring through underwater visual observations and sampling): - Species abundance. - Status of a selected indicator species. - Species richness and density. - Diversity indices.	State	Do not affect negatively
			Indicator 4.11: Changes in abundance, status, richness and density of **Phyto and zoo benthos** attributed to offshore petroleum activities	Impact	Do not affect negatively
			Indicator 4.12: **Nekton - free water fish**: - Identification and counting of species. - Diversity and dominance metrics. - Community characterization	State	Do not affect negatively
			Indicator 4.13: Changes in diversity and dominance of **Nekton** attributed to offshore petroleum activities	Impact	Do not affect negatively
			Indicator 4.14: **Sea mammals, sea turtles and seals (monitoring** through direct observation from boat): - Species abundance. - Status of indicator species (Selected from IUCN Red List) - Density of species	State	Do not affect negatively
			Indicator 4.15: Changes in abundance, status and density of **cetaceans, sea turtles and seals** attributed to offshore petroleum activities	Impact	Do not affect negatively
			Indicator 4.16: **Seabirds** (monitoring using direct observation):	State	Do not affect negatively

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
			- Species abundance. - Status of indicator species (Selected from IUCN Red List) - Density of species		
			Indicator 4.17: Changes in abundance, Status and density of **Seabirds** attributed to offshore petroleum activities	Impact	Do not affect negatively
		Sector complies to relevant standards and implements effective measures to control the introduction and diffusion of Invasive Alien Species (IAS) into the environment	Indicator 4.18: Trend of introduction of invasive species due to petroleum activities	Impact	Decline
5.	**Ecosystem Protection (Coastal Environment)**	Sector development does not cause disturbance to sensitive coastal habitats and areas of special significance	Indicator 5.1: Percent area of sensitive coastal habitats affected by impacts related to the sector	Impact	Zero
6.	**Transboundary Environmental Pressures**	Avoid incidents of transboundary impacts	Indicator 6.1: Number of incidents of transboundary impacts from the offshore petroleum activities	Impact	Zero
7.	**Environmental Governance**	Establish effective environmental governance within the sector with clear roles and responsibilities, inter-sectorial cooperation in environmental management, enhanced capacity of institutions and increased access to environmental information	Indicator 7.1: Number, effectiveness and extent of capacity building projects for the environmental competent authorities	Impact	Increase
			Indicator 7.2: Number of documented conflicts among institutions	Impact	Zero
			Indicator 7.3: Number of documented environmental and social complaints related to the petroleum sector through established grievance mechanism	Impact	Zero
8.	**Intermodal environmental parameters (Reducing**	Sector complies with relevant legislation, strategies, policies and plans for management of chemicals and all wastes throughout their life	Indicator 8.1: Quantity of hazardous wastes generated from offshore petroleum activities	Pressure	Comply with BAT
			Indicator 8.2: Percentage of hazardous waste and chemicals generated by the offshore petroleum activities properly	Pressure	100%

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
	Waste & Consumption Pressures)	cycle	managed		
			Indicator 8.3: Percentage of radioactive/NORM waste generated by the offshore petroleum activities properly managed	Pressure	100%
		Sector exploits its recycling potentials and implements appropriate recycling procedures	Indicator 8.4: Recycling rate, tons of material recycled from offshore petroleum activities	Pressure	Increase
9.	**Intermodal environmental parameters (Exposure to Natural Disasters)**	Sector complies with relevant construction standards and that appropriate measures to prevent accidents during all relevant types of natural disasters are implemented	Indicator 9.1: Direct economic loss attributed to disasters in relation to global gross domestic product (GDP) (Ref. SDGs, C110502)	Impact	0
			Indicator 9.2: Number of accidents caused by failure in infrastructure related to the sector	Impact	0
10.	**Social Conditions**	Contribute to economic development of Lebanon and subsequently to reduction of poverty	Indicator 10.1: Proportion of population living below the national poverty line	State	Decrease
			Indicator 10.2: Amount of funds received by the Lebanese Government from the sector	Impact	Increase
			Indicator 10.3: Amount of funds generated by the sector spent on poverty reduction – especially through vocational trainings and education, social welfare programmes, improved living conditions, support programmes for small businesses, etc.	Impact	Increase
		Contribute to reduction of the unemployment rate and equal working condition	Indicator 10.4: Employment rate due to the offshore petroleum sector	Impact	Increase
			Indicator 10.5: Unemployment rate, by sex, age and persons with disabilities (Ref. SDGs, C080502)	State	Decrease
		High % of sector labor force are local	Indicator 10.6: Percent local labor working for oil and gas companies or service companies	Impact	80%

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
		Sector complies with labor rights and ensures safe and secure working environments for all workers	Indicator 10.7: Frequency rates of fatal and non-fatal occupational injuries, by sex and migrant status (Ref. SDGs, C080801)from the sector	Impact	0
			Indicator 10.8: Level of national compliance with labor rights (freedom of association and collective bargaining) based on International Labor Organization (ILO) textual sources and national legislation, by sex and migrant status (Ref. SDGs, C080802)	State	Increase
11.	**General economy**	Contribute to economic development of Lebanon	Indicator 11.1: GDP attributed to the offshore petroleum sector	Impact	Increase
			Indicator 11.2: Non-oil based GDP	State	Increase
			Indicator 11.3: Oil-based GDP	State	Increase
			Indicator 11.4: Consumer Price Index (Inflation)	State	Reduce
			Indicator 11.5: Foreign Direct Investment	State	Increase
			Indicator 11.6: Foreign Exchange Reserves	State	Increase
			Indicator 11.7: Balance of trade	State	Increase positively (increase export and decrease import)
		Reduce HFO and diesel supply for centralized and decentralized power generation and replacement with natural gas as feedstock	Indicator 11.8: Volume of HFO imported for power generation	State	Reduce
		Put in place a dynamic and well-designed revenue management	Indicator 11.9: Size of SWF	State	Increase

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
		mechanism			
12.	**Education**	Provide guidance to the size and types of jobs created due to the petroleum activities	Indicator 12.1: Graduates with specific skills within the petroleum industry trained and employed	Impact	Increase
		Increase preparedness of Lebanese for jobs of recurring type and high need within the petroleum industry	Indicator 12.2: Unemployment rate of graduates with sector-related degrees reduced	State	Decrease
13.	**Heritage**	Avoid damage of coastal and offshore archaeological and heritage sites from offshore petroleum activities	Indicator 13.1: Current amount of funds available for cultural heritage protection and promotion	State	Increase
			Indicator 13.2: % of cultural and archaeological heritage sites damaged by offshore petroleum activities and related onshore activities.	Impact	0
14.	**Health**	No significant increase in death, illnesses and disabilities related to exposure to sector's hazardous chemicals, air and water pollution	Indicator 14.1: Population with cardiovascular system diseases, respiratory system diseases, cancers and disabilities attributable to offshore petroleum sector	Impact	Do not increase
15.	**Crime**	Reduce risks of crime increase	Indicator 15.1: Number of registered crimes linked to the sector	Impact	0
16.	**Landscapes and visual amenity**	Preserve landscapes	Indicator 16.1: % of nationally classified landscapes exposed to potential impacts	Impact	0%
		Sector complies with the National Land Use Master Plan	Indicator 16.2: Deviation of petroleum facilities from the National Land Use Master Plan requirements	Pressure	None
17.	**Fisheries**	Ensure that the sector does not harm fishing production potentials	Indicator 17.1: Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	Impact	Do not affect negatively
			Indicator 17.2: Total area of where fishing activities excluded due to petroleum activities	Impact	Minimize

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
			Indicator 17.3: Fish and aquatic stock (Ref: MoA) Assessment of biological parameters allowing stock assessments of selected pelagic and demersal fish species (Length-weight relationship, Age groups, Gonado-Somatic Index, Exploitation rate)	State	Increase over a period of 10 years (Ref: MoA)
			Indicator 17.4: Cooperation in applied research and activate the partnership with the concerned institutions (Ref: MoA)	State	Increase
18.	**Shipping**	Minimize disturbance to shipping and navigation activities	Indicator 18.1: Disturbance to shipping activities from the offshore petroleum sector	Impact	Minimize
19.	**Tourism**	Ensure that the sector does not harm tourism attractions and resources	Indicator 19.1: Change in tourist arrivals	Impact	Increase
			Indicator 19.2: Occupancy of coastal/beach resorts and hotels	State	Do not decrease
			Indicator 19.3: Recreational and touristic marine activities i.e. water sports, diving	State	Do not decrease
20.	**Energy**	Potential findings are firstly used to ensure universal access to affordable, reliable and modern energy services within Lebanon	Indicator 20.1: Proportion of population with primary reliance on clean fuels (gas)(Ref. SDGs, C070102) sourced from E&P activities	State	Increase
			Indicator 20.2: Price of unit of energy from E&P activities	State	Decrease
			Indicator 20.3: Change in cost to government to avail natural gas for power	Impacts	Decrease
		Contribute to economic development of Lebanon and subsequently to financing of transition towards increased renewable energy production	Indicator 20.4: Renewable energy share in the total final energy consumption (Ref. SDGs, C070201)	State	12% by 2020 (Ref: National RE Action Plan 2016-2020) 15% by 2030 (unconditional)/ 20% (conditional)

#	Sustainability Factor	SEA Objective	Indicator	Indicator type	Indicator target
					(Ref: NDC by 2030)
		Ensure that any potential findings are firstly used for power generation	Indicator 20.5: Proportion of natural gas in fuel mix used for power generation originating from E&P activities	State	100%
			Indicator 20.6: Change towards achieving the required proportion of natural gas in energy mix originating from E&P activities	Impact	100%
21.	**Infrastructure**	Contribute to economic development of Lebanon and subsequently to financing of infrastructure	Indicator 21.1: Increase in number and capacity of hazardous waste management facilities	Impact	Increase
			Indicator 21.2: Impacts on sub-sea infrastructure due to offshore petroleum activities	Impact	None
			Indicator 21.3: Change in capacity of transport infrastructure to cope with demand	Impact	Increase
22.	**Industry**	Ensure that the sector contributes to industrial development through provision of cheap energy and supporting services	Indicator 22.1: Number of petrochemical and energy intensive industry establishments	Impact	Increase
			Indicator 22.2: Cost of energy	Impact	Decrease
		Increase the access of small-scale industrial and other enterprises to financial services, including affordable credit, and their integration into Petroleum value chains and markets	Indicator 22.3: Number of small-scale industries working in the Petroleum industry and the petroleum services industry	Impact	Increase

8. IMPACT ASSESSMENT

8.1 INTRODUCTION

Environmental impacts are any change to the environment, whether adverse or beneficial, wholly or partially resulting from a project's environmental aspects (ISO 14001:2004). The relation between aspects and impacts is one of cause and effect.

Impacts during reconnaissance activities, exploration phase, development and production phase and decommissioning phase are presented in sections 8.2, 08.4 respectively.

In each section, the environmental, socio-economic and health impacts are identified using impact identification matrices that are prepared based on the possible E&P activities during each phase and the environmental, socio-economic and health components selected for study; it shall be noted that negligible sources of impacts are not considered in the tables; then impacts identified as having the potential to be significant are described. Then, the significance of impacts is first determined considering the main existing control measures and then after additional mitigation measures are proposed. It shall be noted that impacts expected to have negligible significance are not tackled in detail. Furthermore the lists of existing control measures presented in the following sections are not exhaustive but indicative. During ESIA studies the lists should be updated as needed to ensure all applicable measures to mitigate impacts are considered

8.2 IMPACTS FROM RECONNAISSANCE ACTIVITIES

8.2.1 Impact Identification

Impacts from reconnaissance activities are expected from the operation of seismic vessels (including noise generation, atmospheric emissions, physical presence of survey vessels, waste discharges and interaction of equipment on sea bed) in addition to onshore impacts and accidental events.

The environmental and socio-economic receptors expected to be impacted from each activity are shown in the impact identification matrix shown in Table 8-1.

Table 8-1 Impact Identification Matrix –Reconnaissance Activities

Reconnaissance Activities																									
Component		**Physical Environment**						**Biological Environment**							**Others**										
	Activity	**Air Quality**	**Climate change**	**Seawater Quality**	**Sediments Quality/Composition**	**Underwater Noise**	**Above water noise**	**Phyto & zoo benthos**	**Nekton**	**Phyto & zoo plankton**	**Seabirds**	**Cetaceans, turtles and seals**	**Sensitive marine habitats**	**Terrestrial Ecology and coastal habitats**	**Archaeological & Cultural Resources**	**Infrastructure**	**Social Conditions**	**Education**	**Crime**	**General Economy /industry/energy**	**Fisheries**	**Shipping**	**Tourism**	**Health**	**Landscape and Visual Amenity**
Seismic operations	Operation of compressed air sources (Airguns)					X		X	X	X		X	X								X				
	Power generation	X	X	X		X	X																	X	
	Physical presence of survey vessels and towed equipment (including any exclusion zones[8] and lights) /collision with sea mammals/turtles					X			X		X	X	X								X	X			
	Routine vessel discharges and wastes			X	X			X	X	X		X	X								X			X	
	Interaction of equipment on sea bed			X	X			X	X				X		X	X									
Support activities	Supply vessels movement	X	X	X		X	X			X		X	X			X	X				X	X			
	On-shore Support Facilities/provision of supplies						X							X	X	X	X								X
Accidental events	Loss of cable oil	X	X	X	X				X	X	X	X	X				X				X			X	
	Diesel and other hydrocarbon spills	X	X	X	X			X	X	X	X	X	X	X	X		X			X	X	X	X	X	X
	Vessels collision/ Vessels sinking	X	X	X	X			X					X		X	X	X			X		X		X	

[8] Exclusion zones as used in the report refer to areas where activities other than petroleum related activities are not allowed.

8.2.2 Impacts on Air Quality and Climate Change

8.2.2.1 Potential Impacts

Impacts of the prospective phase on air quality and climate change along with the expected main sources of Impacts and cumulative sources of impact are shown in Table 8-2.

Table 8-2 Impacts from Reconnaissance Activities on Air Quality and Climate Change

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	✓ Power generation on the survey vessel ✓ Supply vessels movement ✓ Diesel and other hydrocarbon spills (VOCs)	✓ Ships and Vessels activities in the sea and near areas ✓ Emissions from the transport sector ✓ Pollutants generated from the manufacturing sector and Industrial areas ✓ Contaminants generated by garbage accumulation and burning ✓ Emissions from Power Generation
Increase in emissions of GHGs from the petroleum sector		

8.2.2.2 Main Existing Control Measures

The following are considered to be the main existing control measures to minimize emissions from Reconnaissance Activities:

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- Adopting BAT (Air Quality Law No. 78/2018 & Decree No. 10289/2013/PAR)
- Compliance with Ambient Air Quality Standards (Decision No. 52/1/1996), Emission Limit Values for power generation (Decision No. 8/1/ 2001) and relevant international standards.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills
- Emergency response plan (ERP) is required according to PAR

8.2.2.3 Assessment of Impacts

The consequence rating of impacts on air quality and climate change considers Lebanon's NDC commitment. The contribution was revised by the Ministry of Environment considering that the Oil & gas sector will be emitting 2.569.5 kt $CO_{2eq.}$ in 2030 (MoE, 2019). This value will be decreased by 10% to account for numerous negligible sources (including service vessels and helicopters, equipment deliveries and other activities), resulting in 2,312.55 kt $CO_{2eq.}$. Flue Gas from all kinds of sources encompasses gases air pollutants, particulate matter, and greenhouse gases that entail risks to human health and the environment in general. These include a large concentration of sulfur dioxide (SO_2) and nitrogen oxides (NOx) responsible for acid deposition and a significant concentration of Non-Methane Volatile Organic Compounds (NMVOC) contributing to the production of ground based ozone. Such gases, in significant concentrations, can be toxic and very harmful to the environment.

Sources of these emissions could vary from electricity generation and the transportation sector to the manufacturing sector and industrial areas without excluding the newly developing petroleum sector. In relation with the latter and reconnaissance activities, Ships and Survey Vessels contribute to the emission of air pollutants and Greenhouse Gases by fuel combustion for Power Generation. On the other hand, Fuel and Diesel spills from vessels' engines can also constitute a source of emissions.

In an aim to limit these emissions and their impacts during this phase, regulations and laws have been implemented and new technologies are currently being developed. In fact, the dispersive and open offshore environment facilitates the mitigation by localizing the impact of seismic activities and minimizing it. Literature reveals that the potential for emissions from seismic vessels to cause atmospheric impacts is generally low and thus, the emissions from reconnaissance activities will have a very limited, almost negligible contribution to air pollution (Marcogaz, 2010). Regardless, some recommendation measures could be suggested for further reduction in the emissions.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on Air Quality and Climate Change from Reconnaissance Activities are summarized in Table 8-3.

Table 8-3 Significance Rating of Impacts on Air Quality and Climate from Reconnaissance Activities with Existing Control Measures in Place

Impact Indicator	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	Combustion emissions from power generation ship engines will generate the main pollution that will disperse and might reach the coast. These are however expected to be low in magnitude, of short-term duration, non-frequent and reversible in nature.	1- Negligible A - Almost Certain	Medium
Increase in emissions of GHGs from the petroleum sector	Combustion emissions from power generation ship engines will generate a relatively low quantity of CO_2 but that has a global geographic extent, long effect duration, and not reversible during a human lifetime.	2 – Minor A – Almost Certain	Medium

8.2.2.4 Proposed Mitigation Measures

Additional mitigation measures that would contribute to reducing the significance of impacts on air quality and climate change from Reconnaissance Activities are shown in Table 8-4.

Table 8-4 Proposed mitigation Measures for Impacts on Air Quality and Climate Change from Reconnaissance Activities

Impact Indicator	Proposed Mitigation Measures
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities Increase in emissions of GHGs from the petroleum sector	✓ Use of Low- sulfur Fuel instead of normal diesel for power generation ✓ Ratification of MARPOL Annex 6 to decrease emissions from vessels or directly adopting its provisions, namely: • MARPOL Annex VI sets limits on sulfur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances. • Annex VI prohibits deliberate emissions of ozone depleting substances, which include halons and chlorofluorocarbons (CFCs). New installations containing ozone-depleting substances are prohibited on all ships. However, new installations containing hydro-chlorofluorocarbons (HCFCs) are permitted until 1 January 2020. • Annex VI also sets limits on emissions of nitrogen oxides (NOx) from diesel engines. A mandatory NOx Technical Code, which defines how this shall be done, was adopted by the Conference under the cover of Resolution 2. • Annex VI also prohibits the incineration onboard ship of certain products, such as contaminated packaging materials and polychlorinated biphenyls (PCBs).

8.2.2.5 Assessment of Residual Impacts

The residual impacts on Air Quality and Climate Change from Reconnaissance Activities with existing and additional mitigation measures in place are summarized in Table 8-5.

Table 8-5 Significance Rating of Residual Impacts on Air Quality and Climate Change from Reconnaissance Activities

Impact Indicator	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
	Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	1- Negligible A - Almost Certain	Medium	1- Negligible L – Likely	Acceptable
Increase in emissions of GHGs from the petroleum sector	2 – Minor A – Almost Certain	Medium	2 – Minor A – Almost Certain	Medium

8.2.3 Impacts on Seawater and Sediments

8.2.3.1 Potential Impacts

Impacts from Reconnaissance Activities on seawater and sediments, including sources of impacts from Reconnaissance Activities and cumulative sources of impacts are shown in Table 8-6.

Table 8-6 Impacts from Reconnaissance Activities on Seawater and Sediments

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Pollutants' concentrations in sediments	✓ Routine vessels discharge and wastes ✓ Hydrocarbon diesel and chemical spills	✓ Domestic and Industrial wastes discharged at sea ✓ Leachate from coastal dumps ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels
Impacts related to sedimentation on the sea bed /turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)	✓ Interaction of equipment on sea bed ✓ Vessel sinking to the sea floor	

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Change in chemical characteristics of seawater	✓ Routine vessels discharge and wastes ✓ Hydrocarbon, diesel and chemical spills	discharges and spills. ✓ Dynamite fishing and explosive use.

8.2.3.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
  The measures in these Annexes shall be adopted for the prevention of pollution by oil, chemical substances, sewage and garbage.
- Barcelona Convention and its protocols (1976) provide mechanisms to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment (but require application decrees).
- National Oil Spill Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators are required to prepare Emergency Response Plans (ERP) prior to starting any activity.
- Vessel Monitoring System (VMS) that helps avoiding collision between vessels.

8.2.3.3 Assessment of Impacts

Routine Discharges from survey vessels include treated sanitary waste, domestic waste and deck drainage all highly concentrated in pollutants and toxic substances that can reach the seafloor sediments after passing through the seawater. In the water column, they may affect concentrations of suspended solids, nutrients, and chlorine, as well as generate biochemical oxygen demand (BOD). As these discharges are expected to be diluted rapidly in the sea, impacts would likely be undetectable beyond tens of meters from the source and are considered to be negligible.

Hydrocarbon and Diesel spills can also increase pollutants concentration in sediments and alter seawater properties. A kerosene spill from streamer failure is the most likely source of a hydrocarbon spill with relatively low quantities of oil spilled into the marine environment. The relatively low volumes of oil involved in most streamer accidents and light nature of the oil in the streamers means that it would quickly evaporate and disperse and will thus have limited influence. Complete loss of fuel inventory and streamer reservoir would result in an oil spill of more significant impact but is unlikely to occur.

Similar to wastes discharges, hydrocarbon spills have been proven to acidify seawater, reduce the dissolved oxygen level in the water, increase CO_2 level, salinity, nitrates, phosphates and heavy metals concentrations (Datta *et al.*, 2006).

Although the seismic surveys themselves do not have any impact on the properties of seawater, some might involve a small amount of sea floor disturbance. Seismic surveys will not impact the seafloor if utilizing towed sensors. Surveys that utilize ocean bottom sensors either in 'nodes' (OBN) or in cables (OBC) may have negligible impacts due to sensor placement. It should be noted that sensors are 'placed' on to the seabed and recovered fully, often using ROVs (Remotely Operated Vehicles) in order to place them in precise locations. Regardless, resources that could be affected include benthic communities and sediments dispersion.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on sea water and sediments from Reconnaissance Activities are summarized in Table 8-7.

Table 8-7 Significance Rating of Impacts on Seawater and Sediments from Reconnaissance Activities with Existing Control Measures in Place

Impact Indicator	Consequence Rating Assessment	Consequence Rating Likelihood of Occurrence	Significance Rating
Pollutants' concentrations in sediments	The most significant source of impact includes routine vessel discharges and wastes. Diesel and Hydrocarbon Spills to the sea floor can also have an impact due to their elevated content of pollutants and toxic substances.	2- Minor A –Almost Certain	Medium
Impacts related to sedimentation on the sea bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)	The interaction of equipment on sea bed will not only lead to sedimentation but will also affect existing species causing their burial.	2- Minor A –Almost Certain	Medium
Change in chemical characteristics of seawater attributed to petroleum activities	The most significant source of impact includes the vessels discharges and wastes. The effluents contain pollutants in high concentration which can affect the properties of seawater.	2- Minor A –Almost Certain	Medium

8.2.3.4 Proposed Mitigation Measures

Table 8-8 Proposed mitigation Measures for Impacts on Sea Water and Sediments from Reconnaissance Activities

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Pollutants' concentrations in sediments	✓ Routine vessel discharges and wastes	✓ Treat Wastes and Fluids before Discharge.
	✓ Diesel and other hydrocarbon spills	✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct training and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.
Impacts related to sedimentation on the sea bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)	✓ Interaction of equipment on sea bed	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area, and installation of equipment during Non-productive seasons.
	✓ Vessel sinking	✓ Ensure VMS system is operational.
Change in chemical characteristics of seawater attributed to petroleum activities	✓ Routine vessel discharges and wastes	✓ Treat Wastes and Fluids before Discharge.
	✓ Diesel and other hydrocarbon spills	✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ MOE to publish a list of approved oil dispersants allowed to be used in oil spill response (in line with NOSCP). ✓ Preparation of tier 1 OSCP

8.2.3.5 Assessment of Residual Impacts

The residual impacts on seawater and sediments from Reconnaissance Activities with existing and additional mitigation measures in place are summarized in Table 8-9.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below reflect the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-9.

Table 8-9 Significance Rating of Residual Impacts on Seawater and Sediments from Reconnaissance Activities

Impact Indicator	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
	Consequence Rating Likelihood of Occurrence	Significance Rating	Consequence Rating Likelihood of Occurrence	Significance Rating
Pollutants' concentrations in sediments	2- Minor A –Almost Certain	Medium	1- Negligible A– Almost Certain	Medium
Impacts related to sedimentation on the sea bed/turbidity	2- Minor A –Almost Certain	Medium	1- Negligible A –Almost Certain	Medium
Change in chemical characteristics of seawater attributed to petroleum activities	2- Minor A –Almost Certain	Medium	1- Negligible A –Almost Certain	Medium

8.2.4 *Impacts on Marine Biological Environment*

8.2.4.1 Potential Impacts

Impacts on the marine biological environment from Reconnaissance Activities are shown in Table 8-10 along with the main sources from the prospecting activities and possible cumulative sources.

Table 8-10 Impacts from Reconnaissance Activities on Marine Biological Environment

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
✓ Changes in abundance, status and density of cetaceans, sea turtles and seals ✓ Changes in abundance, status, richness and density of Phyto and zoo benthos ✓ Changes in diversity and dominance of Nekton and Plankton ✓ Changes in abundance, Status and density of Seabirds ✓ Increase in the trend of introduction of invasive species ✓ Percent area of sensitive/ protected marine habitats affected by petroleum activities	✓ Operation of compressed air sources (Airguns) ✓ Hydrocarbon, diesel and chemical spills ✓ Interaction of equipment on sea bed ✓ Physical presence of survey vessels and towed equipment ✓ Routine vessels discharge and wastes ✓ Vessel sinking to the sea floor	✓ Operation of compressed air sources (Airguns) in neighboring countries. ✓ Domestic and Industrial wastes discharged at sea. ✓ Dynamite fishing and explosive use. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Seabirds fishing activities. ✓ Shipment Vessels discharges and spills. ✓ Vessels discharges and spills.

8.2.4.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- Strict compliance with ACCOBAMS recommendations during reconnaissance activities to reduce impacts from underwater noise on marine life; Operators should demonstrate how ACCOBAMS guidelines were taken into consideration in the design and implementation of such activities. Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore reconnaissance activities include the following:
  - **Big Air Bubble Curtains:** a system that produces air bubbles under water breaking the propagation of sound waves
  - **Little Air Bubble Curtain:** A little bubble curtain can be customized and placed much closer to the big bubble curtain, it may consist of a rigid frame placed around of the source. Several configurations are possible.
  - **Hydro Sound Damper**: a technology consisting of fishing nets with small balloons filled with gas and foam (ensure Hydro Sound Damper equipment is retrieved and accounted for so that it does not contribute to marine debris)
  - **Noise Mitigation Screen:** a double-layered screen filled with air and bubbles
  - **Visual monitoring protocol**
  - **Passive Acoustic Monitoring protocol (PAM):** regularly used during a range of operations whether static or mobile to facilitate the detection of marine mammal species during times of limited visibility or darkness.
  - **Marine Mammal Observation protocol**
  - **Soft start protocol:** Noise emissions should begin at low power, increase gradually until full power is reached. The soft start procedure should be of 20 min duration at least.
  - **Use of Acoustic Mitigation Devices (AMD):** Prior to the beginning of the work, AMD should be used to drive away groups or individuals of marine mammals.

- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- Barcelona Convention and its protocols 1976 prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- Convention on Biological Diversity develops strategies for the conservation and the sustainable use of biological diversity.
- The African-Eurasian Water-bird Agreement AEWA is an international agreement aiming to coordinate efforts to conserve bird species migrating between the regions.
- The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.

- The National Biodiversity Strategy and Action Plan (NBSAP).
- Decision 1044/1-2014 sets general conditions to protect cetaceans. Decision 396/1-2014 defines restrictions and regulations to limit and ban seabirds catching.

8.2.4.3 Assessment of Impacts

Natural sounds in the sea are produced by wind, waves, currents, rain, echo-location and communication noises generated by cetaceans, fish, invertebrates and other natural sources such as tectonic activity. In addition to the natural occurring sounds, there are anthropogenic sounds generated by air traffic and shipping activities. The introduction of underwater noise from the oil and gas industry can have a negative impact on sound dependent cetaceans such as dolphins, whales, porpoises and other marine animals.

Noise can affect marine mammals in many ways. At low levels, it might be merely detectable. At somewhat higher levels, it might interfere with animal communication and hinder acoustic signal detection. Noise can alter animal behavior. It can affect the auditory system and induce a shift in hearing threshold. Other systems potentially affected by noise include the vestibular, reproductive, and nervous systems. Noise might cause concussive effects, physical damage to tissues and organs (in particular gas filled), and cavitation (bubble formation).
Stress is a physiological response to a stressor such as noise, aimed at surviving the immediate threat. Prolonged stress can cause serious health problems. The effects of noise and the ranges over which they happen depend on the acoustic characteristics of the source (e.g., noise level, duration, duty cycle, rise time, spectrum), the medium (hydro- and geoacoustic parameters of the environment, bathymetry), and the receiver (e.g., age, size, behavioral state, auditory capabilities). Figure 8-1 gives a bird's-eye view of the potential zones around a source over which some of these effects might happen.

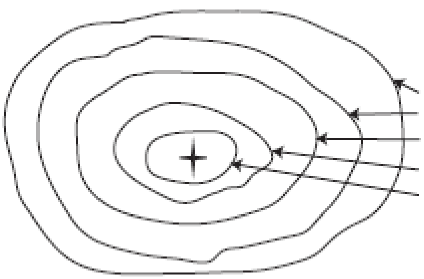


Figure 8-1 Relative Extent of Different Zones of Impact around a Noise Source

The zone of audibility is the furthest extent from the source. As sound spreads through the ocean, its acoustic energy decreases due to propagation losses. Audibility of a sound is limited by the sound dropping below either ambient noise levels or the animal's detection threshold. Audiograms, hearing thresholds as a function of frequency, have been measured for only about 20 marine mammal species and in only few individuals. The threshold is a statistical quantity, e.g., depending on the audiometric paradigm, the level at which the signal was heard 50% of the time. Figure 8-2 shows the lowest hearing thresholds measured for a number of families. Underwater audiograms have not yet been measured for Ursus maritimus (polar bear), Mustelidae (sea otters), Physeteridae (sperm whales), and Balaenidae (baleen whales). Indirect information on hearing stems from observed responses to sound and from anatomical studies. Furthermore, animals are expected to be very sensitive at the frequencies of their own calls.

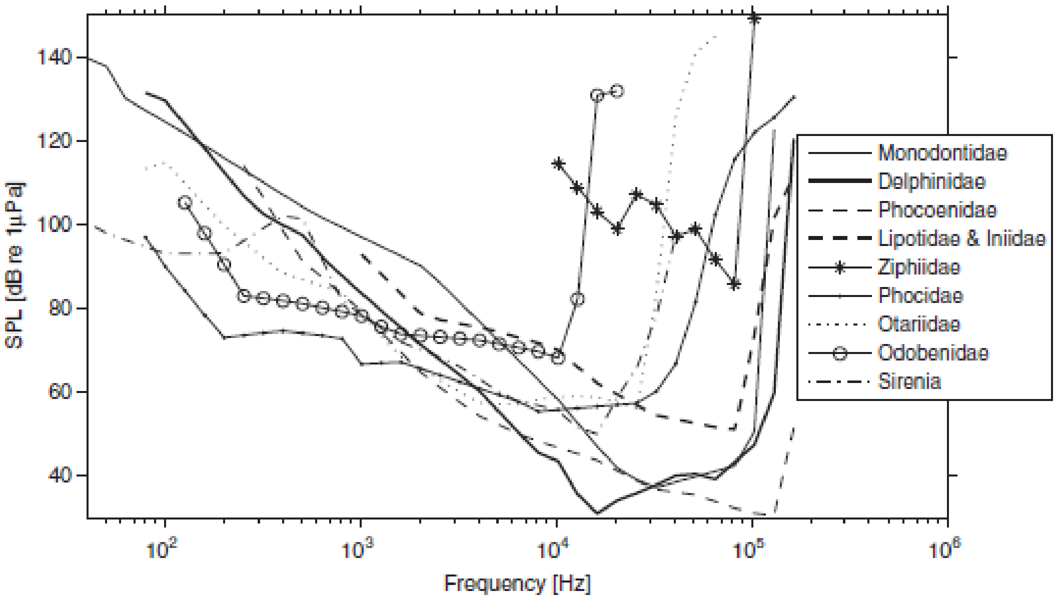


Figure 8-2 Audiograms of Marine Mammal Families. Modified from Erbe (2010)

The zone of responsiveness: The zone of responsiveness is expected to be smaller than the zone of audibility because an animal will not likely respond to a sound that is barely detectable. However, long ranges of behavioral responses (up to 70 km) have been observed (Cosens and Dueck 1988 ; Finley et al. 1990) that were close to the maximum ranges of audibility (Erbe and Farmer 2000). Measured indicators include changes in swim direction and speed, dive duration, surfacing duration and interval, and respiration and changes in contextual behavior and acoustic behavior. Prior exposure (habituation vs. sensitization), age, gender, health, current behavioral state, and other factors affect the likelihood and severity of response. A dose-response curve (risk function) was used by the US Department of the Navy (2009) to predict the percentage of a population that might respond. Southall et al. (2007) ranked behavioral responses reported in the literature on a severity scale from zero to nine, compiled tables of the number of individuals or groups that reacted as a function of severity score and received root mean square (RMS) sound pressure levels (SPLs) because this is the most commonly reported metric. However, it might not be the one that correlates best with behavior. Behavioral analyses should be multivariate, considering the full range of metrics appropriate for the sound source (e.g., SPL_{RMS} , SPL peak, SEL, and signal-to-noise ratio) and the full range of behavioral and contextual variables.

The zone of masking: Noise can mask signals such as communication sounds, echolocation, predator and prey sounds, and environmental sounds. Figure 8-3 shows the bandwidths of sounds emitted by marine mammals. Masking depends on the spectral and temporal characteristics of signal and noise. At a low signal-to-noise ratio (SNR), a signal might just be audible. A higher SNR is needed for signal recognition and discrimination and an even higher SNR for comfortable communication. The potential for masking is reduced by good frequency discrimination, temporal discrimination, and directional hearing abilities of the animal. Masking can be further reduced in some species if the noise is amplitude modulated over a number of frequency bands (comodulation masking release), if the noise has gaps or the signal is repetitive (multiple looks model), and by anti-masking strategies such as deliberate increases in call level and repetition or frequency shifting (Erbe 2008) . Models for the masking of complex calls by anthropogenic noise were developed by Erbe (2000) and Erbe et al. (1999) based on behavioral experiments (Erbe and Farmer 1998).

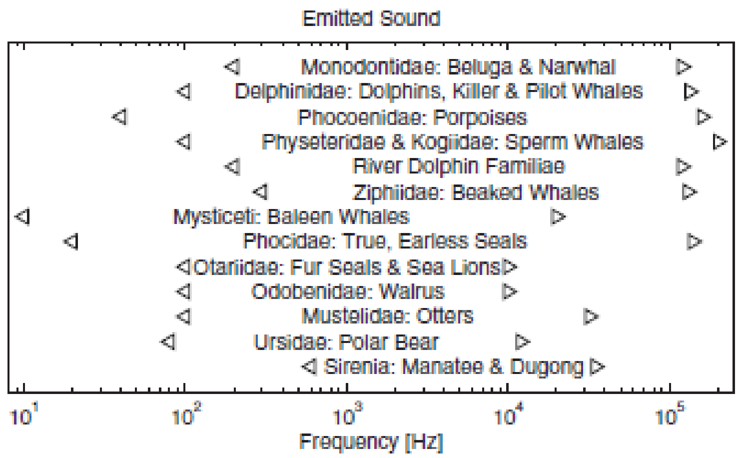


Figure 8-3 Bandwidth of Sounds Emitted by Marine Mammals

Auditory Threshold Shift: Noise exposure can result in a loss of hearing sensitivity, termed threshold shift. If hearing returns to normal after some quiet time, the effect is a temporary threshold shift (TTS); otherwise, it is a permanent threshold shift (PTS). TTS is considered auditory fatigue, whereas PTS is considered injury. TTS, but not PTS, has been measured experimentally in a few species of odontocetes and pinnipeds. Southall et al. (2007) derived initial noise-exposure criteria for marine mammals aimed at preventing injury. Data for TTS onset in marine mammals were combined with data for TTS growth as a function of noise level, and a 40-dB TTS was chosen as the onset of auditory injury (PTS). Marine mammal species were grouped into five functional hearing groups: low-, mid- and high-frequency cetaceans and pinnipeds in air and underwater. Spectral weighting functions (M-weighting) for the five functional hearing groups were applied to the noise in order to emphasize the frequency bands where acoustic exposures to high levels might cause auditory damage. Noise sources were grouped into single pulses, multiple pulses, and non-pulses based on the number of emissions per 24 h and on the level difference if measured with impulse time constants compared with continuous time constants. Thresholds in terms of peak SPL and sound exposure level (SEL) were derived; the one to be reached first was recommended for mitigation. Since then, TTS onset in a high-frequency cetacean has been shown at ~20 dB lower levels (Lucke et al. 2009).

Non-auditory physiological effects: Noise may impact non-auditory organs and systems, but data for marine mammals do not exist. Given that no damage to tissues and organs was observed in marine mammals during TTS experiments, levels will likely be higher. Stress is a physiological response that involves the release of the hormone adrenalin, which increases heart rate, gas exchange, acuity, and blood flow to the brain and muscles for a fight-or-flight response (Wright et al. 2009). Stress responses are intended to improve survival in the face of an immediate threat; however, repetitive or prolonged stress can negatively affect health in the long run. Chronic stress in humans can cause coronary disease, immune problems, anxiety, depression, cognitive and learning difficulties, and infertility. The onset of stress might correspond to fairly low noise levels that induce a behavioral disturbance or masking. Stress might be a direct result of noise, e.g., if an unknown noise is detected, or an indirect result of noise causing, e.g., masking.

During Reconnaissance Activities, seismic vessels and air guns operations constitute the main source of underwater noise. Seismic exploration produces noise pulses that are intermittent but considerably more intense than the continuous noise emitted by most industrial noise sources in the ocean. In fact, the noise level generated from seismic vessels and air guns can reach 262 dB for a band width ranging between 5 and 100 Hz.

It is important to mention, in assessing the effects of noise of animals, that each specie reflects a different behavior and response to noise levels. In other words, the impact each noise level can have would clearly differ between animal types.

Numerous authors have recognized that differences in frequency-specific hearing sensitivity among different animals influence how they are affected by noise exposure.

Southall et al., 2019 proposed six (6) marine mammal hearing groups (refer to Table 8-11) after the review of published literature describing audiometry, auditory anatomy, and sound production for different marine mammal species. Audiometric data included measurements of hearing sensitivity across species-typical frequency ranges obtained using behavioral (psychophysical) methods and measurements of hearing sensitivity (primarily over mid- and high-frequency hearing ranges) obtained using neurophysiological methods. Auditory anatomy was considered with respect to basic ear types defined by sound conduction mechanisms and morphology of middle and inner ear structures, as well as by cochlear type where possible. Additionally, quantitative predictions of low- and/or high-frequency hearing limits derived from auditory models were evaluated (Southall et al. 2019).

Table 8-11 Proposed Marine Mammal Hearing Groups (Southall et al. 2019)

Marine mammal hearing group	Auditory weighting function	Genera (or species) included
Low-frequency cetaceans	LF	Balaenidae (*Balaena,* Eubalaenidae spp.); Balaenopteridae (*Balaenoptera physalus*, *B. musculus*)
		Balaenopteridae (*Balaenoptera acutorostrata*, *B. bonaerensis*, *B. borealis*, *B. edeni*, *B. omurai*; *Megaptera novaeangliae*); Neobalenidae (*Caperea*); Eschrichtiidae (*Eschrichtius*)
High-frequency cetaceans	HF	Physeteridae (*Physeter*); Ziphiidae (*Berardius* spp., *Hyperoodon* spp., *Indopacetus*, *Mesoplodon* spp., *Tasmacetus*, *Ziphius*); Delphinidae (*Orcinus*)
		Delphinidae (*Delphinus*, *Feresa*, *Globicephala* spp., *Grampus*, *Lagenodelphis*, *Lagenorhynchus acutus*, *L. albirostris*, *L. obliquidens*, *L. obscurus, Lissodelphis* spp., *Orcaella* spp., *Peponocephala*, *Pseudorca*, *Sotalia* spp., *Sousa* spp., *Stenella* spp., *Steno*, *Tursiops* spp.); Montodontidae (*Delphinapterus*, *Monodon*); Plantanistidae (*Plantanista*)
Very high frequency cetaceans	VHF	Delphinidae (*Cephalorhynchus* spp.; *Lagenorhynchus cruciger*, *L. austrailis*); Phocoenidae (*Neophocaena* spp., *Phocoena* spp., *Phocoenoides*); Iniidae (*Inia*); Kogiidae (*Kogia*); Lipotidae (*Lipotes*); Pontoporiidae (*Pontoporia*)
Sirenians	SI	Trichechidae (*Trichechus* spp.); Dugongidae (*Dugong*)
Phocid carnivores in water Phocid carnivores in air	PCW PCA	Phocidae (*Cystophora*, *Erignathus*, *Halichoerus*, *Histriophoca*, *Hydrurga*, *Leptonychotes*, *Lobodon*, *Mirounga* spp., *Monachus*, *Neomonachus*, *Ommatophoca*, *Pagophilus*, *Phoca* spp., *Pusa* spp.)
Other marine carnivores in water Other marine carnivores in air	OCW OCA	Odobenidae (*Odobenus*); Otariidae (*Arctocephalus* spp., *Callorhinus*, *Eumetopias*, *Neophoca*, *Otaria*, *Phocarctos*, *Zalophus* spp.); Ursidae (*Ursus maritimus*); Mustelidae (*Enhydra*, *Lontra feline*)

Low-Frequency (LF) Cetacean Hearing Group: It contains all of the mysticetes. The absence of direct hearing data for this taxon continues to warrant substantial caution in attempting to predict their hearing capabilities and any potential susceptibility of their hearing to noise exposure. Audible frequency ranges estimated for baleen whales from vocalization frequencies and anatomical modeling, limited anecdotal observations of spontaneous responses to tonal signals in free-ranging animals, as well as the phylogenetic distinctions from odontocete cetaceans support the general designation of the mysticetes as a discrete, LF-oriented hearing group. (Southall et al. 2019).

High-Frequency (HF) Cetacean Hearing Group: The HF cetacean group contains most delphinid species (e.g., bottlenose dolphin, common dolphin, and pilot whale), beaked whales, sperm whales, and killer whales. Hearing sensitivity has been directly measured for approximately one-third of the species within this group using either behavioral audiometry or neurophysiological, AEP measurements. Given best hearing sensitivity at frequencies of several tens of kHz or higher for many of the species in this hearing group, they are described as HF species (Southall et al. 2019).

Very High-Frequency (VHF) Cetacean Hearing Group: The VHF cetacean group comprises the true porpoises, most river dolphin species, pygmy/dwarf sperm whales, as well as a number of oceanic dolphins (Commerson's, Chilean, Heaviside's, Hector's, Hourglass, and Peale's dolphins). Direct measurements of hearing using behavioral and/or AEP methods are available for three species within this group, each indicating substantially higher upper-frequency hearing limits than HF cetaceans, with best sensitivity in some species exceeding 100 kHz.

Phocid Carnivores in Air (PCA) and Water (PCW) Hearing Groups: This group contains all the true seals, including harbor, gray, and freshwater seals; elephant and monk seals; and both Antarctic and Arctic ice seals. Southall et al. (2007) noted the significant differences in hearing between the phocid and otariid pinnipeds, particularly the much higher, upper-frequency hearing limits of phocids measured in water, but concluded there were insufficient data on unmasked amphibious hearing and especially the effects of noise on hearing to consider separate groups, weighting functions, and TTS/PTS-onset levels. A number of subsequent audiometric studies have been published which confirm the extremely broad (7 to 8 octaves in some species) range of best hearing sensitivity among phocid seals (which for this family is the widest among any mammalian taxa), with upper-frequency cut-offs exceeding 60 kHz in almost all species (see Reichmuth et al., 2013; Finneran, 2016), (Southall et al. 2019). The only seal specie present in Lebanon is the Mediterranean Monk Seal.

Sea Turtles: 3 main species of marine turtles are found in Lebanese waters: The Loggerhead turtle, the Green turtle and the Leatherback turtle. Two other species have also been reported offshore Lebanon: The Hawksbill Sea turtle and the African Softshell Turtle. In general, sea turtles are sensitive at noise levels between 166 and 175 dB.

Fish

At very close range, seismic noise could affect the fitness and survival of fish and invertebrates causing abnormal development and possibly mortality to eggs and larvae. These acute effects have only been observed at distances less than 5 m from the air gun, with more frequent and severe effects occurring at the distances less than 1.5 m (Dalen etal. 2007; Payne 2004). Payne et al. (2009) exposed capelin and monkfish eggs to seismic sound with SPLs of 199 to 205 dB re 1 µPa. Conclusions from this study determined that there was no difference in mortality between control and exposed eggs. Booman et al. (1996) exposed various life stages (egg to fry) of commercially important North Atlantic fish to SPLs of 220-242 dB re 1 µPa which corresponded to distances of 0.75 to 6 m from the airgun. The study showed that some injury and mortality occurred, but only at distances which were close to the sound source (<15 m). (Stantec, 2014)Aside from the noise generated by Survey and Support Vessels, benthic communities, Nekton and Plankton and marine mammals can be vulnerable to waste discharges and hydrocarbon spills. Discharged waste water can hold dissolved or undisclosed by-products such as fat and oil, food scraps, household chemicals, soap and detergent rich in phosphate, nitrate and microbiological pathogens. If discharged into aquatic environments and locations with important biodiversity, it can damage ecosystems, create algal blooms and pose significant human health risks. Compounds containing nitrogen and phosphorus can increase the ecosystem's productivity including lack of oxygen and severe reductions fish and other animal populations (Idulk et al., 2015).

Solid Wastes on the other hand, include Non-oil pollutants such as glass, paper, cardboard, aluminium, steel cans, and plastics which can be hazardous in nature. Once discharged, Solid waste that enters the ocean may become marine debris and can then pose a threat to marine organisms and coastal communities (Idulk et al., 2015).

As previously mentioned in Section 8.2.3.3, survey vessels are a source of spills of lubricating oil, fuel oil, grease and water into bilges which usually contain solid matters and metals. Any seabirds on the water surface would be potentially at risk from any slicks that could form, although the extent of such a slick would be expected to be limited. Marine mammals are considered to be less vulnerable to fouling than seabirds, as they would be expected to move away from any oil pollution. However, marine mammals are believed to be more at risk from inhaling volatile elements in the oil, although these would generally evaporate rapidly from the slick.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on marine biological environment from Reconnaissance Activities are summarized in Table 8-12.

Table 8-12 Significance Rating of Impacts on Marine Biological Environment from Reconnaissance Activities with Existing Control Measures in Place

Impact Indicator	Consequence Rating Assessment	Consequence Rating Likelihood of Occurrence	Significance Rating
Changes in abundance, status and density of cetaceans, sea turtles and seals	Routine Vessel Discharges and wastes constitute a significant source of impact due to their high content in metals and toxic pollutants. The noise generated by Operation of compressed air sources (Airguns) may have negative impact on marine mammals.	3- Moderate P –Possible	Medium
Changes in abundance, status, richness and density of Phyto and zoo benthos	Routine Vessel Discharges and wastes constitute the most significant source of impact due to their high content in metals and toxic pollutants.	4- Major P -Possible	High
Changes in diversity and dominance of Nekton and Plankton	The most significant source of impact includes diesel and other hydrocarbons spills considered highly toxic for Nekton and Plankton. Other sources mentioned above can also have an important impact.	3- Moderate P –Possible	Medium
Changes in abundance, Status and density of Seabirds	The density and abundance of seabirds are highly vulnerable to diesel and hydrocarbon spills from the survey vessels and other support vessels.	3- Moderate P -Possible	Medium
Trend of introduction of invasive species	The only significant source of impact is the physical presence of survey vessels and towed equipment and possibility of ballast water discharge in the sea.	4- Major P -Possible	High
Percent area of sensitive/ protected marine habitats affected by petroleum activities	The main source of impact includes Diesel and Hydrocarbon Spills from Vessels' Engines. Sinking of Vessels can also have a significant influence.	3- Moderate P -Possible	Medium

8.2.4.4 Proposed Mitigation Measures

Table 8-13 Proposed mitigation Measures for Impacts on Marine Biological Environment from Reconnaissance Activities

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Changes in abundance, status and density of cetaceans, sea turtles and seals	✓ Operation of compressed air sources (Airguns) ✓ Physical presence of survey vessels and towed equipment causing collision with sea mammals and generating underwater noise ✓ Routine vessels discharge and wastes ✓ Hydrocarbon and Diesel spills	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. And adopt Airguns Operations during Non-productive seasons of target species. ✓ Operators to demonstrate that underwater noise levels and high risk areas are reduced to the minimum possible extent ✓ Minimize cumulative effects from airguns operations through coordination with other similar activities in the East-Med. ✓ The following procedures from IAGC/IOGP monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations should be adopted: • Procedure for commencement of operations • Procedure for interruptions to ongoing operations • Procedure for testing source elements ✓ Take into consideration Standard Airgun Mitigation Procedure from JNCC guidelines for minimizing the risk of injury to marine mammals from geophysical surveys. ✓ Treat Wastes and Fluids before Discharge. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct training and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.
Changes in abundance, status, richness and density of Phyto and zoo benthos	✓ Routine vessels discharge and wastes ✓ Interaction of equipment on sea bed ✓ Hydrocarbon and diesel spills ✓ Vessel sinking to the sea floor	✓ Treat Wastes and Fluids before Discharge. ✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. And installation of equipment during Non-productive, seasons. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Changes in diversity and dominance of Nekton and Plankton	✓ Operation of compressed air sources (Airguns) ✓ Physical presence of survey vessels and towed equipment causing collision with sea mammals and generating underwater noise ✓ Routine vessels discharge and wastes ✓ Hydrocarbon and diesel spills	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. And conduct activities during Non-productive seasons. ✓ Treat Wastes and Fluids before Discharge. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.
Changes in abundance, Status and density of Seabirds	✓ Physical presence of survey vessels and towed equipment causing collision with sea mammals and generating underwater noise	✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.
	✓ Hydrocarbon and diesel spills	
Trend of introduction of invasive species	✓ Physical presence of survey vessels and towed equipment	✓ Ensure towed equipment is free of alien species. ✓ Ensure strict compliance with the Ballast Water Convention requirements and capacity of MoPWT to monitor such compliance.
Percent area of sensitive/ protected marine habitats affected by petroleum activities	✓ Interaction of equipment on sea bed ✓ Hydrocarbon and diesel spills ✓ Vessel sinking to the sea floor	✓ Avoid activities in the vicinity of protected areas/areas proposed for protection and establishing a buffer zone around such areas. Buffer zones shall be determined in EIA studies. ✓ Compliance with protected areas management plans. ✓ Establish a code of conduct for operating in proximity to protected and sensitive areas. ✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. And installation of equipment during Non-productive, season. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.

8.2.4.5 Assessment of Residual Impacts

The residual impacts on marine biological environment during Reconnaissance Activities with existing and additional mitigation measures in place are summarized in Table 8-14.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-13.

Table 8-14 Significance Rating of Residual Impacts on Marine Biological Environment from Reconnaissance Activities

Impact Indicator	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
	Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Changes in abundance, status and density of cetaceans, sea turtles and seals	3- Moderate P –Possible	Medium	1- Negligible P –Possible	Low
Changes in abundance, status, richness and density of Phyto and zoo benthos	3- Moderate A –Almost Certain	High	1- Negligible A –Almost Certain	Medium
Changes in diversity and dominance of Nekton and Plankton	3- Moderate P –Possible	Medium	2- Minor A –Almost Certain	Medium
Changes in abundance, Status and density of Seabirds	3- Moderate P -Possible	Medium	No Additional Mitigation Measures can be foreseen.	
Trend of introduction of invasive species	4- Major P -Possible	High	3- Moderate P –Possible	Medium
Percent area of sensitive/ protected marine habitats affected by petroleum activities	3- Moderate P -Possible	Medium	1- Negligible P –Possible	Low

8.2.5 Impacts on Coastal Environment

8.2.5.1 Potential Impacts

Table 8-15 Impacts of Reconnaissance Activities on Coastal Environment

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Percent area of sensitive coastal habitats affected by impacts related to the sector	✓ Onshore support facilities and provisions of supplies ✓ Hydrocarbon, diesel and chemical spills	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Vessels discharges and spills.

8.2.5.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- Barcelona Convention and its protocols (1976) provide mechanisms to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.
- The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.
- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements.
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators are required to submit ERPs and ensure readiness to comply with ERP prior to initiating any activities.

8.2.5.3 Assessment of Impacts

Seismic survey vessels and Support Vessels may have numerous streamers deployed containing several thousand liters of oil in each and the potential for larger volume spills cannot be ruled out. When oil is spilled in the sea, it initially spreads in the sea, depending on its relative density and composition. If the oil reaches the shoreline or coast by wave's movements and wave and wind currents, it can interact with coastal sediments causing erosion and contamination. It can also leave black lines of oil on the beach and oil can coat plants and rocks. The latter occurs directly if oil is spilled near the coast from the first place.

Animal species on the shore can also be harmed, injured or killed either directly by feeding on toxic food contaminated by the oil, or by direct contact with the oil on the animals' skin or feathers in the case of birds for example.

From another perspective, and although seismic operations have limited interaction with onshore facilities, onshore impacts can arise from the increasing pressure on ports and from the increasing traffic to supply logistics. Although such impacts are reduced by the limited duration of seismic operations, some mitigation measures specifying the land-based infrastructure that will be used to cater for the requirement shall be assessed during EIA studies. The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on coastal environment from Reconnaissance Activities are summarized in Table 8-16.

Table 8-16 Significance Rating of Impacts on Coastal Environment from Reconnaissance Activities with Existing Control Measures in Place

Impact Indicator	Consequence Rating Assessment	Consequence Rating Likelihood of Occurrence	Significance Rating
Percent area of sensitive coastal habitats affected by impacts related to the sector	The most significant source of impact includes Diesel and Hydrocarbon Spills from Survey and Support Vessels.	4- Major P -Possible	High

8.2.5.4 Proposed Mitigation Measures

Table 8-17 Proposed mitigation Measures for Impacts on Coastal Environment from Reconnaissance Activities

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Percent area of sensitive coastal habitats affected by impacts related to the sector	Onshore support facilities and provisions of supplies	• Optimize travel trips and travel routes when transporting chemicals and wastes • Transport of chemicals shall fulfil the requirements of international conventions and standards including IMDG Code for Dangerous Goods. • EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to: • prevent accidental spillage of chemicals;

Impact Indicator	Source of Impact	Proposed Mitigation Measures
		• intervene in case of accidental spillage of chemical products.
	Hydrocarbon and chemical spills	• Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. • Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. • Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents. • Chemical storage shall follow international standard in terms of packaging and labelling of products (GHS, CLP). • Each chemical must have its SDS. • Operators should develop a database to register chemical products. (quantity, uses, specific stored requirements, risks, PPE, etc.)

8.2.5.5 Assessment of Residual Impacts

The residual impacts on coastal environment from Reconnaissance Activities with existing and additional mitigation measures in place are summarized in Table 8-18.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-17.

Table 8-18 Significance Rating of Residual Impacts on Coastal Environment from Reconnaissance Activities

Impact Indicator	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
	Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Percent area of sensitive coastal habitats affected by impacts related to the sector	4- Major P -Possible	High	1- Negligible A –Almost Certain	Medium

8.2.6 *Impacts on Fisheries*

8.2.6.1 *Potential Impacts*

Table 8-19 Impacts from Reconnaissance Activities on Fisheries

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	✓ Operation of compressed air sources (Airguns) ✓ Routine vessels discharge and wastes ✓ Hydrocarbon, Diesel and chemical spills ✓ Physical presence of survey vessels and towed equipment	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use.
Total area of where fishing activities excluded due to petroleum activities		
Loss of fishermen income due to excluded area		

8.2.6.2 *Main Existing Control Measures*

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore reconnaissance activities shall be followed (see section 8.2.4.2).
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- Barcelona Convention and its protocols (1976) have instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- Convention on Biological Diversity develops strategies for the conservation and the sustainable use of biological diversity.
- The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.
- The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.
- The National Biodiversity Strategies and Action Plan (NBSAP).
- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.

8.2.6.3 Assessment of Impacts

Diesel and Hydrocarbon Spills could possibly occur due to engines leakage from Survey or Support Vessels deep in the sea or near the coast. The latter does not only affect marine mammals and species but can also highly influence fishes and aquatic stocks.

Although previous researches revealed that adult fishes are capable of avoiding water with high concentrations of hydrocarbons, many incidents in relatively shallow waters reported large numbers of fish mortality and kills including 1-year-old fishes of commercially important sole due to the massive concentration of emulsified oil (Hjermann et al., 2007). Even at low concentrations, oil can "taint" fishes releasing unpleasant odors and flavor to their flesh. If tainted, fishes can constitute a human health hazard rendering them unmarketable for extended periods (Birtwell & McAllister 2002). Fish eggs and larvae on the other hand are planktonic which exposes them to toxic compounds contained in the water. Oil has also been known to wipe out fish eggs.

The type and composition of the oil will also influence the gravity of the impact; fish toxicity can be caused by spills of light petroleum products while heavier oil can only have a detrimental effect in cases of fish in larval or spawning stages.

Other than spills, Vessels can also discharge domestic wastes and fluids that contain, in general, organic substances, solids and mineral acids and even after treatment, will still have pollutants affecting all fish species. This type of pollution can alter the water's properties and lead to excessive growth in nutriments causing fishes' eutrophication. If not killed, a long-term exposure of fishes to sub lethal concentration of pollutants can make fishes susceptible to diseases affecting the population of the species over a longer period.

Similar to other marine animals and species, fishes are vulnerable to high noise levels generated by air guns operations. According to Genesis Oil and Gas Consultants report for the Department of Energy and Climate Change (2011), Fishes show disturbances at noise levels between 187 dB and 208 db. While noise levels generated by air guns operations exceed 220 dB, fishes are expected to disperse away from the source. The latter interferes with normal migration and orientation patterns changing the composition of population or species diversity.

One main interaction of seismic operations with the fishing industry and shipping will be the physical presence of the survey vessel and streamers. Both fishing and seismic vessels have limited maneuverability when towing their gear.

As previously mentioned, acquisition of 2D seismic data requires the towing of a single streamer of between 3 to 12 km in length at around 5m depth. Surveys operate in a grid shape and therefore need turning area at the end of each line. 3D seismic surveys, however, tow a number of streamers in parallel and the length of streamers are shorter than for 2D seismic, around 3 km in length. In both cases whilst the survey is being undertaken, the survey vessel has limited capability for taking avoiding action in respect of other ships and vessels that will therefore need to keep clear of the survey vessel. Fishing vessels will be unable to fish in the vicinity of a seismic survey and will therefore lose access to grounds in the survey area for the duration of the survey. In such case, geophysical operators undertake fisheries liaison tasks to minimize impacts. This takes the form of pre-notification to fisheries groups of where a vessel may be operating and for how long, as well as the employment of on-board fisheries liaison personnel from the local community (subject to the completion of adequate safety training). These on-board personnel communicate with those operating vessels in the nearby area in order to advise of survey vessel movements over the next 24 to 48 hours, allowing close coordination with local fishers in order that the impacts on their activities and area restrictions are minimized.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on fisheries from Reconnaissance Activities are summarized in Table 8-20.

Table 8-20 Significance Rating of Impacts on Fisheries from Reconnaissance Activities with Existing Control Measures in Place

Impact Indicator	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	Routine vessel discharges and wastes are considered the most significant source of impact. Diesel and Hydrocarbon spills also constitute a source of impact with major concern.	2- Minor A –Almost Certain	Medium
Total area of where fishing activities excluded due to petroleum activities	The only source of impact is the physical presence of survey vessels and towed equipment.	2- Minor A –Almost Certain	Medium
Loss of fishermen income due to excluded area	The only source of impact is the physical presence of survey vessels and towed equipment.	2- Minor A –Almost Certain	Medium

8.2.6.4 Proposed Mitigation Measures

Table 8-21 Proposed mitigation Measures for Impacts on Fisheries from Reconnaissance Activities

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	✓ Operation of compressed air sources (Airguns) ✓ Routine vessels discharge and wastes ✓ Hydrocarbon and Diesel spills	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Adopt Airguns Operations during Non-productive seasons of target species. ✓ Treat Wastes and Fluids before Discharge. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Monitoring of chemical concentrations in edible fish and invertebrate tissue.

Impact Indicator	Source of Impact	Proposed Mitigation Measures
		✓ Conduct training and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.
Total area of where fishing activities excluded due to petroleum activities	✓ Physical presence of survey vessels and towed equipment	✓ Limit Exclusion Zones to Safety Zones
Loss of fishermen income due to excluded area	✓ Physical presence of survey vessels and towed equipment	✓ In the case of a survey planned in an area of intensive fishing, discussions with Fisheries Associations shall be initiated as early as possible, and, in any case, at least 45 days before the planned date in order that the implications can be fully considered. A clear communication plan shall be developed and a fair compensation scheme in case of loss of equipment shall be proposed. ✓ Employment of on-board fisheries liaison personnel from the local community (subject to the completion of adequate safety training). These on-board personnel communicate with those operating vessels in the nearby area in order to advise of survey vessel movements over the next 24 to 48 hours, allowing close coordination with local fishers in order that the impacts on their activities and area restrictions are minimized. ✓ Maintain exclusion zones around survey vessels and its towed streamer arrays to avoid interruption of commercial fishing operations.

8.2.6.5 Assessment of Residual Impacts

The residual impacts on fisheries from Reconnaissance Activities with existing and additional mitigation measures in place are summarized in Table 8-22.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-21.

Table 8-22 Significance Rating of Residual Impacts on Fisheries from Reconnaissance Activities

Impact Indicator	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
	Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	2- Minor A –Almost Certain	Medium	2- Minor A –Almost Certain	Medium
Total area of where fishing activities excluded due to petroleum activities	2- Minor A –Almost Certain	Medium	1- Negligible P –Possible	Low
Loss of fishermen income due to excluded area	2- Minor A –Almost Certain	Medium	1- Negligible P –Possible	Low

8.2.7 Impacts on Ambient Noise Levels

8.2.7.1 Potential Impacts

Table 8-23 Impacts from Reconnaissance Activities on Ambient Noise Levels

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Ambient noise levels measured in the vicinity of petroleum facilities/ support activities in the coastal area	✓ Power generation from seismic vessels ✓ Supply vessels movement ✓ Helicopter movement ✓ On-shore support facilities/provision of supplies	✓ Other vessels activity in the sea ✓ Land transportation ✓ Other noise sources in the coastal region

8.2.7.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MoE Decision No. 52/1/1996, National maximum allowable noise levels and the permissible noise exposure standards.
- Offshore blocks are located more than 3 nm away from the shoreline.

- Locations for onshore support facilities should be selected in compliance with the National Land Use Master Plan.

8.2.7.3 Assessment of Impacts

The consequence rating, likelihood of occurrence, significance rating and acceptability of the environmental impacts on ambient noise levels from Reconnaissance Activities are summarized in Table 8-24.

Table 8-24 Significance Rating of Impacts on Ambient Noise Levels from Reconnaissance Activities with Existing Control Measures in Place

Impact Indicator	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Ambient noise levels in coastal cities due to offshore petroleum activities	Ambient noise levels generated from Reconnaissance Activities will be similar to noise from regular shipping and port activities and not expected to have a noticeable impact on noise levels in the coastal region.	1- Negligible L -Likely	Low

8.2.7.4 Proposed Mitigation Measures

No additional mitigation measures are proposed.

8.2.7.5 Assessment of Residual Impacts

Since impacts on ambient noise levels from Reconnaissance Activities are low and no additional mitigation measures are proposed, the residual impacts assessment is of the significance presented in Table 8-24.

8.3 IMPACTS DURING EXPLORATION PHASE

8.3.1 Impact Identification

Impacts during exploration phase are expected from the installation of drilling rig, operation of drilling rig (including wells drilling, physical presence of the rig, discharge of drill cuttings and other effluent (including routine vessels discharges and waste), flaring and power generation), movement of support vessel and helicopters in addition to on-shore support facilities and accidental events. The environmental and socio-economic receptors expected to be impacted from each activity are shown in the impact identification matrix presented in Table 8-25.

Table 8-25 Impact Identification Matrix – Exploration Phase

EXPLORATION AND APPRAISAL PHASES																									
Component		Physical Environment						Biological Environment							Others										
Activity		Air Quality	Climate change	Seawater Quality	Sediments Quality/Composition	Underwater Noise	Above water noise	Phyto & zoo benthos	Nekton	Phyto & zoo plankton	Seabirds	Cetaceans, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats	Archaeological & Cultural Resources	Infrastructure	Social Conditions	Education	Crime	General Economy /industry/energy	Fisheries	Shipping	Tourism	Public Health	Landscape and Visual Amenity
Mobilization and positioning in place of Drilling ship/mooring	Tension Leg Platforms	X	X	X	X	X	X	X					X		X	X									
	SPAR- Single Point Anchor Reservoir	X	X	X	X	X	X	X					X		X	X									
	Drill Ships	X	X	X	X	X	X	X	X	X		X	X		X	X					X	X		X	
	Semi-Submersible Platforms	X	X	X	X	X	X	X	X	X			X		X	X					X	X		X	
Drilling Rig Operation	Single Well drilling	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			X	X	X	X	X
	Multiple wells drilling	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X			X	X	X	X	X
	Physical presence of the drilling rig							X	X	X	X	X	X								X	X	X	X	X
	Flaring and power generation (noise and air emissions)	X	X			X	X																X	X	X
	Discharge of drill cuttings & fluids/Onshore Disposal	X	X			X	X					X		X	X	X	X		X	X		X		X	X
	Discharge of drill cuttings & fluids/Cuttings Re-injection	X	X	X	X	X	X	X																	
	Discharge of water-based drill cuttings & fluids/Discharge to the Sea			X	X			X	X	X	X	X	X								X			X	
	Discharge of oil/synthetic-based drill cuttings & fluids/Discharge to the Sea	X	X	X	X			X	X	X	X	X	X								X			X	
	Discharge of drill cuttings & fluids/Exporting Waste	X	X			X	X					X				X						X			

Component / Activity		EXPLORATION AND APPRAISAL PHASES																							
		Physical Environment						Biological Environment							Others										
		Air Quality	Climate change	Seawater Quality	Sediments Quality/Composition	Underwater Noise	Above water noise	Phyto & zoo benthos	Nekton	Phyto & zoo plankton	Seabirds	Cetaceans, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats	Archaeological & Cultural Resources	Infrastructure	Social Conditions	Education	Crime	General Economy /industry/energy	Fisheries	Shipping	Tourism	Public Health	Landscape and Visual Amenity
	Other effluent discharges ((including routine vessels discharges and waste))			X	X			X	X	X	X	X	X								X				
	Chemicals storage offshore																							X	
	Chemicals storage onshore													X	X	X		X		X				X	
	Chemicals transportation by Sea	X	X			X	X					X										X		X	
	Chemicals transportation by land	X	X											X	X	X		X						X	
Support activities	Movement of Support Vessels	X	X			X	X					X		X		X	X				X	X			
	Helicopter Movement	X	X				X				X	X				X									
	On-shore Support Facilities/provision of supplies						X								X	X	X				X				X
Accidental Events	Gas blow out	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X	X
	Oil spills	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
	Spills of fuel and chemicals	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X	X
	Collisions/ Transportation and storage accidents					X	X										X			X		X	X	X	
	Loss of stability					X	X								X		X			X		X	X	X	

8.3.2 Impacts on Air Quality and Climate Change

8.3.2.1 Potential Impacts

Table 8-26 Impacts of Exploration Phase on Air Quality and Climate Change

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities Increase in emissions of GHGs from the petroleum sector	✓ Mobilization and Positioning in place of drilling rig ✓ Flaring and power generation ✓ Fugitive Emissions ✓ Wells Drilling ✓ Re-injection of drill cuttings and fluids ✓ Movement of support vessel and Transport of waste and chemicals ✓ Helicopter Movement ✓ Gas and Oil Blow-Out ✓ Spills of Fuel and Chemicals	✓ Ships and vessels activities in the sea and near areas ✓ Emissions from the transport sector ✓ Pollutants generated from the manufacturing sector and industrial areas ✓ Contaminants generated by garbage accumulation and burning ✓ Emissions from power generation

8.3.2.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA.
- Application of the Best Available Techniques (BAT) as stipulated by the Air Quality Protection Law (78/2018) to minimize the impact on air quality.
- Compliance with Ambient Air Quality Standards (Decision No. 52/1/1996), Emission Limit Values for power generation (Decision No. 8/1/ 2001) and relevant international standards.
- An emission permit is to be obtained from MoE as per Law No. 78/2018 (in the absence of the permit, such permission is obtained via the EIA process).
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Emergency response planning is required according to PAR.
- Flaring or venting and all types of Air Emissions release is subject to a permit from Ministry of Energy and Water and Emergency Flaring requires registration and reporting to the Minister within 24 hours from occurrence.
- The Ministry of Environment's Decision Number 99-1/2013 regarding the submission of information on Green House Gas emissions for all facilities.

8.3.2.3 Assessment of Impacts

The consequence rating of impacts on air quality and climate change considers Lebanon's NDC commitment. The contribution was revised by the Ministry of Environment considering that the Oil & gas sector will be emitting 2.569.5 kt $CO_{2eq.}$ in 2030 (MoE, 2019). This value will

be decreased by 10% to account for numerous negligible sources (including service vessels and helicopters, equipment deliveries and other activities), resulting in 2,312.55 kt $CO_{2eq.}$. Unlike Reconnaissance Activities, the exploration phase necessitates the mobilization and the positioning of a drilling rig that is mounted on certain type of platform or a ship. Regardless of the type, petroleum-derived fuels are consumed in diesel engines during drilling operations to power mud pumps, pump cement, apply torque to the drill string and to retrieve subsurface equipment. Vessels, Support Aircraft and Helicopters are also powered by burning fuel. Fuel combustion will emit to the atmosphere GHGs, air pollutants including CO, NOx, SO_2 and other unburned hydrocarbons along with particulate matter in fairly elevated concentrations causing significant environmental degradation and impacting the quality of air. Lower amounts can be generated from Hydrocarbon Spills and Fugitive Emissions resulting from equipment damage and leakage. Although sometimes adopted as a safety measure, gas flaring and venting is considered one of the most significant sources of emissions which can occur during the exploration phase. In addition, and in the case of a successful drilling, atmospheric emissions may additionally include those arising from the combustion of produced hydrocarbons during well testing.

Nevertheless, the impact of the emitted contaminants and gases have been mitigated for by adopting standards and developing laws and response plans that establish regulations for environmental management and conservation and limit pollutants emission into the atmosphere. Progress in regard to technological mitigation measures that reduce emissions especially during drilling operations can also be acknowledged.

As previously mentioned, the impacts of emissions are generally mitigated circumstantially by the open and dispersive environment offshore and drilling rigs and support vessels are in general, built and operated to standards and in compliance with the regulations. Finally, since oil and gas exploration activities are not permitted near the shore, impacts on coastal or onshore air quality are not expected to be high, although it is recognized that there are onshore/near shore sources of emissions (including service vessels and helicopters, equipment deliveries and other activities).

Quantification of emissions was conducted for different scenarios taking the following assumptions into consideration:

Scenario 0: "Do Nothing" scenario - BAU

- No E&P activities
- Gasification of power plants continues via imported LNG
- 3.5 million tons of LNG needed[9].

Whereas:

  - Gasification entails Fugitive emissions and combustion for power generation; and

[9] MoE/UNDP/GEF (2015). National Greenhouse Gas Inventory Report and Mitigation Analysis for the Energy Sector in Lebanon. Beirut, Lebanon

- Transmission (for 100 km) entails Fugitive emissions and combustion for power generation

Results were as follows and considered acceptable compared to the NDC commitment for GHGs.

	CO	NOx	SO2	NMVOC	PM	CO2	CH4	N2O	CO2 eq.
Gasification (t/yr)	0.05	0.24	<0.01	0.04	0	65.51	0.49	0.001	76.14
Transmission (t/yr)	0.04	0.18	<0.01	0.08	0	48.97	0.97	0.001	69.61

Scenario 1: "No commercial deposits" scenario

- 0 commercial discoveries are made
- Exploration only
- Gasification continues and 3.5 million tons of LNG needed[10]

Whereas:

- Gasification entails fugitive emissions and combustion for power generation;
- Transmission (for 100 km) entails fugitive emissions and combustion for power generation; and
- Exploration is considered to have a negligible impact (SGI, 2015, Marcogaz, 2010), as presented below (assuming two exploration wells are drilled per year and would require 3,000 tons of Marine Gasoil for power generation).

3,000 tons MGO (1% S) per drilling rig	CO	NOx	SO2	NMVOC	PM	CO2	CH4	N2O	CO2 eq.
Emissions (t/yr) per drilling rig	16.8	121.5	60	4.8	3.6	9,558.9	0.4	0.08	9,591

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on Air Quality and Climate Change during Exploration Phase are summarized in Table 8-27.

[10] MoE/UNDP/GEF (2015). National Greenhouse Gas Inventory Report and Mitigation Analysis for the Energy Sector in Lebanon. Beirut, Lebanon

Table 8-27 Significance Rating of Impacts on Air Quality and Climate Change during Exploration Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	S1	The quantities emitted are negligible and the pollutants lifetime is of few weeks. Moreover, the frequency is low in this scenario.	1- Negligible A -Almost certain	Medium
	S2	The quantities emitted are not important and the pollutants lifetime is of few weeks. Moreover, the frequency is low in this scenario like for scenario 1.	1- Negligible A -Almost certain	Medium
	S3	The quantities emitted are more important than the two other scenarios, but the pollutants lifetime is of few weeks. The number of wells is higher in this scenario.	2- Minor A -Almost certain	Medium
Increase in emissions of GHGs from the petroleum sector	S1	The quantities emitted are negligible however GHG geographic extent is global with the pollutants lifetimes of many years and this effect is not reversible during a human lifetime. On the other hand, the frequency is low in this scenario	4 – Major A – Almost certain	High
	S2	The quantities emitted are not important but considerably however GHG geographic extent is global with the pollutants lifetimes of many years and this effect is not reversible during a human lifetime. On the other hand, the frequency is low in this scenario	4 – Major A – Almost certain	High
	S3	The quantities emitted are more important than S1 and S2 but still low however GHG geographic extent is global with the pollutants lifetimes of many years and this effect is not reversible during a human lifetime. On the other hand, the frequency is low in this scenario	4 – Major A – Almost certain	High

8.3.2.4 *Proposed Mitigation Measures*

Table 8-28 Proposed mitigation Measures for Impacts on Air Quality and Climate Change during Exploration Phase

Impact Indicator	Proposed Mitigation Measures
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	✓ Ensure enforcement of BAT as required by Law 78/2018 (Air Quality Protection Law) and Decree No. 10289/2012 (PAR); this requires proper training of MoE and LPA personnel on BAT applicable to the offshore oil and gas industry and the review of BAT demonstration in EIA studies; MoE/LPA need to ensure that BAT is integrated , implemented and properly maintained during operation ✓ Use of Green diesel instead of Marine Gasoil where technically feasible; green diesel has a significantly lower sulfur content ✓ Air dispersion modelling study be prepared as part of the EIA for the
Increase in emissions of GHGs from the petroleum sector	

Impact Indicator	Proposed Mitigation Measures
	drilling activities to better assess the potential of impacts on air quality in the coastal area. ✓ Fuel efficiency measures shall be taken in the selection process for platform, support vessels and helicopters, where possible. ✓ Ratification of MARPOL Annex 6 to decrease emissions (refer to Table 8-4 for main requirements) ✓ Regular check for leaks with latest technology and take prompt action ✓ Explore possibilities for the implementation of Decree No. 167/2017 that provides incentives for environmental investments and assess its applicability to the offshore E&P sector

8.3.2.5 Assessment of Residual Impacts

The residual impacts on Air Quality and Climate Change during Exploration Phase with existing and additional mitigation measures in place are summarized in Table 8-29.

Table 8-29 Significance Rating of Residual Impacts on Air Quality and Climate Change during Exploration Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	S1	1- Negligible A -Almost certain	Medium	1- Negligible L -Likely	Acceptable
	S2	1- Negligible A -Almost certain	Medium	1- Negligible L - Likely	Acceptable
	S3	2- Minor A -Almost certain	Medium	1- Negligible L - Likely	Acceptable
Increase in emissions of GHGs from the petroleum sector	S1	4 – Major A – Almost certain	High	3 – Moderate A – Almost certain	High
	S2	4 – Major A – Almost certain	High	3 – Moderate A – Almost certain	High
	S3	4 – Major A – Almost certain	High	3 – Moderate A – Almost certain	High

8.3.3 Impacts on Seawater and Sediments

8.3.3.1 Potential Impacts

Table 8-30 Impacts of Exploration Phase on Seawater and Sediments

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in pollutants' concentrations in sediments	✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluents discharge ✓ Dredging activities for ports and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, transportation and storage accidents and loss of stability	✓ Domestic and Industrial wastes discharged at sea ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharged and spills. ✓ Dynamite fishing and explosive use.
Impacts related to sedimentation on the sea bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)	✓ Mobilization and positioning in place of drilling rig (Tension Leg Platforms & SPAR-Single Point Anchor Reservoir) ✓ Mobilization and positioning in place of drilling rig (Drill Ships & Semi-Submersible Platforms) ✓ Dredging activities for ports and onshore support facilities ✓ Wells drilling in the continental slope and in the deep sea ✓ Discharge of drill cuttings & fluids to the sea in the continental slope and in the deep sea	
Change in chemical characteristics of seawater attributed to petroleum activities	✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluents discharge ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, transportation and storage accidents and loss of stability	
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	✓ Well Drilling on the Continental Slope	

8.3.3.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the

discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.

- Barcelona Convention and its protocols (1976) have instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators are required to prepare ERPs and demonstrate readiness to implement it prior to initiating any activity.
- The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.

8.3.3.3 Assessment of Impacts

During the Drilling phase, exploratory wells are drilled to physically prove the presence of hydrocarbons and to study the commerciality of the field. Offshore drilling operations are initiated without the set and use of a marine riser for the first segment and mud is introduced in the drill pipe to cool down the drill bit and provide the proper pressure balance. Under such circumstances, the mud along with the drill cuttings will be directly discharged from the wellhead to around 5 meters above the seabed. For subsequent segments, and when the riser has been correctly placed, the contaminated drilling waste will be directed to the drill ship where it would be processed and then typically discharged around 2 meters below sea-surface level (Vinhateiro, Isaji, & Comerma, 2014). A discharge near the sea surface and not on the sea floor especially during strong waves and currents, will allow high dispersal, mixing and low settlement in one location which can reduce from the gravity of impact. The impact however will be significantly higher if the discharge does not occur in deep sea but on the continental slope leading to the loss of endemic and other species of global interest.

Another point of concern is the type of mud used. Oil-Based Muds have been widely prohibited by legislations in many nations because of their damaging effects and high level of contamination which suggests the necessity of land treating the cuttings and fluids before disposal. Although their effects cannot be neglected, Water-Based Cuttings and Muds are much less toxic which explains why this type is the most adopted.

Effluents Discharge on the other hand, can also highly affect the pollutants concentration in sediments and the characteristics of Seawater. The latter refers to routine discharges of sewage and domestic wastes (including food waste), deck drainage, and miscellaneous discharges, all subject to MARPOL regulations. The effluents typically contain chemical pollutants and heavy metals that can easily alter the composition and properties of the water and the sediments if directly discharged without treatment:

- Sanitary waste will be treated using a marine sanitation device that produces an effluent with a minimum residual chlorine concentration of 1.0 mg/L and no visible floating solids or oil and grease.
- Wastewater treatment sludge will be transported to shore for disposal at an approved facility.
- Grey water includes water from showers, sinks, laundries, and galleys, safety showers, and eye-wash stations and does not require treatment before discharge.
- Food waste, a type of domestic waste, will be ground prior to discharge, in accordance with MARPOL requirements.

Hydrocarbon and Chemical Spills are another environmental concern associated with the Petroleum Industry leading to the increase in pollutants concentrations in sediments and altering the chemical composition of Seawater. The severity of the impact would depend on the volume spilled, the composition of the spilled fluid and the weather conditions. If the fluid involved is Oil from engines or equipment leakage, the pre-prepared National Oil Spill Contingency Plan for drilling operations, developed based on Spill Models, will specify the level of spill response equipment and facilities.

Before Wells are drilled or ports and support facilities are constructed, dredging activities are undertaken with the aim of making the sea floor as smooth and as straight as possible. These operations involve the removing of material and sediments from sea bed and the disposal of the spoils in deeper intact areas. The problem lies in the fact that the spoils and waste materials contain high concentration of pollutants and heavy metals which can have significant impact on the sediments and Seawater. To reduce the impact, dredged spoils should be transported for Land Treatment and disposed at sea beyond the continental shelf.

Another important main source of impact is the action of well drilling itself. For exploration drilling, the drilling rig is towed into position and kept in place by anchors and DP systems. Depending on the type of the drilling rig used, sea floor sediments could be disturbed during installation and removal of drilling rigs. The gravity of the impact depends on the location of drilling; whether the wells are drilled on the continental slope or in the deep sea. The continental slope is the slope between the continental shelf and the deep-sea floor and is considered an unstable and sensitive zone if drilling operations were to be conducted in the area. The latter is delineated in blue on the map of Offshore Lebanon and is shown in exact dimensions in Figure 8.2.

Drilling on the continental slope can lead to sedimentation on the seabed which includes burial of species of concern and alternation of the size of sediments. It is also a main cause of Submarine Land Slides. In sensitive areas such as these, additional studies and mitigation strategies should be considered to determine whether certain techniques and/or technologies may avail capabilities favorable to drilling and production activities while reducing risks to levels as low as reasonably practicable (ALARP).

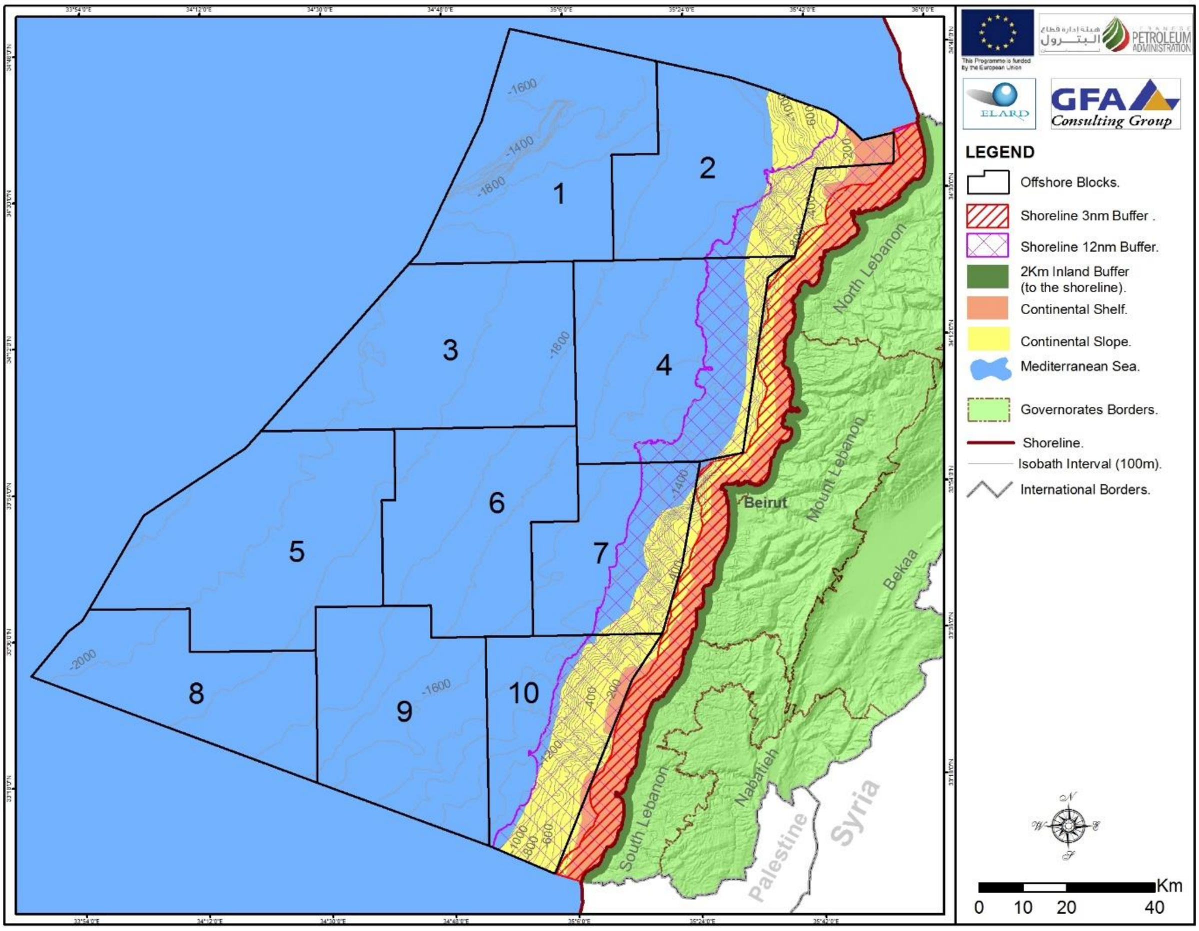


Figure 8-2 Sensitive Zones on the Lebanese Coast

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on sea water and sediments during Exploration Phase are summarized in Table 8-31.

Table 8-31 Significance Rating of Impacts on Seawater and Sediments during Exploration Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating Likelihood of Occurrence	Significance Rating
Increase in pollutants' concentrations in sediments	S1 S2 S3	Especially if untreated, Oil and Synthetic-Based Drill Cuttings and Fluids constitute a major source for Sediments Pollution once discharged into the sea which explains why the use of these muds is prohibited in many nations.	3- Moderate A -Almost Certain	High
Impacts related to sedimentation on the sea	S1	The most significant sources of Impact include Mobilization and Positioning of Tension Leg and SPAR drilling rigs, dredging activities for support	3- Moderate A -Almost Certain	High

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating Likelihood of Occurrence	Significance Rating
bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)		facilities, Wells Drilling Operations and Drill Cuttings and Fluids Discharge on the Continental Slope leading to the loss of endemic and rare species.		
	S2	Main sources of Impact include Mobilization and Positioning of Tension Leg and SPAR drilling rigs, dredging activities for support facilities, Wells Drilling Operations on the Continental Slope and in Deep Sea and Drill Cuttings and Fluids Discharge on the Continental Slope.		
	S3	Mobilization and Positioning of Tension Leg and SPAR drilling rigs, dredging activities for support facilities, Wells Drilling Operations and Drill Cuttings and Fluids Discharge on the Continental Slope and in the Deep Sea constitute the main sources of sedimentation and lead to the loss of endemic and rare species.		
Change in chemical characteristics of seawater attributed to petroleum activities	S1	The Discharge of Water-based and Oil/Synthetic-based Drill Cuttings & fluids to the sea and possible Chemical and Fuel spills from Vessel can alter the chemical properties of the Water.	2- Minor A -Almost Certain	Medium
	S2	The Discharge of Water-based Drill Cuttings & Fluids to the Sea, whether at depth or near the surface, can significantly impact the characteristics of Seawater.	3- Moderate A -Almost Certain	High
	S3	The main Petroleum sources negatively affecting the characteristics of sea water include the Discharge of Water-based and Oil/Synthetic-based Drill Cuttings & fluids to the Deep Sea or on the Continental Slope.	3- Moderate A -Almost Certain	High
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	S1	The only source of impact is related to Well Drilling Operations on the Continental Slope which can trigger serious Submarine Land Slides and highly affect Sediments on the Sea floor.	5- Critical U -Unlikely	High
	S2			
	S3			

8.3.3.4 Proposed Mitigation Measures

Table 8-32 Proposed mitigation Measures for Impacts on Sea Water and Sediments during Exploration Phase

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Increase in pollutants' concentrations in sediments	✓ Discharge of water-based drill cuttings and fluids to the Sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluents discharges ✓ Dredging activities for ports and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, transportation and storage accidents and loss of stability	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of drilling activities. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents. ✓ Chemical storage shall follow international standard in terms of packaging and labelling of products (GHS, CLP). ✓ Transport of chemicals shall fulfil the requirements of international conventions and standards including IMDG Code for Dangerous Goods.
Impacts related to sedimentation on the sea bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)	✓ Mobilization and positioning in place of drilling rig (Tension Leg Platforms & SPAR-Single Point Anchor Reservoir) ✓ Mobilization and positioning in place of drilling rig (Drill Ships & Semi-Submersible Platforms) ✓ Dredging activities for ports and onshore support facilities ✓ Wells drilling in the continental slope / shelf ✓ Wells drilling in the deep sea ✓ Discharge of drill cuttings & fluids in the continental slope	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area, and mobilize and position rigs and drill during non-productive Seasons. ✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Avoid drilling on the Continental Slope/shelf. ✓ If drilling in the continental slope/shelf is not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment ✓ Operators to follow waste management recommendations in section 9.2.3.

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	✓ Discharge of drill cuttings & fluids in the deep sea	
Change in chemical characteristics of seawater attributed to petroleum activities	✓ Discharge of water-based drill cuttings and fluids to the Sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluents discharge ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, transportation and storage accidents and loss of stability	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Treatment of Effluent Fluids before Discharge as per MARPOL requirements. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ MOE to publish a list of approved oil dispersants allowed to be used in oil spill response (in line with NOSCP). ✓ Ensure safety critical equipment and processes are in place and operational prior to start of drilling activities ✓ Operators to prepare tier 1 OSCP ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	✓ Well Drilling on the Continental Slope	✓ Avoid drilling on the Continental Slope. ✓ If drilling in the continental slope/shelf is not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment.

8.3.3.5 *Assessment of Residual Impacts*

The residual impacts on seawater and sediments during Exploration Phase with existing and additional mitigation measures in place are summarized in Table 8-33.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-32.

Table 8-33 Significance Rating of Residual Impacts on Seawater and Sediments during Exploration Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in pollutants' concentrations in sediments	S1	3- Moderate A -Almost Certain	High	1- Negligible A -Almost Certain	Medium
	S2			2- Minor A -Almost Certain	Medium
	S3			2- Minor A -Almost Certain	Medium
Impacts related to sedimentation on the sea bed/turbidity	S1 S2 S3	3- Moderate A -Almost Certain	High	2- Minor A -Almost Certain	Medium
Change in chemical characteristics of seawater attributed to petroleum activities	S1	2- Minor A -Almost Certain	Medium	2- Minor L -Likely	Medium
	S2 S3	3- Moderate A -Almost Certain	High	2- Minor L -Likely	Medium
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	S1 S2 S3	5- Critical U -Unlikely	High	**No Additional Mitigation Measures can be foreseen.**	

8.3.4 Impacts on Marine Biological Environment

8.3.4.1 Potential Impacts

Table 8-34 Impacts of Exploration Phase on Marine Biological Environment

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Changes in abundance, status and density of cetaceans, sea turtles and seals	✓ Physical presence of the drilling rig including noise and light ✓ Noise generated during wells drilling ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluent discharge ✓ Collisions and Noise generated by the movement of support vessel and chemicals/wastes transportation ✓ Collisions and Noise generated in exporting drill cuttings	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
	& fluids ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Helicopter movement	movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use. ✓ Seabirds fishing activities.
Changes in abundance, status, richness and density of Phyto and zoo benthos	✓ Mobilization and positioning in place of drilling rig (Tension Leg Platforms & SPAR-Single Point Anchor Reservoir) ✓ Mobilization and positioning in place of drilling rig (Drill Ships & Semi-Submersible Platforms) ✓ Wells drilling in the continental slope and in deep sea ✓ Re-injection of drill cuttings and fluids ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the Sea ✓ Dredging activities for ports and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	
Changes in diversity and dominance of Nekton and Plankton	✓ Physical presence of the drilling rig ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluents discharge ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use. ✓ Seabirds fishing activities.
Changes in abundance, Status and density of Seabirds	✓ Physical presence of the drilling rig ✓ Helicopter Movement ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Discharge of water-based drill cuttings & fluids/Discharge to the Sea ✓ Discharge of oil/synthetic-based drill cuttings & fluids/Discharge to the Sea	
Increase in the trend of introduction of invasive species	✓ Effluents discharge and ballast water ✓ Bio-fouling on drillships, mobile rigs, and service vessels	
Percent area of sensitive/ protected marine habitats affected by petroleum activities	✓ Mobilization and positioning in place of drilling rig (Tension Leg Platforms & SPAR-Single Point Anchor Reservoir) ✓ Mobilization and positioning in place of drilling rig (Drill Ships & Semi-Submersible Platforms) ✓ Wells drilling in the continental slope and the deep sea ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Dredging activities for ports and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	

8.3.4.2 Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- The Ballast Water Management Convention (2004) establishes standards, procedures and guidelines for the management and control of ships' ballast water and sediments.
- Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore petroleum activities shall be followed. The guidelines necessitate the employment of the following:
    - **Big Air Bubble Curtains:** a system that produces air bubbles under water breaking the propagation of sound waves
    - **Little Air Bubble Curtain:** A little bubble curtain can be customized and placed much closer to the big bubble curtain, it may consist of a rigid frame placed around of the source. Several configurations are possible.
    - **Hydro Sound Damper**: a technology consisting of fishing nets with small balloons filled with gas and foam (ensure Hydro Sound Damper equipment is retrieved and accounted for so that it does not contribute to marine debris)
    - **Noise Mitigation Screen:** a double-layered screen filled with air and bubbles
    - **BEKA shells**: double steel wall with intern and outer bubble curtains and acoustic decoupling
    - **Visual monitoring protocol**
    - **Passive Acoustic Monitoring protocol (PAM):** regularly used during a range of operations whether static or mobile to facilitate the detection of marine mammal species during times of limited visibility or darkness.
    - **Marine Mammal Observation protocol**
    - **Soft start protocol:** Noise emissions should begin at low power, increase gradually until full power is reached. The soft start procedure should be of 20 min duration at least.
    - **Use of Acoustic Mitigation Devices (AMD):** Prior to the beginning of the work, AMD should be used to drive away groups or individuals of marine mammals.
- Barcelona Convention and its protocols (1976) establishes instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- The African-Eurasian Water-bird Agreement AEWA is an international agreement aiming to coordinate efforts to conserve bird species migrating between the regions.

- The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands
- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators are required to develop an ERP and demonstrate readiness to implement it prior to starting any activity.
- The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.
- The National Biodiversity Strategy and Action Plan (NBSAP).
- Decision 1044/1-2014 sets general conditions to protect cetaceans.
- Decision 396/1-2014 defines restrictions and regulations to limit and ban seabirds catching.

8.3.4.3 Assessment of Impacts

During Drilling Operations, a significant level of noise typically continuous and of low frequency, is induced by the action of the drill bit itself as it moves through the seabed strata, the drill string and the riser once set. The higher and most effecting noise however is related to the mobilization and positioning of the drilling platforms, the movement of support and supply vessels and near the coast-dredging activities.

1. *Mobilization and Positioning of Drilling Platforms*

Sound levels originating from offshore installations will depend on the type of platform adopted. Anchored and Floating Platforms typically generate more sound than fixed platforms due to the use of propellers and thrusters to maintain position. **Regardless, Fixed Platforms are not considered for offshore Lebanon where waters are relatively deep.** The table below compares the noise level and band widths generated from Drill Ships, Semi-Submersibles and Fixed Platforms during different activities for comparative purposes.

Table 8-35 Sound Levels Measured from Different Types of Drilling Platform during Periods When Drilling and not Drilling

Source Type	Activity	Source Noise Level	Band Width (kHz)
Drill Ship	Logging	125 dB (rms) re 1μPa @ 170 m	0.02 – 1
	Drilling	195 dB (rms) re 1μPa @ 1 m	0.001 – 1.39
Semi-Submersible	Active – Not Drilling	117 dB (rms) re 1μPa @ 125 m	0.01 – 10
	Drilling*	115 dB (rms) re 1μPa @ 405 m	0.01 – 10
Fixed Platforms	Drilling	162 dB (rms) re 1μPa @ 1 m	0.01 – 10

**On a semi-submersible rig, the drilling machinery and generators are located on solid platforms above the water, where sound is lost as it transmits through the air and the rig flotation structure (Richardson et al, 1995).*

2. Support and Supply Vessels

The vessels used to support offshore activities and supply the drilling platforms are also an important source of acoustic pollution. Noise from these sources originates from engines and gears and propellers. Vessels moving to site can generally produce more noise than stationary vessels because of propeller cavitation noise. In certain situations where a supply vessel is required to refuel a drilling rig, the boat will have to maintain its position alongside the rig by dynamic positioning which adds the noise generated by thrusters to the previous list. The average noise level radiated from the movement of Support Vessels ranges between 160 and 195 dB for a band width of 0.1-10 Hz.

Low-flying helicopters responsible for personnel transfer may also increase localized underwater noise levels since the noise created by rotor blades and exhaust pipe is anticipated to be directly reflected on the sea surface.

3. Dredging Activities

Dredging activities involve the removing of material and sediments from sea bed and the disposal of the spoils in deeper intact areas. The activities are sound-generating with a noise level average ranging between 168 and 186 dB for a band width of 0.1 Hz-1 kHz that is highly detected by marine animals.

The noise generated by dredging activities does not constitute the only impact on the marine environment, but such operations adopted on the continental shelf and slope known for the high productivity levels and biodiversity, could lead to the loss of species of global concern and interest.

Marine mammals are highly vulnerable to the previously mentioned noise-generating activities and the sensitivity of species to noise levels were included in section 8.2.4.3. In general, the expected impact depends on:

- **Ambient noise levels:** a combination of sounds in the sea produced natural sources such as winds, waves and ocean, currents, rain and other anthropogenic sounds generated by air traffic and shipping,

- **The strength of the sound source and the noise level:** which depends on the source itself. The source noise level generated by Drilling activities usually ranges between 160 and 195 dB with a band width between 200 and 300 Hz (Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive, 2011).

- **The sound transmission conditions of the receiving environment**,

- **The proximity of animals to the noise in relation to their ability to detect such sound frequencies:** depends on to animal type, age, sex, habitat, individual variation, and previous habituation to noise (Richardson *et al,* 1995).

Another source of high influence is possible chemical and Hydrocarbons Spills, the discharge of Effluents and Drill Cuttings and Fluids. The severity of the situation increases if the discharge occurs in areas of biodiversity and photosynthesis. In fact, the sea can be divided into 3 regions:

- **Continental Shelf:** for depth between 0 and 200m. The region is viewed as an area of productivity and photosynthesis.
- **Continental Slope:** for depth between 200 and 1200m - 1500m including the canyons. The region is considered an area of high biodiversity and acts as nutrient highway between the continental shelf and the deep sea.
- **Deep Sea:** for depth beyond 1200-1500m. The region is characterized by absence of light and very specific biodiversity.

The later shows that if the discharge occurs in continental shelf and slope, the loss of Nekton, Plankton and Benthos species can be anticipated. Other than the discharge, the existing communities can be affected during the removal of the drilling rig, if the rig was anchored.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on marine biological environment during Exploration Phase are summarized in Table 8-36.

Table 8-36 Significance Rating of Impacts on Marine Biological Environment during Exploration Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating Likelihood of Occurrence	Significance Rating
Changes in abundance, status and density of cetaceans, sea turtles and seals	S1	The noise generated from Wells Drilling and Chemical and Fuel Spills are considered the main two sources of impact influencing the density and abundance of Marine Mammals. Other sources include Water-based or Oil/Synthetic Drill Cuttings and Effluent Discharges to the sea.	4- Major P -Possible	High
	S2 S3	The noise generated from Wells Drilling and Chemical and Fuel Spills are considered the main two sources of impact influencing the density and abundance of Marine Mammals. Other sources include Water-based or Oil/Synthetic Drill Cuttings and Effluent Discharges to the sea and the noise generated by the Movement of Support Vessels.	4- Major P -Possible	High
Changes in abundance, status, richness	S1	Other than the impact of Drill Ships & Semi-Submersible Platforms Mobilization and Positioning, Discharge of oil/synthetic-	3- Moderate A -Almost Certain	High

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
and density of Phyto and zoo benthos		based drill cuttings & fluids to the Sea and Chemicals and Fuel Spills. Dredging activities constitute the most significant source of impact on the density of Benthos.		
	S2, S3	Dredging activities are the most significant source of impact. Other sources include Drill Ships, Semi-Submersible, Tension Leg and SPAR Platforms Mobilization and Positioning, Wells Drilling Operations, Discharge of oil/synthetic-based drill cuttings & fluids to the Sea and Chemicals and Fuel Spills.	3- Moderate A -Almost Certain	High
Changes in diversity and dominance of Nekton and Plankton	S1	The Discharge of oil/synthetic-based drill cuttings & fluids to the Sea and Spills of fuel and chemicals are considered the most significant sources of impact.	3- Moderate A -Almost Certain	High
	S2, S3	The main source of impact is the effluent discharges which contain Pollutants and Heavy Metals. Other sources include Discharge of oil/synthetic-based drill cuttings & fluids to the Sea and Fuel and Chemicals Spills.	3- Moderate A -Almost Certain	High
Changes in abundance, Status and density of Seabirds	S1, S2, S3	Possible Chemical and Fuel Spills are considered the most significant source of influence on the Density and Abundance of Seabirds. Helicopter Movements and Gas and Oil Blow-outs can also have a significant influence on the indicator.	3- Moderate P -Possible	Medium
Increase in the trend of introduction of invasive species	S1, S2, S3	The only sources of influence are Effluents Discharge and Ballast Water Discharge.	4- Major P -Possible	High
Percent area of sensitive/ protected marine habitats affected by petroleum activities	S1	Most significant sources of Impact include Wells Drilling in the continental slope and Discharge of Water-based and Oil/synthetic-based drill cuttings & fluids to the continental slope leading to loss of endemic and other species of global concern. Gas and Oil Blow outs can also be considered as important sources of influence.	3- Moderate A -Almost Certain	High
	S2, S3	Aside from the impact of Tension Leg and SPAR platforms Mobilization and Positioning, Wells drilling in deep sea, Discharge of Water-based and Oil/synthetic-based drill cuttings & fluids to the continental slope and Gas and Oil Blow out, Wells drilling operations conducted on the continental slope constitute the most significant source of impact.	4- Major A -Almost Certain	High

8.3.4.4 Proposed Mitigation Measures

Table 8-37 Proposed mitigation Measures for Impacts on Marine Biological Environment during Exploration Phase

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Changes in abundance, status and density of cetaceans, sea turtles and seals	✓ Physical presence of the drilling rig ✓ Noise generated during wells drilling ✓ Discharge of water-based drill cuttings and fluids to the Sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluents discharge ✓ Collisions and Noise generated by the movement of support vessel and chemicals/wastes transportation ✓ Collisions and Noise generated in exporting drill cuttings & fluids ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Ensure operators consider applicable ACCOBAMS recommendations for noise reduction and demonstrate that underwater noise levels and high risk areas are reduced to the minimum possible extent during drilling using ALARP methodology ✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Optimize travel trips and travel routes when transporting chemicals and wastes ✓ Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods. ✓ EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of drilling. ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Changes in abundance, status, richness and density of Phyto and zoo benthos	✓ Mobilization and positioning in place of drilling rig (Tension Leg Platforms & SPAR-Single Point Anchor Reservoir) ✓ Mobilization and positioning in place of drilling rig (Drill Ships & Semi-Submersible Platforms) ✓ Wells drilling in the continental slope and in deep sea ✓ Re-injection of drill cuttings and fluids ✓ Discharge of water-based drill cuttings and fluids to the Sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the Sea ✓ Dredging activities for ports	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. And mobilize, position drilling rigs and drill during Non-Productive Season. ✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of drilling ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	of accidents. ✓ Mapping of sea-grass meadows in Lebanese shallow waters shall be conducted prior to activities.
Changes in diversity and dominance of Nekton and Plankton	✓ Physical presence of the drilling rig ✓ Discharge of water-based drill cuttings and fluids to the Sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the Sea ✓ Effluents discharge ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Treatment of Effluent Fluids before Discharge. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of drilling ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Changes in abundance, Status and density of Seabirds	✓ Physical presence of the drilling rig ✓ Helicopter Movement ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Optimize and reduce the number of Helicopter Trips. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of drilling ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Increase in the trend of introduction of invasive species	✓ Effluent discharge and ballast water	✓ Set Strict Restrictions regarding Ballast Water Discharge. ✓ Ensure compliance with Ballast Water Convention
Percent area of sensitive/ protected marine habitats affected by petroleum activities	✓ Mobilization and positioning in place of drilling rig (Tension Leg Platforms & SPAR-Single Point Anchor Reservoir) ✓ Mobilization and positioning in place of drilling rig (Drill Ships & Semi-Submersible	✓ Avoid activities in the vicinity of protected areas/areas proposed for protection and establishing a buffer zone around such areas. Buffer zones shall be determined in EIA studies. ✓ Drilling and production within protected areas are prohibited ✓ Compliance with protected areas management plans. ✓ Establish a code of conduct for operating in

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	Platforms) ✓ Wells drilling in the continental slope ✓ Wells drilling in the deep sea ✓ Discharge of water-based drill cuttings and fluids to the continental slope ✓ Discharge of water-based drill cuttings and fluids in the deep sea ✓ Discharge of Oil/Synthetic-based drill cuttings and fluids to the continental slope ✓ Discharge of Oil/Synthetic-based drill cuttings and fluids in the deep sea ✓ Dredging activities for ports and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	proximity to protected and sensitive areas. ✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. ✓ Avoid drilling on the Continental Slope. ✓ If drilling in the continental slope/shelf is not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment ✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of drilling ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.

8.3.4.5 <u>Assessment of Residual Impacts</u>

The residual impacts on marine biological environment during Exploration Phase with existing and additional mitigation measures in place are summarized in Table 8-38.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-37.

Table 8-38 Significance Rating of Residual Impacts on Marine Biological Environment during Exploration Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Changes in abundance, status and density of cetaceans, sea turtles and seals	S1	3- Moderate A -Almost Certain	High	2- Minor A -Almost Certain	Medium
	S2 S3	3- Moderate A -Almost Certain	High	2- Minor A -Almost Certain	Medium
Changes in abundance, status, richness and density of Phyto and zoo benthos	S1	3- Moderate A -Almost Certain	High	2- Minor L -Likely	Medium
	S2 S3	3- Moderate A -Almost Certain	High	3- Moderate L -Likely	Medium
Changes in diversity and dominance of Nekton and Plankton	S1	3- Moderate A -Almost Certain	High	2- Minor L -Likely	Medium
	S2 S3	3- Moderate A -Almost Certain	High	2- Minor L -Likely	Medium
Changes in abundance, Status and density of Seabirds	S1 S2 S3	3- Moderate P -Possible	Medium	1- Negligible L -Likely	Low
Increase in the trend of introduction of invasive species	S1 S2 S3	4- Major P -Possible	High	3- Moderate P -Possible	Medium
Percent area of sensitive/ protected marine habitats affected by petroleum activities	S1	3- Moderate A -Almost Certain	High	2- Minor L -Likely	Medium
	S2 S3	4- Major A -Almost Certain	High	2- Minor L -Likely	Medium

8.3.5 *Impacts on Coastal Environment*

8.3.5.1 *Potential Impacts*

Table 8-39 Impacts of Exploration Phase on Coastal Environment

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Percent area of sensitive coastal habitats affected by impacts related to the sector	✓ Movement of support vessel and chemicals/wastes transportation ✓ Dredging activities for ports and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use.

8.3.5.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.
- The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.
- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators are required to prepare ERPs and demonstrate readiness for their implementation prior to initiating any activities.

8.3.5.3 Assessment of Impacts

All offshore petroleum activities require ports and onshore support facilities that are typically constructed near the coast. Prior to that, the sea near the coast needs to be dredged and the spoils are usually released in the sea. If discharged near the coast and without prior treatment, these wastes can, aside from altering the sediments and seawater properties, negatively affect the sensitive coastal habitats.

Similar to how Dredging spoils along with domestic and drilling wastes and chemicals are transported to onshore facilities, other needed chemicals, fluids and supplies are delivered to the drilling platform. The transportation is typically done by using Support and Supply Vessels running on Fuel and Diesel Engines. Since the movements of the vessel are concentrated near the shore, a significant impact on the coastal habitats can be anticipated. The effect may not only come from the movement of the vessels itself but also from possible Fuel and Chemicals Spills due to leakage. Another source of Spills is related to Gas and Oil Blow-Outs that occur due to pressure differences. The incidents take place at the wellbore but can reached the coast due to strong waves and currents. The presence of these spills near the coast can alter Coastal habitats and affect Coastal Tourism in the area.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on coastal environment during Exploration Phase are summarized in Table 8-40.

Table 8-40 Significance Rating of Impacts on Coastal Environment during Exploration Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Percent area of sensitive coastal habitats affected by impacts related to the sector	S1	Dredging activities and Chemicals and Fuel Spills are considered the main source of impact.	3- Moderate A -Almost Certain	High
	S2 S2	In addition to Dredging activities and Chemicals and Fuel Spills, the impact of the Movement of Support Vessels for chemicals and Wastes transportation is assumed to be negatively significant.	3- Moderate A -Almost Certain	High

8.3.5.4 *Proposed Mitigation Measures*

Table 8-41 Proposed mitigation Measures for Impacts on Coastal Environment during Exploration Phase

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Percent area of sensitive coastal habitats affected by impacts related to the sector	✓ Movement of support vessel and chemicals/wastes transportation	✓ Optimize travel trips and travel routes when transporting chemicals and wastes ✓ Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods. ✓ EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.
	✓ Dredging activities for ports and onshore support facilities	✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf.
	✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of drilling ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.

8.3.5.5 Assessment of Residual Impact

The residual impacts on coastal environment during Exploration Phase with existing and additional mitigation measures in place are summarized in Table 8-42.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-41.

Table 8-42 Significance Rating of Residual Impacts on Coastal Environment during Exploration Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Percent area of sensitive coastal habitats affected by impacts related to the sector	S1	3- Moderate A -Almost Certain	High	3- Moderate P -Possible	Medium
	S2	3- Moderate A -Almost Certain	High	3- Moderate P -Possible	Medium
	S2				

8.3.6 Impacts on Fisheries

8.3.6.1 Potential Impacts

Table 8-43 Impacts of Exploration Phase on Fisheries

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	✓ Physical presence of the drilling rig ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Movement of support vessel and chemicals/wastes transportation ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use.
Total area of where fishing activities excluded due to petroleum activities	✓ Physical presence of the drilling rig	
Loss of fishermen income due to excluded area	✓ Physical presence of the drilling rig	

8.3.6.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore petroleum activities shall be followed (See section 8.3.4.2).
  - MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
  - Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
  - The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.
  - The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.
  - The National Biodiversity Strategy and Action Plan (NBSAP).
  - Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
  - Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.

8.3.6.3 Assessment of Impacts

Interference with sea users due to physical presence of the rig, vessels, and subsea equipment, is definitely expected. During the drilling phase, an increase in the vessel activity in the region is anticipated mainly due to the addition of the Supply and Support Vessels and Helicopters required for transporting goods and personnel to and from the drilling rig.

For safety reasons, it has been proposed to determine a radius surrounding the rig to be a safety exclusion zone where fishing is not permitted. The safety exclusion zone will be 500 m radius area at all times as per UNCLOS except when within territorial waters where it could be more if warranted by risk assessments. The safety exclusion zone will exclude a defined area from fishing access and will affect the fishermen's income if the exclusive area is large. At the end of the drilling plan, if the well was not found to be commercial, it will be plugged, the riser will be completely removed, and fishing activities can resume.

Aside from the negative impact the physical presence of petroleum vessels has, rigs and platforms might serve in certain cases, as Fish Aggregating Devices having beneficial influence on the fisheries and aquatic stocks. A Fish Aggregating Device (FAD) is an object used to attract various fish species in the sea leading to increase in catches and aquatic stocks. Detolle et al (1998) claim that catches at Reunion Island increased by 143% over a period of eight years subsequent to the deployment of FADs.

On the other hand, there exists several factors negatively influencing the aquatic stocks such as the discharged cuttings and fluids and possible chemical and fuel spills which are highly known for high concentrations in metals and pollutants. The latter can lead to cases of asphyxiation of fishes and mortality by toxicity.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on fisheries during Exploration Phase are summarized in Table 8-44.

Table 8-44 Significance Rating of Impacts on Fisheries during Exploration Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	S1	Main sources of Impact include Discharges of Water-Based Drill Cuttings and Fluids to the sea.	3- Moderate A -Almost Certain	High
	S2	In addition to the Discharges of Water-Based Drill Cuttings and Fluids to the sea, the movement of Support Vessels for chemical and wastes transportation constitute a main source of impact.	3- Moderate A -Almost Certain	High
	S3	The discharge of Water-Based and Oil/Synthetic-Based Drill Cuttings and Fluids to the sea and the movement of Support Vessels for chemical and wastes transportation can have a negative effect on the Fish and Aquatic Stock.	3- Moderate A -Almost Certain	High
Total area of where fishing activities excluded due to petroleum activities	S1 S2 S3	The only source of impact includes the Physical Presence of the Drilling Rig.	2- Minor A -Almost Certain	Medium
Loss of fishermen income due to excluded area	S1 S2 S3	The only source of impact includes the Physical Presence of the Drilling Rig.	2- Minor A -Almost Certain	Medium

8.3.6.4 *Proposed Mitigation Measures*

Table 8-45 Proposed mitigation Measures for Impacts on Fisheries during Exploration Phase

Impact Indicator		Proposed Mitigation Measures
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	✓ Physical presence of the drilling rig ✓ Discharge of water-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Movement of support vessel and chemicals/wastes transportation ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Optimize travel trips and travel routes when transporting chemicals and wastes ✓ Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods. ✓ EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of drilling ✓ Monitoring of chemical concentrations in edible fish and invertebrate tissue. ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents. ✓ Regional baseline studies should be conducted by independent scientists/resource agencies to the extent possible prior to any licenses being offered so that sensitive resources can be better defined in each block
Total area of where fishing activities excluded due to petroleum activities	✓ Physical presence of the drilling rig	✓ Limit Exclusion Zones to Safety Zones
Loss of fishermen income due to excluded area	✓ Physical presence of the drilling rig	✓ At the time of submitting a well plan for approval, operators shall inform fishermen through the Fisheries Associations. In addition, in the case of a well-planned in an area of intensive fishing, discussions with the Fisheries Associations must be initiated as early as possible, and preferably not less than 90 days before planned commencement of drilling.

8.3.6.5 Assessment of Residual Impacts

The residual impacts on fisheries during Exploration Phase with existing and additional mitigation measures in place are summarized in Table 8-46.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-45.

Table 8-46 Significance Rating of Residual Impacts on Fisheries during Exploration Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating Likelihood of Occurrence	Significance Rating	Consequence Rating Likelihood of Occurrence	Significance Rating
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	S1	3- Moderate A -Almost Certain	High	1- Negligible L -Likely	Low
	S2			2- Minor L -Likely	Medium
	S3				
Total area of where fishing activities excluded due to petroleum activities	S1	2- Minor A -Almost Certain	Medium	1- Negligible P -Possible	Low
	S2				
	S3				
Loss of fishermen income due to excluded area	S1	2- Minor A -Almost Certain	Medium	1- Negligible P -Possible	Low
	S2				
	S3				

8.3.7 Impacts on Ambient Noise Levels

8.3.7.1 Potential Impacts

Table 8-47 Impacts of Exploration Phase on Ambient Noise Levels

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in ambient noise levels measured in the vicinity of petroleum facilities/ support activities in the coastal area	✓ Wells drilling ✓ Power generation on the rig ✓ Supply vessels movement ✓ Helicopter movement ✓ On-shore support facilities/ provision of supplies ✓ Gas blow out ✓ Oil spills ✓ Spills of fuel and chemicals ✓ Collisions/ Transportation and storage accidents ✓ Loss of stability	✓ Other vessels activity in the sea ✓ Land transportation ✓ Other noise sources in the coastal region

8.3.7.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MoE Decision No. 52/1/1996, National maximum allowable noise levels and the permissible noise exposure standards.
- Offshore blocks are located more than three (3) nm away from the shoreline.
- Locations for onshore support facilities should be selected in compliance with the National Land Use Master Plan.

8.3.7.3 Assessment of Impacts

The consequence rating, likelihood of occurrence, significance rating and acceptability of the environmental impacts on ambient noise levels during Exploration Phase are summarized in Table 8-48.

Table 8-48 Significance Rating of Impacts on Ambient Noise Levels during Exploration Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	S1	Ambient noise levels generated during exploration phase from wells drilling and power generation are not expected to have an impact on ambient noise levels in the coastal area given the distance from the shoreline. Impacts from support activities are of short duration and low magnitude and not expected to have a noticeable impact on noise levels in the coastal region.	1- Negligible L -Likely	Low
	S2		1- Negligible L -Likely	Low
	S3		1- Negligible L -Likely	Low

8.3.7.4 Proposed Mitigation Measures

No additional mitigation measures are proposed.

8.3.7.5 Assessment of Residual Impacts

Since impacts on ambient noise levels in the Exploration phase are low and no additional mitigation measures are proposed, the residual impacts are of the significance presented in Table 8-48.

8.4 IMPACTS DURING PRODUCTION PHASE

8.4.1 Impact Identification

The environmental and socio-economic receptors expected to be impacted from production phase activities are shown in the impact identification matrix presented in Table 8-49.

Table 8-49 Impact Identification Matrix – Production Phase

DEVELOPMENT AND PRODUCTION PHASE																									
Component / Activity		Physical Environment						Biological Environment							Others										
		Air Quality	Climate change	Seawater	Sea bed	Underwater Noise	Above water noise	Phyto & zoo benthos	Nekton	Phyto & zoo plankton	Seabirds	Sea Mammals, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats	Archaeological & Cultural Resources	Infrastructure	Social Conditions	Education	Crime	General Economy /industry/energy	Fisheries	Shipping	Tourism	Health	Landscape and Visual Amenity
Installation of platforms	Tension Leg Platforms	X	X	X	X	X	X	X					X		X	X							X		
	SPAR- Single Point Anchor Reservoir	X	X	X	X	X	X	X					X		X	X									
	Drill Ships	X	X	X	X	X	X	X		X			X		X	X									
	Semi-Submersible Platforms	X	X	X	X	X	X	X					X		X	X									
Platform Operation	Single Well drilling	X	X	X	X	X	X	X					X		X	X		X							
	Multiple wells drilling	X	X	X	X	X	X	X					X		X	X		X							
	Physical presence of the platform							X	X	X	X	X	X								X	X			X
	Flaring and power generation (noise and air emissions)	X	X			X	X					X												X	
	Discharge of drill cuttings & fluids/Onshore Disposal	X	X			X	X					X				X						X			
	Discharge of drill cuttings & fluids/Cuttings Re-injection	X	X	X	X	X	X	X																	
	Discharge of water-based drill cuttings & fluids/Discharge to the Sea			X	X			X	X	X		X	X								X			X	
	Discharge of oil/synthetic-based drill cuttings & fluids/Discharge to the Sea	X	X	X	X			X	X	X		X	X								X			X	
	Discharge of drill cuttings & fluids/Exporting Waste	X	X			X	X					X										X			
	Produced Water /Onshore transport and treatment	X	X			X	X					X				X									
	Produced Water / Discharge to the sea			X	X			X	X	X		X	X								X			X	
	Produced Water / Re-injection	X	X	X	X	X	X	X																	
	Produced Sand /Onshore transport and treatment	X	X			X	X					X				X						X			
	Produced Sand / Discharge to the sea			X	X			X	X	X		X	X											X	
	Produced Sand / Re-injection	X	X	X	X	X	X	X																	
	NORM waste/ Disposal and treatment onshore	X	X			X	X					X				X						X			

DEVELOPMENT AND PRODUCTION PHASE																									
Component		Physical Environment						Biological Environment							Others										
	Activity	Air Quality	Climate change	Seawater	Sea bed	Underwater Noise	Above water noise	Phyto & zoo benthos	Nekton	Phyto & zoo plankton	Seabirds	Sea Mammals, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats	Archaeological & Cultural Resources	Infrastructure	Social Conditions	Education	Crime	General Economy /industry/energy	Fisheries	Shipping	Tourism	Health	Landscape and Visual Amenity
	NORM waste/ Export	X	X			X	X					X										X			
	Other effluent discharges (including routine vessels discharges and waste)			X	X			X	X	X	X	X	X												
	Chemicals storage offshore																							X	
	Chemicals storage onshore															X								X	
	Chemicals transportation by Sea	X	X			X	X					X										X		X	
	Chemicals transportation by land	X	X																					X	
Support activities	Movement of Support Vessel	X	X			X	X					X		X		X	X					X			
	Helicopter Movement	X	X				X				X	X				X									
	On-shore Support Facilities/provision of supplies						X								X	X	X				X				X
Development options	Installation of Subsea System	X	X	X	X	X	X	X				X	X	X	X	X									
	Onshore processing facilities	X	X				X							X	X	X	X	X		X				X	X
	Offshore processing facilities	X	X	X	X	X	X	X	X	X	X	X	X					X			X	X	X	X	X
	Onshore transmission network													X	X	X	X			X					
Export options	Export of gas Via the Arab gas pipeline (onshore)													X	X	X	X			X					
	Export of gas Via the Turkish pipelines (offshore)	X	X	X	X	X	X	X					X		X	X	X			X					
	Export of liquid hydrocarbons via tankers	X	X			X	X					X										X		X	
	Offshore LNG terminal	X	X	X		X	X	X	X	X	X	X	X					X			X	X	X	X	X
	Onshore LNG terminal	X	X		X		X	x						X	X	X	X	X		X				X	X
Accidental Events	Gas blow out	X	X	X	X			X	X	X	X	X	X	X		X				X	X	X	X	X	X
	Oil spills	X	X	X	X			X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
	Spills of fuel and chemicals	X	X	X	X			X	X	X	X	X	X	X		X				X	X	X	X	X	X
	Collisions/ Transportation and storage accidents	X	X	X	X			X	X	X	X	X	X	X	X	X	X			X		X	X	X	
	Loss of stability														X		X			X		X	X	X	

8.4.2 Impacts on Air Quality and Climate Change

8.4.2.1 Potential Impacts

Table 8-50 Impacts of Production Phase on Air Quality and Climate Change

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities Increase in emissions of GHGs from the petroleum sector	✓ Production/Processing ✓ Transmission via Pipelines ✓ LNG Terminal (Offshore/Onshore) ✓ Export of liquid Hydrocarbons via Tankers ✓ Transport and Support Activities including transport of waste and chemicals ✓ Helicopter Movement ✓ Gas and Oil Blow-Out ✓ Spills of Fuels and Chemicals ✓ Fugitive emissions	✓ Shipment Ships and Vessels activities in the sea and near areas ✓ Emissions from the transport sector ✓ Pollutants generated from the manufacturing sector and Industrial areas ✓ Contaminants generated by garbage accumulation and burning ✓ Emissions from Power Generation

8.4.2.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- Demonstration of the use of Best Available Technologies (BAT) is required by the Air Quality Law #78/2018.
- Air emissions release is subject to a permit obtained from the Ministry of Environment under the Air Quality Law # 78/2018.
- The Ministry of Environment's Decision Number 99-1/2013 regarding the submission of information on Green House Gas emissions for all facilities.
- Application of the Best Available Techniques (BAT) as stipulated by the Air Quality Protection law (78/2018) to minimize the impact on air quality.
- Compliance with Ambient Air Quality Standards (Decision No. 52/1/1996), Emission Limit Values for power generation (Decision No. 8/1/ 2001) and relevant international standards.
- Flaring or venting and all types of Air Emissions release is subject to a permit from Ministry of Environment and Water and Emergency Flaring requires registration and reporting to the Minister within 24 hours from occurrence.
- National Oil Spill Contingency Plan.
- Operators are required to prepare an ERP and demonstrate readiness to implement it prior to start of any activities.

8.4.2.3 Assessment of Impacts

The consequence rating of impacts on air quality and climate change considers Lebanon's NDC commitment. The contribution was revised by the Ministry of Environment considering that the Oil & gas sector will be emitting 2.569.5 kt $CO_{2eq.}$ in 2030 (MoE, 2019). This value will be decreased by 10% to account for numerous negligible sources (including service vessels and helicopters, equipment deliveries and other activities), resulting in 2,312.55 kt $CO_{2eq.}$. During the production phase, the operations and activities are much more intense suggesting an increase in gas emissions and contaminants. The main sources of emissions are expected from the power generation at Platform and associated vessels, support aircraft and helicopters, all powered by diesel and fuel combustion engines. Power is also similarly provided offshore for all equipment used during the production processes and for compression equipment so that the produced gas can be transported onshore. During combustion, CO_2 along with CH_4 air pollutants including CO, NOx, SOx, PM, and other unburned hydrocarbons are emitted into the atmosphere in elevated concentrations contributing to global warming and acid formation.

Other sources of emissions entail chemical and hydrocarbon spills associated with either damaged equipment leakage or engine wastes from platforms and transmission ships and vessels or gas and oil blow-out incidents. The risk of accidental hydrocarbon and/or chemical spillage to the sea is one of the main environmental concerns associated with the Petroleum Industry due to the related significant number of environmental impacts on air quality. The actual impacts depend on many factors, including the volume and type of oil spilled, and sea and weather conditions. A response Plan has been previously developed to mitigate for such accidental events.

In the case of oil and gas production, flaring and venting of the associated gas for disposal might also be source of gas emissions. Often adopted as a safety measure in the event of an emergency, power or equipment failure, or other plant upset condition, Flaring and Venting operations involve the emission of pollutants and Greenhouse Gases at extremely high concentration justifying the existence of permits and laws regulating such emissions.

Sources of emissions will also include gas exports via pipeline and/or Liquefaction and LNG exports via tankers and associated activities in combination with related production and processing operations. The impact influenced by the amount of emissions, is highly dependent on the amount of petroleum produced and transported. For a limited production, the related emissions will be significantly small and will gradually elevate as the amount of produced hydrocarbons increases.

Quantification of emissions was conducted based on mass balance of energy with the proper technology used in each step while integrating Ecoinvent 2.0 emissions factors for different production scenarios taking the following assumptions into consideration:

Scenario 2: "Low resources" scenario:

- 1 commercial discovery: Natural Gas only (no liquid hydrocarbons)
- Exploration + production from 2029 to 2048
- 0.2 Tcf/year beginning 2029 to meet local demand for 20 years

Whereas:

- Production/Processing entails:
  - Fugitive emissions
  - Combustion for power generation
  - Diesel consumption for emergency power plant
- Transmission (300 km) entails:
  - Fugitive emissions
  - Combustion for power generation

Quantification results for this scenario are presented below for the 0.2 Tcf production rate (local demand).

Emissions (t/yr)	CO	NOx	SO2	NMVOC	PM	CO2	CH4	N2O	CO2 eq.
0.2 Tcf	**221.83**	**1,133.83**	**7.63**	**1,008.70**	**2.88**	**294,372**	**11,916**	**5.27**	**546,254**

Scenario 3: "High resources" scenario

- Multiple commercial discoveries: NG & Oil
- Exploration + production from 2029 to 2048
- Natural Gas (NG): 0.2 Tcf/year in 2029 and additional 0.2 Tcf per year till production reaches 1.1 Tcf/year
- Oil: production of 13 MMbbl/yr (export via tankers)
- Different options for gas export
  - Export pipelines
  - LNG infrastructure

For Scenario 3a, the case of use of NG for local demand (entailing production/processing and transmission for 300 km) and oil extraction and export via tankers, estimates of emissions was as follows:

- **Local demand (0.2 Tcf):** NG + Transmission 300 km

Emissions (t/yr)	CO	NOx	SO2	NMVOC	PM	CO2	CH4	N2O	CO2 eq.
0.2 Tcf	**221.83**	**1,133.83**	**7.63**	**1,008.70**	**2.88**	**294,372**	**11,916**	**5.27**	**546,254**
0.4 Tcf	443.65	2,267.67	15.26	2,017.31	5.76	588,744	23,832	10.55	1,092,489
0.5 Tcf	554.58	2,834.58	19.08	2,521.75	7.20	735,930	29,790	13.18	1,365,635
0.6 Tcf	665.48	3,401.51	22.89	3,025.93	8.64	883,117	35,748	15.82	1,638,722
1.1 Tcf	1,220.07	6,236.07	41.97	5,547.85	15.84	1,619,046	65,538	28.99	3,004,397

- **Export: Oil 13 MMbbl/yr**

Emissions (t/yr)	CO	NOx	SO2	NMVOC	PM	CO2	CH4	N2O	CO2 eq.
Preproduction	19	46	1	204	2	6,610	530	0	17,789
Extraction	1,777	1,484	7	2,846	52	650,706	10,768	10	879,912
Storage	13	2	3	631	0	3,612	166	0	7,113
Total	1,809	1,532	11	3,682	54	660,928	11,465	10	904,814

Notes:
- Emissions were calculated based on EF per barrel using the real figures of ENVIRON (Oil and Gas Emission Inventory Enhancement Project for CenSARA States, 2012) study for preproduction, extraction, and storage and for on-shore and off-shore platforms.
- Emissions of Navigation in national waters is negligible (<2%) compared to national emissions (Waked et al., 2012)

For Scenario 3b additionally including NG export (Liquefaction or Pipelines), estimates of emissions was as follows:

- **Export: NG Liquefaction + 200 km transmission from platform to onshore liquefaction plants**

Emissions (t/yr)	CO	NOx	SO2	NMVOC	PM	CO2	CH4	N2O	CO2 eq.
0.2 Tcf	1,211	6,027	17	30	0	1,665,858	138	30	1,678,150
0.4 Tcf	2,423	12,055	33	61	0	3,331,715	276	61	3,356,300
0.6 Tcf	3,635	18,082	50	91	0	4,997,573	415	91	5,034,450
0.8 Tcf	4,846	24,110	67	122	0	6,663,431	553	121	6,712,599
1 Tcf	6,058	30,137	83	152	0	8,329,288	691	151	8,390,749

Export: NG Production + Transmission 200 km to Arab Gas Pipeline or Turkey

Emissions (t/yr)	CO	NOx	SO2	NMVOC	PM	CO2	CH4	N2O	CO2 eq.
0.2 Tcf	196	1,007	7	1,008	3	259,347	11,912	5	510,952
0.4 Tcf	393	2,014	15	2,016	6	518,695	23,825	9	1,021,883
0.6 Tcf	589	3,021	22	3,024	9	778,042	35,736	14	1,532,814
0.8 Tcf	785	4,028	29	4,032	12	1,037,389	47,649	19	2,043,767
1 Tcf	982	5,036	36	5,040	14	1,296,737	59,561	23	2,554,697

In comparison with NDC commitment, the CO_{2eq}. emissions from the petroleum activities for Scenario 2 (0.2 Tcf of NG + 300 km transmission to the Lebanese shore) are considered to be negligible for limited gas production and local transportation. As for scenario 3a (NG 0.2 Tcf for local demand + 13 MMbbl/yr of Oil export), the emissions of GHG are higher than Scenario 2 but still within the allowed limit of the NDC, i.e. 2,312.55 kt CO_2eq. On the other hand, when considering the Scenarios 3a and 3b, two options are considered (Figure 8-4 and Figure 8-5): the NG export reaches the Emissions limit allowed by NDC for Oil & Gas at 0.33 Tcf/yr of NG export via pipelines. This export value can be increased but is conditioned by the mitigation extent of CO2eq, while the NG liquefaction reaches the Emissions limit allowed by NDC for Oil & Gas at only 0.14 Tcf making this option less favorable over the NG export via pipelines. It is worth noting that without the Oil production and export, the NG export via pipelines would reach 0.69 Tcf and the liquefaction option would reach 0.3 Tcf.

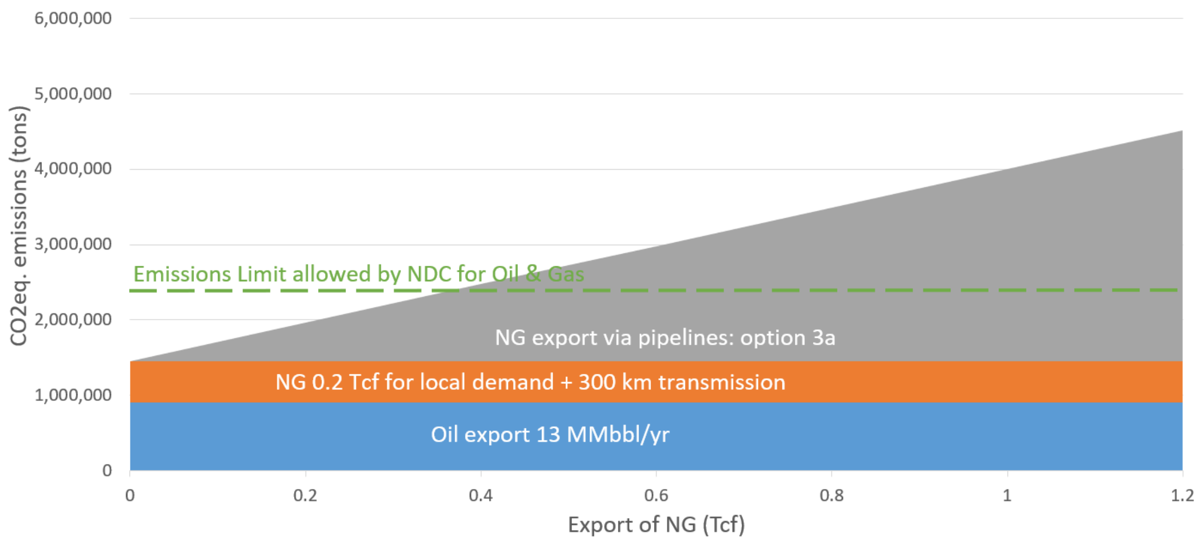


Figure 8-4 CO_{2eq} Emissions for Scenario 3a option

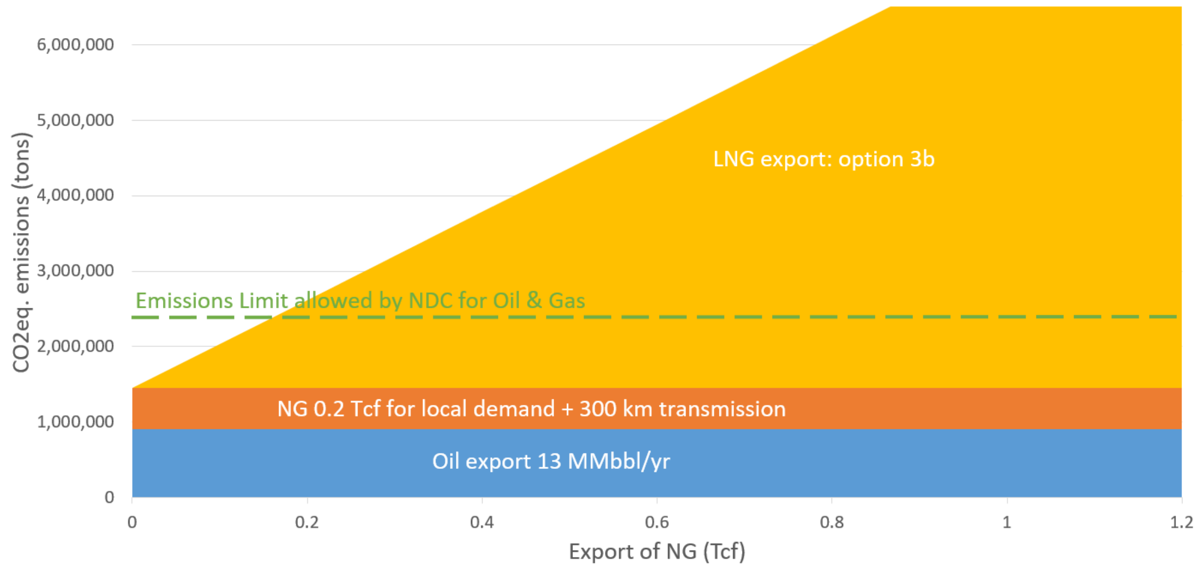


Figure 8-5 CO_{2eq} Emissions for Scenario 3b option

With the increasing concern for air quality and in an aim to further reduce emissions, there has been continuous work and effort to find ways to reduce the industry's environmental footprint. Other than the existing mitigation laws and regulations that emphasize on emission reduction and environmental conservation, new Technologies now serve to improve the environmental performance and reduce energy use and carbon emissions. From another hand, impacts are also partially mitigated by the open and dispersive environment offshore. Platforms and support vessels are in general built and operated to standards and in compliance with regulations and since oil and gas exploration and production activities are not permitted near the shore, lower impacts on coastal or onshore air quality are expected.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on Air Quality and Climate Change during Production Phase are summarized in Table 8-51.

Table 8-51 Significance Rating of Impacts on Air Quality and Climate Change during Production Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	S2	Magnitude of emissions is low however the duration of the impact is long-term given the long-term nature of production activities.	2 - Minor A- Almost certain	Medium
	S3	Magnitude of emissions is moderate and the duration of the impact is long-term given the long-term nature of production activities.	3 – Moderate A- Almost certain	Medium
Increase in emissions of GHGs from the petroleum sector	S2	Low emissions of GHGs with global impact, a long-term duration, and irreversible effect	5 – Critical A – Almost certain	High
	S3	Moderate emissions of GHGs with global impact, a long-term duration, and irreversible effect.	5 – Critical A – Almost certain	High

8.4.2.4 Proposed Mitigation Measures

Table 8-52 Proposed mitigation Measures for Impacts on Air Quality and Climate Change during Production Phase

Impact Indicator	Proposed Mitigation Measures
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	✓ Ensure enforcement of BAT as required by Law 78/2018 (Air Quality Protection Law) and Decree 10289/2012 (PAR); this requires proper training of MoE and LPA personnel on BAT applicable to the offshore oil and gas industry and the review of BAT demonstration in EIA studies; MoE/LPA need to ensure that BAT is integrated, implemented and properly maintained during operation ✓ Use of Green diesel instead of Marine Gasoil where technically feasible; green diesel has a significantly lower sulfur content ✓ Fuel efficiency measures shall be taken in the selection process for platform, support vessels and helicopters.
Increase in emissions of GHGs from the petroleum sector	✓ Controlling and reducing fugitive emissions in the design, operation, and maintenance of offshore facilities through the selection of appropriate valves, flanges, fittings and seals ✓ Ratification of MARPOL Annex 6 to decrease emissions (refer to Table 8-4 for main requirements)) ✓ Compliance with USEPA regulations regarding Leak Detection and Repair (LDAR), namely: 40 CFR Part 60 Subpart OOOO; 40 CFR Part 60 Subpart OOOOa, and the final Rule: Federal Register Vol.81 No. 107, June 3, 2016, EPA 40 CFR Part 60 (Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources) ✓ Regular check for leaks with latest technology and take prompt action ✓ Implementation of the Paris Agreement ✓ Operators should offset a portion of their emissions during production (15% is recommended as a minimum, in line with NDC commitments); such offset could be done by directly financing renewable energy projects and energy efficiency initiatives, reforestation (or enhancement of carbon sinks) and/or contributing in local funds (such as the BDL scheme of NEEREA or any subsequent similar frameworks, including the National Fund for the Environment) or any combination of the above; if development plans lead to excessive GHG emissions negatively affecting Lebanon's national commitments, then offset plans should compensate the additional emissions in a way to ensure meeting the unconditional emissions reduction targets set by the government ✓ GHG emissions reduction demonstrations are mandatory as part of EIA studies (demonstrating that GHG emissions were reduced to the maximum extent possible before incremental emissions reduction costs become excessive) ✓ Mandatory GHG emissions reporting from operators ✓ Explore possibilities for the implementation of Decree 167/2017 that provides incentives for environmental investments and assess its applicability to the offshore E&P sector ✓ Ensure Energy efficiency concepts are integrated in design, operations and maintenance of production facilities ✓ Consider the introduction of using renewable energy technologies in exploration and production activities. ✓ On the longer term, and as production fields become available, carbon capture and sequestration initiatives should be considered as part of their development and production plans.

8.4.2.5 Assessment of Residual Impacts

The residual impacts on Air Quality and Climate Change during Production Phase with existing and additional mitigation measures in place are summarized in Table 8-53.

Table 8-53 Significance Rating of Residual Impacts on Air Quality and Climate Change during Production Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	S2	2 - Minor Almost certain	Medium	2 - Minor Almost certain	Medium
	S3	3 – Moderate A- Almost certain	Medium	2 - Minor A- Almost certain	Medium
Increase in emissions of GHGs from the petroleum sector	S2	5 – Critical A – Almost certain	High	4 – Major A – Almost certain	High
	S3	5 – Critical A – Almost certain	High	4 – Major A – Almost certain	High

8.4.3 Impacts on Seawater and Sediments

8.4.3.1 Potential Impacts

Table 8-54 Impacts of Production Phase on Seawater and Sediments

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in pollutants' concentrations in sediments	✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of produced water ✓ Discharge of produced Sand ✓ Effluents Discharge ✓ Dredging activities for ports and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, Transportation and Storage Accidents and Loss of Stability	✓ Domestic and Industrial wastes discharged at sea ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharged and spills. ✓ Dynamite fishing and explosive use.
Impacts related to sedimentation on the sea bed	✓ Mobilization and positioning in place of Platform in the continental slope and deep sea	✓ Domestic and Industrial wastes discharged at sea ✓ Physical presence and noise

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)	✓ Wells drilling in the continental slope and in deep sea ✓ Discharge of drill cuttings and fluids in the continental slope and in deep sea ✓ Discharge of produced Sand in the continental slope and in deep sea ✓ Dredging activities for ports and onshore support facilities ✓ Installation of Subsea System and offshore pipeline for gas export ✓ Installation of offshore processing facilities in the continental slope and in deep sea ✓ Installation of LNG terminals in the continental slope and in deep sea	generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharged and spills. ✓ Dynamite fishing and explosive use.
Change in chemical characteristics of seawater attributed to petroleum activities	✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of produced water in the continental slope and in deep sea ✓ Discharge of produced Sand in the continental slope and in deep sea ✓ Effluents discharge ✓ Offshore processing facilities ✓ Offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, Transportation and Storage Accidents and Loss of Stability	✓ Domestic and Industrial wastes discharged at sea ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharged and spills. ✓ Dynamite fishing and explosive use.
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	✓ Well Drilling on the Continental Slope	✓ Domestic and Industrial wastes discharged at sea ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharged and spills. ✓ Dynamite fishing and explosive use.

8.4.3.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.

- Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements.
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators need to prepare an ERP and demonstrate readiness to implement it prior to starting any activity.
- The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.

8.4.3.3 Assessment of Impacts

During Development and Production, production wells will be drilled to extract the hydrocarbon resources. With that being said, similar effects but somehow more severe than those during the exploration phase will be anticipated during the production phase. As detailed in section 8.2.3.3, the severity of the impact of drilling activities on the marine environment can be further aggravated possibly leading to submarine landslides, if operations occur on the sensitive and unstable continental slope located between the continental shelf and the deep sea. It is recommended to avoid all activities and discharges on the continental slope and this cannot avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment. The sensitive area is delineated in section 8.2.3.3.

The development phase also includes installation of pipelines and installations which can re-suspend bottom sediments and cause seafloor disturbances depending on the type of platforms adopted. In general, Physical impacts on the sea bottom may occur in connection with installing pipelines, cables, platforms including platform legs and anchoring. Pipeline burial causes impact during the installation phase because of disturbance of the seabed and mobilization of sediment. The volume and distance that suspended sediments disperse depends on particle size, weight and current velocity. The area of impact during pipeline burial is considered to be within 10 – 20 m of the line, but once buried, pipelines usually have insignificant impacts except in the case of pipeline failure and loss of hydrocarbons in the sea.

The water produced with the hydrocarbons from the formation along with the drill cuttings from drilling operations constitute a serious source of pollution if discharged to the sea, depending on the level of treatment achieved. Although many laws limit the level of contaminants which can be discharged and oblige treatment before discharge, the concentration of pollutants from produced waters and drill cuttings cannot be neglected (Bakke et al., 2013). The severity of the environmental impact depends on the composition of the produced water related to the geological characteristics of each reservoir. The latter might include dispersed oil, aromatic hydrocarbons and organic material. It can also contain alkylphenols, heavy metals, naturally occurring radioactive material, inorganic salts, low-molecular organic acids like acetic acid and even high levels of sulfur and sulfides. In addition, the produced water can also include previously produced yet injected water, to reduce the discharges, containing traces of chemicals such as biocides, corrosion inhibitors and emulsion breakers (Johnsen et al., 2004).

As previously detailed, drilling wastes consist of rock cuttings and remnants of drill mud which is typically formed from a liquid with a weighting material. Additives, such as emulsifiers and pH and shale control agents, are added to the mud to improve its performance making its discharge toxic and detrimental (Davies and Kingston, 1992). Toxicity of the mud and the cuttings is not only determined based on hydrocarbon content, but also depends on chemicals and heavy metals from impurities usually present in the barite (Grant et at., 2002).

Once drilling operations take place, it is anticipated that large volumes of contaminated drill cuttings will pile up on the seabed around the rig leading to sediment contamination capable of also affecting seafloor benthos. With the years, piles may produce other toxic compounds such as esters and organic acids (Rowland et al., 2011).

Because numerous wells would be drilled at each production location, more vessel trips will be required to transport cuttings to the final disposal locations during the drilling period. The latter suggests higher possibilities of accidental oil and chemical spills from vessels. Spills can also occur from the platform itself and from injection wells (Bakke et al., 2013) and will have a major impact on the sediments and the seawater characteristics.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on sea water and sediments during Production Phase are summarized in Table 8-55.

Table 8-55 Significance Rating of Impacts on Seawater and Sediments during Production Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating Likelihood of Occurrence	Significance Rating
Increase in pollutants' concentrations in sediments	S2 S3	The Discharge of Produced Water and Produced Sand to the sea constitute the Sources of Impact with the highest significance due to their salinity and high content of Organic Acids, PAHs and Metals. Other important sources include discharge of cuttings and effluents to the sea.	4- Major A -Almost Certain	High
Impacts related to sedimentation on the sea bed/turbidity (burial	S2	Aside from the effects of Drilling on the slope, Offshore Processing facilities installation in the continental slope and	5- Critical A -Almost Certain	High

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating	Significance Rating
of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)		the discharge of produced sand in the deep sea, the source with the highest significance is the discharge of Produced Sand in the continental slope.		
	S3	Many sources are considered to have the most significant impact: Well drilling in the continental slope, discharge of drill cuttings and produced sand in the continental slope, Offshore Processing facilities installation or LNG terminal installation in the continental slope.	5- Critical A -Almost Certain	High
Change in chemical characteristics of seawater attributed to petroleum activities	S2	The discharge of produced water and sand and effluents has the most significant effect on the chemical properties of Seawater.	4- Major A -Almost Certain	High
	S3	The most significant impact is due to the discharge of drill cuttings and fluids, produced water and sand and effluents.	4- Major A -Almost Certain	High
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	S2 S3	The only source of impact is related to Well Drilling Operations on the Continental Slope which can trigger serious Submarine Land Slides and highly affect Sediments on the Sea floor.	5- Critical P -Possible	High

8.4.3.4 *Proposed Mitigation Measures*

Table 8-56 Proposed mitigation Measures for Impacts on Sea Water and Sediments during Production Phase

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Increase in pollutants' concentrations in sediments	✓ Discharge of water-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of produced water ✓ Discharge of produced Sand ✓ Effluents Discharge ✓ Dredging activities for ports	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf. ✓ Increase operational capacities

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	and onshore support facilities ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, Transportation and Storage Accidents and Loss of Stability	and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents
Impacts related to sedimentation on the sea bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.)	✓ Mobilization and positioning in place of Platform in the continental slope ✓ Mobilization and positioning in place of Platform in the deep sea ✓ Wells drilling in the continental slope ✓ Wells drilling in deep sea ✓ Discharge of drill cuttings and fluids in the continental slope ✓ Discharge of drill cuttings and fluids in deep sea ✓ Discharge of produced Sand in the continental slope ✓ Discharge of produced Sand in deep sea ✓ Dredging activities for ports and onshore support facilities ✓ Installation of Subsea System and offshore pipeline for gas export ✓ Installation of offshore processing facilities in the continental slope ✓ Installation of offshore processing facilities in deep sea	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Consider Land Treatment of produced sand or re-injection if technically feasible. ✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf. ✓ Avoid all activities and equipment installation on the continental slope (except for pipelines). ✓ If activities in the continental slope/shelf are not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment
Change in chemical characteristics of seawater attributed to petroleum activities	✓ Discharge of water-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Avoid discharge in the continental slope. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	✓ Discharge of produced water in the sea ✓ Discharge of produced Sand in the sea ✓ Effluents discharge ✓ Offshore processing facilities ✓ Offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Collisions, Transportation and Storage Accidents and Loss of Stability	compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ MOE to publish a list of approved oil dispersants allowed to be used in oil spill response (in line with NOSCP). ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	✓ Well Drilling on the Continental Slope	✓ Avoid drilling on the Continental Slope.

8.4.3.5 *Assessment of Residual Impacts*

The residual impacts on seawater and sediments during Production Phase with existing and additional mitigation measures in place are summarized in Table 8-57.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-56.

Table 8-57 Significance Rating of Residual Impacts on Seawater and Sediments during Production Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating Likelihood of Occurrence	Significance Rating	Consequence Rating Likelihood of Occurrence	Significance Rating
Increase in pollutants' concentrations in sediments	S2	4- Major A -Almost Certain	High	2- Minor A -Almost Certain	Medium
	S3	5- Critical A -Almost Certain	High	2- Minor A -Almost Certain	Medium
Impacts related to	S2	5- Critical	High	2- Minor	Medium

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
sedimentation on the sea bed/turbidity		A -Almost Certain		A -Almost Certain	
	S3	4- Major A -Almost Certain	High	3- Moderate A -Almost Certain	High
Change in chemical characteristics of seawater attributed to petroleum activities	S2	4- Major A -Almost Certain	High	2- Minor A -Almost Certain	Medium
	S3	5- Critical P -Possible	High	3- Moderate A -Almost Certain	High
Occurrence of Submarine Land Slides and related Impacts (Tsunamis, Change of sediments particle size) due to petroleum activities	S2	5- Critical P -Possible	High	**No Additional Mitigation Measures can be foreseen.**	
	S3	5- Critical P -Possible	High		

8.4.4 *Impacts on Marine Biological Environment*

8.4.4.1 *Potential Impacts*

Table 8-58 Impacts of Production Phase on Marine Biological Environment

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Changes in abundance, status and density of cetaceans, sea turtles and seals	✓ Physical presence of the platform including the generated noise and light ✓ Noise generated from wells drilling ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the sea ✓ Discharge of produced water to the sea ✓ Discharge of produced Sand to the sea ✓ Effluents discharge ✓ Movement of support vessels ✓ Chemicals and waste transportation to land or for export ✓ Physical presence of offshore processing facilities ✓ Physical presence of offshore LNG terminals ✓ Export of liquid hydrocarbons via tankers ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use.
Changes in abundance, status, richness and density of Phyto and zoo benthos	✓ Mobilization and positioning in place of Platform in the continental slope and deep sea ✓ Wells drilling in the continental slope and in deep sea ✓ Re-injection of drill cuttings and fluids ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of produced Sand in the continental slope	

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
	and in deep sea ✓ Re-injection of produced Sand and water ✓ Installation of Subsea System and offshore pipeline for gas export ✓ Installation of offshore processing facilities ✓ Installation of offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	
Changes in diversity and dominance of Nekton and Plankton	✓ Physical presence of the drilling rig ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids in the sea ✓ Discharge of produced water in the sea ✓ Discharge of produced Sand in the sea ✓ Effluents discharge ✓ Physical Presence of offshore processing facilities ✓ Physical Presence of offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use.
Changes in abundance, Status and density of Seabirds	Physical presence of the drilling rig Helicopter Movement Physical presence of offshore processing facilities Physical presence of offshore LNG terminals Gas & Oil Blow-Out Fuel and chemicals spills	
Increase in the trend of introduction of invasive species	Effluents Discharge and Ballast water	
Percent area of sensitive/ protected marine habitats affected by petroleum activities	✓ Mobilization and positioning in place of Platform in the continental slope and deep sea ✓ Wells drilling in the continental slope and in deep sea ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of produced Sand in the continental slope and in deep sea ✓ Effluents discharge ✓ Dredging activities for ports and onshore support facilities ✓ Installation of Subsea System and offshore pipeline for gas export ✓ Installation of offshore processing facilities ✓ Installation of offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	

8.4.4.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- The Ballast Water Management Convention (2004) establishes standards, procedures and guidelines for the management and control of ships' ballast water and sediments.
- Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore petroleum activities shall be followed. The guidelines necessitate the employment of the following:
  - **Big Air Bubble Curtains:** a system that produces air bubbles under water breaking the propagation of sound waves
  - **Little Air Bubble Curtain:** A little bubble curtain can be customized and placed much closer to the big bubble curtain, it may consist of a rigid frame placed around of the source. Several configurations are possible.
  - **Hydro Sound Damper**: a technology consisting of fishing nets with small balloons filled with gas and foam (ensure Hydro Sound Damper equipment is retrieved and accounted for so that it does not contribute to marine debris)
  - **Noise Mitigation Screen:** a double-layered screen filled with air and bubbles
  - **BEKA shells**: double steel wall with intern and outer bubble curtains and acoustic decoupling
  - **Visual monitoring protocol**
  - **Passive Acoustic Monitoring protocol (PAM):** regularly used during a range of operations whether static or mobile to facilitate the detection of marine mammal species during times of limited visibility or darkness.
  - **Marine Mammal Observation protocol**
  - **Soft start protocol:** Noise emissions should begin at low power, increase gradually until full power is reached. The soft start procedure should be of 20 min duration at least.
  - **Use of Acoustic Mitigation Devices (AMD):** Prior to the beginning of the work, AMD should be used to drive away groups or individuals of marine mammals.
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- The African-Eurasian Water-bird Agreement AEWA is an international agreement aiming to coordinate efforts to conserve bird species migrating between the regions.
- The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.

- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators are required to develop an ERP and demonstrate readiness to implement it prior to start of any activities.
- The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.
- The National Biodiversity Strategy and Action Plan (NBSAP).

8.4.4.3 Assessment of Impacts

When studying the effect of the discharge of produced water in the sea, the impact of hydrocarbon-related products such as BTEX and PAH compounds, is usually neglected as these substances evaporate quickly. This however cannot be generalized as some animals in close contact with discharge points can be significantly affected under chronic exposure; both compounds can be considered as environmental contaminants that can be carcinogens (Harvey, 1997).

Produced water discharge does not constitute the only source of PAH and BTEX; these compounds can also be released to the sea through oil spills. In fact, researches have previously shown that the possibility of spills occurring is the highest during stages of hydrocarbon extraction whether from the production platforms or from the supporting vessels. Oil sheens, similar to oil spills, can have devastating short and long-term effects on marine ecosystems. Marine mammals such as seals and whales must surface to breathe (NOAA, 2016) which implies that once these animals surface in oil sheens and spills, they can ingest or inhale toxins or be directly affected by skin contact with the oil.

Other than the impacted marine mammals, seabirds are also directly affected as they feed at sea; it is highly possible that they ingest organisms contaminated with toxins or they come in direct contact with the oil damaging their plumage structure and feathers (Wiese et al., 2003).

Even if discharged at sea level and becoming widely dispersed, cuttings are expected to cause subtle changes to the benthic community structure on the long run (Brattegard, 2011) as they can cause a reduction in oxygen due to the biodegradation and chemical toxicity.

Aside from discharges, the physical presence of the production platform might pose an issue as it remains in place for long period of time. During this time, the noise and lights from routine operations, may affect marine biota including plankton, fishes, marine mammals, sea turtles, and birds. Animals generally avoid areas around the production platforms due to noise while others might be attracted to fish populations around the structures. The most likely impacts would be short-term behavioral changes in mammals. As for birds, evidence indicates that migrating birds can become disoriented when encountering a steady artificial light source at night causing birds to circle the light source for hours, increasing the risk of collision with the lighted structure, decreasing fat reserves, and potentially interrupting migration (Weiss et al. 2012, Montevecchi 2006, Longcore and Rich 2004).

Finally, Sea floor-disturbing activities during installation of production facilities can crush benthic organisms and affect micro and macro faunas.

The detailed impacts of facility installation, as mentioned in section 8.4.3.3, will depend on the type of facility. Pipeline installation for any particular project is likely to take several weeks to several months and would crush benthic organisms under the pipeline and anchors and introduce turbidity in the immediate vicinity of the pipe laying operations. The footprint of the pipeline, or the affected zone around it, is dependent on length, diameter, and the degree of burial or build-up of gravel among other factors. Benthic communities will be impacted for a variable period of time. In areas of soft sediments, where most pipelines are trenched and buried, the soft bottom fauna re-colonizes within a year or two. In areas of harder substrates, the recovery of benthic communities may take longer, up to 10 years in deeper colder water areas. The main concern with regard to potential impacts is the placement of structures in areas where sensitive benthic communities, coral communities and areas of special marine biodiversity importance exists.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on marine biological environment during Production Phase are summarized in Table 8-59.

Table 8-59 Significance Rating of Impacts on Marine Biological Environment during Production Phase with Existing Control Measures in Place

Impact Indicator	**Scenario**	Consequence Rating Assessment	**Consequence Rating** **Likelihood of Occurrence**	**Significance Rating**
Changes in abundance, status and density of cetaceans, sea turtles and seals	S2 S3	The most significant sources of impact include the discharge of produced sand and water to the sea due to their high concentration in pollutants and contaminants.	5- Critical A -Almost Certain	High
Changes in abundance, status, richness and density of Phyto and zoo benthos	S2	Discharge of produced sand to the sea and the re-injection of produced sand and water are the sources with the highest significance.	4- Major A -Almost Certain	High
	S3	The most significant sources of impact include Well Drilling operations, discharge of oil/synthetic-based drill cuttings and fluids, discharge of produced sand to the sea and r-injection of produced sand with produced water.	4- Major A -Almost Certain	High
Changes in diversity and dominance of Nekton and Plankton	S2 S3	The main sources of impact are the discharge of oil/synthetic-based drill cuttings and fluids, discharge of	4- Major A -Almost Certain	High

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating	Significance Rating
		produced sand and water and effluents discharge.		
Changes in abundance, Status and density of Seabirds	S2 S3	This indicator is highly vulnerable to chemicals and fuel spills due to the high toxicity and contaminations. Other significant sources of impact include the physical presence of the rig, processing facilities and LNG terminals, Helicopter Movement and Gas Blow-Out incidents.	1- Negligible P -Possible	Low
Increase in the trend of introduction of invasive species	S2 S3	The only two significant sources of impact are effluents discharges and ballast water discharges.	4- Major P -Possible	High
Percent area of sensitive/ protected marine habitats affected by petroleum activities	S2	Well drilling operations in the continental slope, discharge of oil/synthetic based drill cuttings and fluids and discharge of produced sand in the continental slope and in the deep sea constitute the most significant sources of impact.	4- Major A -Almost Certain	High
	S3	The most significant source of impact includes the discharge of produced sand in the continental slope. Other less significant sources include well drilling in the continental slope and in deep sea, discharge of drill cuttings in fluids and effluents to the sea.	5- Critical A -Almost Certain	High

8.4.4.4 *Proposed Mitigation Measures*

Table 8-60 Proposed mitigation Measures for Impacts on Marine Biological Environment during Production Phase

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Changes in abundance, status and density of cetaceans, sea turtles and seals	✓ Physical presence of the platform including the generated noise and light ✓ Noise generated from wells drilling ✓ Discharge of water-based drill cuttings and fluids to the sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the sea ✓ Discharge of produced water to the sea ✓ Discharge of produced sand to the sea ✓ Effluents discharge	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Drill during non-productive Seasons. ✓ Operators should demonstrate that ACCOBAMS guidelines and mitigation measures are integrated in design and demonstrate that underwater noise levels and high risk areas are reduced to the minimum possible extent during drilling ✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Optimize travel trips and travel routes when transporting chemicals and wastes ✓ Transport of chemicals shall fulfil the

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	✓ Movement of support vessels ✓ Chemicals and waste transportation to land or for export ✓ Physical presence of offshore processing facilities ✓ Physical presence of offshore LNG terminals ✓ Export of liquid hydrocarbons via tankers ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	requirements of IMDG Code for Dangerous Goods. ✓ EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Changes in abundance, status, richness and density of Phyto and zoo benthos	✓ Mobilization and positioning in place of Platform in the continental slope and deep sea ✓ Wells drilling in the continental slope and in deep sea ✓ Re-injection of drill cuttings and fluids ✓ Discharge of water-based drill cuttings and fluids to the sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the sea ✓ Discharge of produced sand in the continental slope and in deep sea ✓ Re-injection of produced Sand and water ✓ Installation of Subsea System ✓ Installation of offshore export pipelines ✓ Installation of offshore processing facilities ✓ Installation of offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Drill and install equipment during non-productive Seasons. ✓ Avoid drilling in the continental slope. ✓ If drilling in the continental slope/shelf is not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment. ✓ Mapping of sea-grass meadows in Lebanese shallow waters shall be conducted prior to activities. ✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Changes in diversity and	✓ Physical presence of the drilling rig	✓ Operators to follow waste management recommendations in section 9.2.3.

Impact Indicator	Source of Impact	Proposed Mitigation Measures
dominance of Nekton and Plankton	✓ Discharge of water-based drill cuttings and fluids in the sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids in the sea ✓ Discharge of produced water in the sea ✓ Discharge of produced Sand in the sea ✓ Effluents discharge ✓ Physical Presence of offshore processing facilities ✓ Physical Presence of offshore LNG terminal ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities. ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Changes in abundance, Status and density of Seabirds	✓ Physical presence of the drilling rig ✓ Helicopter Movement ✓ Physical presence of offshore processing facilities ✓ Physical presence of offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities. ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Increase in the trend of introduction of invasive species	✓ Effluent Discharge and Ballast water	✓ Set Strict Restrictions regarding Ballast Water Discharge. ✓ Ensure MoPWT has needed capacity to monitor compliance with Ballast Water Convention
Percent area of sensitive/ protected marine habitats affected by petroleum activities	✓ Mobilization and positioning in place of Platform in the continental slope ✓ Mobilization and positioning in place of Platform in the deep sea ✓ Wells drilling in the continental slope ✓ Wells drilling in deep sea ✓ Discharge of water-based drill cuttings and fluids to the continental slope ✓ Discharge of water-based drill cuttings and fluids in the deep sea	✓ Avoid activities on the continental slope (except pipeline laying). ✓ If activities in the continental slope/shelf are not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment. ✓ Avoid activities in the vicinity of protected areas/areas proposed for protection and establishing a buffer zone around such areas. Buffer zones shall be determined in EIA studies. ✓ Drilling and production in protected areas are prohibited ✓ Compliance with protected areas management plans. ✓ Establish a code of conduct for operating in

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	✓ Discharge of oil/synthetic-based drill cuttings and fluids to the continental slope ✓ Discharge of oil/synthetic-based drill cuttings and fluids in the deep sea ✓ Discharge of produced Sand in the continental slope ✓ Discharge of produced Sand in deep sea ✓ Effluents discharge ✓ Dredging activities for ports and onshore support facilities ✓ Installation of Subsea System ✓ Installation of offshore pipeline for gas export ✓ Installation of offshore processing facilities ✓ Installation of offshore LNG terminals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills ✓ Loss of Stability	proximity to protected and sensitive areas. ✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Drill and install equipment during non-productive Seasons. ✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities. ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.

8.4.4.5 Assessment of Residual Impacts

The residual impacts on marine biological environment during Production Phase with existing and additional mitigation measures in place are summarized in Table 8-60.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-61.

Table 8-61 Significance Rating of Residual Impacts on Marine Biological Environment during Production Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Changes in abundance, status and density of cetaceans, sea turtles and seals	S2 S3	5- Critical A -Almost Certain	High	3- Moderate A -Almost Certain	High
Changes in abundance, status, richness and density of Phyto and zoo benthos	S2	4- Major A -Almost Certain	High	2- Minor A -Almost Certain	Medium
	S3	4- Major A -Almost Certain	High	3- Moderate A -Almost Certain	High
Changes in diversity and dominance of Nekton and Plankton	S2 S3	4- Major A -Almost Certain	High	2- Minor L -Likely	Medium
Changes in abundance, Status and density of Seabirds	S2 S3	1- Negligible P -Possible	Low	1- Negligible P -Possible	Low
Increase in the trend of introduction of invasive species	S2 S3	4- Major P -Possible	High	3- Moderate P -Possible	Medium
Percent area of sensitive/ protected marine habitats affected by petroleum activities	S2	5- Critical A -Almost Certain	High	2- Minor A -Almost Certain	Medium
	S3	5- Critical A -Almost Certain	High	3- Moderate A -Almost Certain	High

8.4.5 Impacts on Coastal Environment

8.4.5.1 Potential Impacts

Table 8-62 Impacts of Production Phase on Coastal Environment

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Percent area of sensitive coastal habitats affected by impacts related to the sector	✓ Movement of Support Vessels and transportation of wastes and chemicals ✓ Dredging activities for ports and onshore support facilities ✓ Installation of Subsea System	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea.

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
	and pipelines for gas export ✓ Installation of on-shore processing facilities ✓ Installation of on-shore LNG terminals ✓ Installation of on-shore transmission network ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills.	✓ Shipment vessels discharges and spills. ✓ Dynamite fishing and explosive use.

8.4.5.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to, requirements of PAR, OPRL and EPA
- MARPOL Annex I provide regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.
- The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.
- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.
- National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.
- Operators are required to prepare an ERP and demonstrate readiness to implement it prior to start of any activities.

8.4.5.3 Assessment of Impacts

During the production phase, support is provided to the production platform by service vessels and helicopters from onshore bases ports and airports located in the coastal area. The latter increases risks of oil and chemical spills from onshore facilities to the coast which can influence coastal animals and seawater properties. Dredging activities are required near the coast to build these ports and onshore facilities. These operations affect seawater characteristics and sediments sizes and pollutants concentrations in sediments.

Similar effects to the ones mentioned in section 8.3.5.3 can be anticipated from spills, blow-outs, vessels movements and dredging operations.

During the production phase, the coastal environment is also highly vulnerable to the installation and operation of export pipelines, onshore processing facilities, LNG terminals and transmission network. The impact can be reviewed in section 8.3.5.3.

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on coastal environment during Production Phase are summarized in Table 8-63.

Table 8-63 Significance Rating of Impacts on Coastal Environment during Production Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Percent area of sensitive coastal habitats affected by impacts related to the sector	S2 S3	The most significant source of impact is the installation and operation of onshore processing facilities and LNG terminals.	4- Major A -Almost Certain	High

8.4.5.4 *Proposed Mitigation Measures*

Table 8-64 Proposed mitigation Measures for Impacts on Coastal Environment during Production Phase

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Percent area of sensitive coastal habitats affected by impacts related to the sector	✓ Movement of Support Vessels and transportation of wastes and chemicals	✓ Optimize travel trips and travel routes when transporting chemicals and wastes ✓ Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods. ✓ EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.
	✓ Dredging activities for ports and onshore support facilities	✓ Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea. ✓ Use of Silt Curtains allowing suspended matter to settle before removal of the curtains. ✓ Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf.
	✓ Installation of Subsea System	✓ Consider ecologically sensitive areas in the routing and siting of such systems

Impact Indicator	Source of Impact	Proposed Mitigation Measures
	✓ Installation of pipelines for gas export	
	✓ Installation of on-shore processing facilities	✓ Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Install equipment during non-productive Seasons.
	✓ Installation of on-shore LNG terminals	
	✓ Installation of on-shore transmission network	
	✓ Gas & Oil Blow-Out	✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure safety critical equipment and processes are in place and operational prior to start of activities ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
	✓ Fuel and chemicals spills	

8.4.5.5 Assessment of Residual Impacts

The residual impacts on coastal environment during Production Phase with existing and additional mitigation measures in place are summarized in Table 8-65.

It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-64.

Table 8-65 Significance Rating of Residual Impacts on Coastal Environment during Production Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Percent area of sensitive coastal habitats affected by impacts related to the sector	S2 S3	4- Major A -Almost Certain	High	3- Moderate A -Almost Certain	High

8.4.6 Impacts on Fisheries

8.4.6.1 Potential Impacts

Table 8-66 Impacts of Production Phase on Fisheries

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	✓ Physical presence of the platform ✓ Discharge of water-based and oil/synthetic-based drill cuttings and fluids to the continental slope and in the deep sea ✓ Discharge of produced water in the continental slope and in deep sea ✓ Movement of Support Vessels and transportation of wastes and chemicals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Domestic and Industrial wastes discharged at sea. ✓ Physical presence and noise generated by ships and vessels movements in the sea. ✓ Shipment Vessels discharges and spills. ✓ Dynamite fishing and explosive use.
Total area of where fishing activities excluded due to petroleum activities	✓ Physical presence of the platform ✓ Physical presence of offshore processing facilities ✓ Physical presence of offshore LNG terminal	
Loss of fishermen income due to excluded area	✓ Physical presence of the platform ✓ Physical presence of offshore processing facilities ✓ Physical presence of offshore LNG terminal	

8.4.6.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore petroleum activities shall be followed (refer to section 8.4.4.2).
- MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.
- Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.
- The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.
- The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.
- The National Biodiversity Strategy and Action Plan (NBSAP).

- Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements
- Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.

8.4.6.3 *Assessment of Impacts*

As mentioned in section 8.3.6.3, some fish species are attracted to production platforms which serve as PADs. As fishes remain near the platforms, catches are much bigger than further away (Løkkeborg et al., 2002). The only posed problem is the contamination of the fishes from possible discharges near the area. As discharges may contain toxic traces of hydrocarbons, previously prepared assessments prove that the exposure of fishes to small quantities of PAH will not have a significant effect on the reproduction of fish stocks (Neff et al. ,2006). It is however, the heavy metals and acidic content of the produced water and discharged fluids that can be detrimental.

Large volumes of oil can alter the quality of the water in which fishes live due to their concentration in toxic substances that can interfere with sexual development and reproduction in fish (Meier et al., 2001). Contaminants in discharges can also affect fish growth and lead to cardiac defects, oxidative stress and DNA damage (Carls et al., 2005).

The consequence rating, likelihood of occurrence, significance rating and acceptability of each of the identified environmental impacts on fisheries during Production Phase are summarized in Table 8-67.

Table 8-67 Significance Rating of Impacts on Fisheries during Production Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	S2	The most significant source of impact is the discharge of produced water to the sea which is highly concentrated in pollutants and contaminants.	4- Major A -Almost Certain	High
	S3			
Total area of where fishing activities excluded due to petroleum activities	S2	The physical presence of the platform, the offshore processing facilities and offshore LNG terminals (S3) constitute the main sources of impact.	3- Moderate A -Almost Certain	High
	S3		4- Major A -Almost Certain	High
Loss of fishermen income due to excluded area	S2	The physical presence of the platform, the offshore processing facilities and offshore LNG terminals (S3) constitute the main sources of impact.	3- Moderate A -Almost Certain	High
	S3		4- Major A -Almost Certain	High

8.4.6.4 Proposed Mitigation Measures

Table 8-68 Proposed mitigation Measures for Impacts on Fisheries during Production Phase

Impact Indicator	Source of Impact	Proposed Mitigation Measures
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	✓ Physical presence of the platform ✓ Discharge of water-based drill cuttings and fluids to the sea ✓ Discharge of oil/synthetic-based drill cuttings and fluids to the sea ✓ Discharge of produced water in the sea ✓ Movement of Support Vessels and transportation of wastes and chemicals ✓ Gas & Oil Blow-Out ✓ Fuel and chemicals spills	✓ Operators to follow waste management recommendations in section 9.2.3. ✓ Optimize travel trips and travel routes when transporting chemicals and wastes ✓ Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods. ✓ EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents. ✓ Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP. ✓ Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs. ✓ Ensure that safety critical equipment and processes are in place and operational prior to start of activities ✓ Monitoring of chemical concentrations in edible fish and invertebrate tissue. ✓ Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.
Total area of where fishing activities excluded due to petroleum activities	✓ Physical presence of the platform ✓ Physical presence of offshore processing facilities ✓ Physical presence of offshore LNG terminal	✓ Limit Exclusion Zones to Safety Zones
Loss of fishermen income due to excluded area	✓ Physical presence of the platform ✓ Physical presence of offshore processing facilities ✓ Physical presence of offshore LNG terminal	✓ At the time of submitting a well plan for approval, operators shall inform fishermen through the Fisheries Associations. In addition, in the case of activities planned in an area of intensive fishing, discussions with the Fisheries Associations must be initiated as early as possible, and preferably not less than 90 days before planned commencement of activity.

8.4.6.5 Assessment of Residual Impacts

The residual impacts on fisheries during Production Phase with existing and additional mitigation measures in place are summarized in Table 8-69. It is important to mention that the significance rating with planned control measures and additional proposed mitigation measures presented below signify the most significant rating from all sources of impact or the worst-case scenario taking into account **only the sources with possible additional mitigation measures** as reflected in Table 8-68.

Table 8-69 Significance Rating of Residual Impacts on Fisheries during Production Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	S2, S3	4- Major A -Almost Certain	High	3- Moderate L -Likely	Medium
Total area of where fishing activities excluded due to petroleum activities	S2	3- Moderate A -Almost Certain	High	2- Minor P -Possible	Medium
	S3	4- Major A -Almost Certain	High	3- Moderate P -Possible	Medium
Loss of fishermen income due to excluded area	S2	3- Moderate A -Almost Certain	High	2- Minor P -Possible	Medium
	S3	4- Major A -Almost Certain	High	3- Moderate P -Possible	Medium

8.4.7 Impacts on Ambient Noise Levels

8.4.7.1 Potential Impacts

Table 8-70 Impacts of Production Phase on Ambient Noise Levels

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in ambient noise levels measured in the vicinity of petroleum facilities/ support activities in the coastal area	✓ Wells drilling ✓ Power generation on the rig ✓ Movement of support vessels/ waste and chemicals transportation ✓ Helicopter movement ✓ On-shore support Facilities/provision of supplies ✓ Onshore processing facilities ✓ Offshore processing facilities ✓ Offshore LNG terminal ✓ Onshore LNG terminal	✓ Land transportation ✓ Other vessels activity in the sea ✓ Other noise sources in the coastal region

8.4.7.2 Main Existing Control Measures

- Compliance with the regulatory requirements (refer to Section 1 and Volume 3 of the SEA report) including, but not limited to requirements of PAR, OPRL and EPA
- MoE Decision No. 52/1/1996, National maximum allowable noise levels and the permissible noise exposure standards.
- Offshore blocks are located more than three (3) nm away from the shoreline.
- Locations for onshore facilities should be selected in compliance with the National Land Use Master Plan.

8.4.7.3 Assessment of Impacts

The consequence rating, likelihood of occurrence, significance rating and acceptability of the environmental impacts on ambient noise levels during Production Phase are summarized in Table 8-24.

Table 8-71 Significance Rating of Impacts on Ambient Noise Levels during Production Phase with Existing Control Measures in Place

Impact Indicator	Scenario	Consequence Rating Assessment	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in ambient noise levels in coastal cities due to offshore petroleum activities	S2	The source of most significant impact is the onshore processing facilities.	2- Minor A –Almost certain	Medium
	S3	Sources of most significant impacts include the onshore processing facilities and the onshore LNG terminals	2- Minor A –Almost certain	Medium

8.4.7.4 Proposed Mitigation Measures

- Select locations of onshore facilities in line with the National Land Use Master Plan (petroleum related facilities should be located in areas designated as industrial and not in residential areas)
- Enclose the noise source at onshore facilities and add noise barriers or noise berms, as applicable
- The combined sound pressure level of equipment shall not exceed 85 dBA[11] at a distance of 1 m from the equipment in all directions.
- Noise modelling study shall be prepared as part of the environmental impact assessment study for the processing facilities and LNG terminals.

[11] Based on IFC EHS.

- Frequency of helicopter trips should be scheduled in a way to avoid significant noise impacts to nearby receptors at the point of take-off and landing

8.4.7.5 *.Assessment of Residual Impacts*

The residual impacts on ambient noise levels during Production Phase with existing and additional mitigation measures in place are summarized in Table 8-72.

With existing and additional proposed mitigation measures, the magnitude of impacts on ambient noise levels will decrease, however, given the long duration of activities resulting in a high frequency, the overall consequence rating of impact significance will not change.

Table 8-72 Significance Rating of Residual Impacts on Ambient Noise Levels during Production Phase

Impact Indicator	Scenario	With Planned Control Measures		With Planned Control Measures and Additional Proposed Mitigation Measures	
		Consequence Rating / Likelihood of Occurrence	Significance Rating	Consequence Rating / Likelihood of Occurrence	Significance Rating
Increase in concentrations of criteria air contaminants in coastal cities due to offshore petroleum activities	S2	2- Minor A –Almost certain	Medium	2- Minor A –Almost certain	Medium
	S3	2- Minor A –Almost certain	Medium	2- Minor A –Almost certain	Medium

8.5 SOCIO-ECONOMIC IMPACTS

Socio-economic impacts differ in nature from environmental impacts, as they impact the Lebanese society itself and can be realized, whether positive or negative, much quicker and more directly, due to society's own self-interest

Socio-economic impacts, as well as reaction of the Lebanese society to them will vary among different E&P scenarios. Both positive and negative socio-economic impacts, as well as expectations of Lebanese society vary based on drivers like type and abundance of found hydrocarbons, % of found hydrocarbons which can economically be exploited, selected technological and technical solutions, strategic development priorities, etc. As such, the assessment of socio-economic impacts is linked directly to different E&P scenarios (refer to Section 3.4 for description of E&P scenarios).

It shall be noted that the same impact assessment methodology presented in Section 2.5 was followed to assess potential socio-economic impacts, however, assessment results are presented in the following sub-section per E&P Scenarios. Socio-economic impacts during different E&P activities phases were identified in the Impact Identification Matrices presented earlier in Table 8-1, Table 8-25 and Table 8-49.

Socio-economic issues addressed in the SEA report include the following topics:

- General Economy
- Social conditions
- Health
- Education
- Cultural Heritage
- Tourism
- Landscapes and visual amenity
- Infrastructure
- Shipping

It shall be noted that the assessment of impacts on fisheries was previously included in sections 0, 8.3.6 and 8.4.6.

8.5.1 General Economy

8.5.1.1 Potential Impacts

Impacts of E&P activities on Economy including sources of impacts and cumulative sources of impacts are shown in Table 8-73.

Table 8-73 Impacts on General Economy

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
✓ Increase in GDP attributed to the offshore petroleum sector ✓ Change in Consumer Price Index (Inflation) ✓ Change in Foreign Direct Investment ✓ Change in Foreign Exchange Reserves ✓ Change in Balance of trade	✓ Development of the petroleum sector a driver of increased income and investments in development of other sectors ✓ Increased demand for shipping, land transport and support services ✓ Increased investments in infrastructure (can be used for other sectors) ✓ Accidental situations ✓ Missed opportunity to positively impact non-oil productive sectors	Other economic activities in the countries

8.5.1.2 Main Existing control measures

- The consideration of establishment of the sovereign wealth fund
- Having a modern fiscal regime
- OPRL, Article 67: Local content: 1) A Right Holder as well as its subcontractors shall give priority to Lebanese persons in the award of contracts for construction of a Facility and the supply of material, goods and services related to Petroleum Activities when terms and conditions offered by Lebanese suppliers are equal to their competitors. 2) A Right Holder as well as its subcontractors shall employ qualified personnel of Lebanese nationality whenever available. Right Holder shall also organize and fund the training of Lebanese personnel associated with Petroleum Activities.

- PAR, Article 148: If the Right Holder in the course of Petroleum Activities causes a) limitation in or disturbance of activities and rights, fishing fields or occupied land; or b) limitations in aquaculture activities; or c) fishing or aquaculture equipment to be moved to less favorable locations as seen from a maritime resource management or commercial point of view; then the Right Holder shall compensate the physical or legal person affected by such demonstrable disturbance or damage. The same applies with regard to liability and claims if the vessel(s) or craft(s), equipment, catch or harvest of a physical or legal person is polluted, damaged or lost due to Petroleum Activities.
- PAR, Article 157: The Right Holder shall ensure that the Operator gives preferential treatment to the procurement of Lebanese originating goods and services when such goods and services are internationally competitive with regard to quality, availability, price and performance. Lebanese originating goods and services are those that in substance or measured by value added are predominantly manufactured, constructed or performed in Lebanon, by Lebanese or by an entity owned and controlled by Lebanese.
- EPA, Article 20 on Recruitment and Training stipulates that: as of the beginning of the Exploration Phase, not less than eighty per cent (80%) of the aggregate number of employees of the Right Holders (including the Operator) shall be Lebanese nationals.
- PAR: Emergency Response Plan.

8.5.1.3 <u>Assessment of Impacts</u>

The development scenarios of the oil and gas industry are highly uncertain. The future of this sector in Lebanon depends on a range of factors that are volatile and beyond Lebanon's control. The uncertainties can be described at various levels extending from the offshore geology to the availability of markets and the development solutions and infrastructure put in place among others. Two factors carry the top risk and importance and incorporate several other sub-factors: the technically recoverable volumes of hydrocarbon resources in offshore Lebanon and the sale prices of these hydrocarbons at the dates of extraction.

In any case, E&P activities could affect the following economic indicators, depending of course on the level of discoveries and development options:

- ✓ Contribution to Gross Domestic Product (GDP): if commercial reserves are found (Scenarios 2 or 3) and developed, this would add to the projected GDP around 2029; the actual contribution to GDP cannot be estimated but could become important in case significant discoveries are made and are exported; in this case E&P activities would also contribute to GDP growth
- ✓ Job creation: E&P activities are cyclic in nature; important job creation (but temporary) could be achieved in case of discoveries and particularly during development phases, when significant investments are made to develop the needed infrastructure to bring hydrocarbons to market; during production phases, direct job

creation is rather limited; under a high development scenario (S3), not more than 6000 permanent jobs are expected to be generated; this is relatively limited when compared to the potential job creation of other sectors like tourism and industry

- ✓ Balance of Trade: if commercial discoveries are made and developed, it would have positive impacts on the balance of trade; this is because it would at least reduce the need for the import of hydrocarbons for electricity generation and under a high development scenario, would also lead to exports, further contributing to the national balance of payments
- ✓ Increased number of petrochemical and energy intensive industry establishments and increased number of small-scale industries and SMEs in petroleum industry value-chain. Such benefits are expected in scenario 3 than in scenario 2 with only limited development. However, this relies upon the decision of the government on where and how to invest the revenues.
- ✓ Debt to GDP: a major economic problem in Lebanon is its significant debt to GDP, currently at 145%, one of the highest in the world; if discoveries are made, E&P activities would support increase in GDP, and hence reduction in Debt to GDP; however it is important to note that if revenues are actually generated from E&P activities, it is generally not recommended that such revenues be used to repay debt; a more sustainable practice is to invest part of the revenues in productive sectors, which in turn would bring fiscal revenues to the government
- ✓ Inflation: if discoveries are made, E&P activities could actually lead to an increase in inflation if adequate economic measures are not established; this is due to general market speculation, leading to the increase in prices in the market; however control of such inflation is possible in case an effective revenue management mechanism is in place
- ✓ Corruption: the E&P sector in Lebanon has already established strong safeguards to control corruption in the sector; this includes the recently adopted Transparency Law for the offshore oil and gas sector and the provision of a Sovereign Wealth Fund to manage revenues from the sector; Resource extraction could also lead to the so-called resource curse whereby other economic sectors are negatively affected by oil and gas activities, leading to a shift of employees from non-oil to oil related activities, neglect of non-oil sectors, increase in prices leading to inflation and overall reduction in the purchase power of local residents. Other possible negative impacts include:
- ✓ Migration of skilled labor and talents to the oil and gas sector
- ✓ Inflating wages and thus increasing production cost
- ✓ Increasing the exchange rate of local currency
- ✓ Reduction of the export competitiveness of non-oil sources of livelihood

Accidental situations could lead to economic loss in productive sectors such as fisheries, and tourism in addition the O&G sector itself. Accidental impacts were addressed in previous sections.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on General Economy during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-74.

Table 8-74 Significance Rating of Impacts on General Economy

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating With Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating With Planned Control Measures and Additional Proposed Mitigation Measures
Increased GDP and amount of funds received by the Lebanese Government from the sector	1	0		No impact		No impact
	2	+	B – Beneficial P - Possible	Beneficial	B – Beneficial P - Possible	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Increased number of petrochemical and energy intensive industry establishments	1	0		No impact		No impact
	2	+	B – Beneficial P - Possible	Beneficial	B – Beneficial P - Possible	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Increased number of small-scale industries and SMEs in Petroleum industry value-chain	1	0		No impact		No impact
	2	+	B – Beneficial U - Unlikely	Beneficial	B – Beneficial U - Unlikely	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Reduced cost of energy in Lebanon	1	0		No impact		No impact
	2	+	B – Beneficial U - Unlikely	Beneficial	B – Beneficial U - Unlikely	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Balance of Trade from export of HC and reducing import of gas	1	0		No impact		No impact
	2	+	B – Beneficial L - Likely	Beneficial	B – Beneficial L - Likely	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Accidental situations and subsequent economic loss in productive sectors (fisheries, etc.)	1	-	3- Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	3- Moderate U - Unlikely	Medium - Acceptable (with EMS in place)
	2	-	3- Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	3- Moderate U - Unlikely	Medium - Acceptable (with EMS in place)
	3	-	3- Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	3- Moderate U - Unlikely	Medium - Acceptable (with EMS in place)

8.5.1.4 Proposed Mitigation Measures

In order to maximize the positive economic impacts from the sector and minimize the likelihood of the negative impacts surfacing in Lebanon, the following mitigation measures are recommended:

- Develop a robust revenue management mechanism; establishment of a Sovereign Wealth Fund is stipulated in the OPRL; design of the SWF should be carefully done preferably in a highly participatory manner to ensure it can lead to a sustainable use of possible resources generated from the sector;
- Develop a local content and local supply development strategy to operationalize the existing policies; It should be noted that any on-board position requires personnel to have suitable safety training, and with reference to the Maritime Labor Convention of 2006, personnel should have undergone full STCW'95 training to consist of all of the following elements;
    - Personal Survival Techniques (STCW A-VI / 1-1)
    - Fire Prevention and Fire Fighting (STCW A-VI / 1-2)
    - Elementary First Aid (STCW A-VI/ 1-3)
    - Personal Safety and Social Responsibilities (STCW A- VI/1 – 4)
    - Proficiency in Security Awareness (STCW VI/6, paragraph 1 and Section A-VI/6, paragraph 4)
- Promote transparency and accountability to mitigate social and economic risks and particularly the risk of corruption in the sector which could negatively affect the economic growth and prevent the country to reach its optimal goals behind the oil and gas sector; the adoption of Transparency Law in the Offshore Oil and Gas sector (Law 84/2018) is an excellent step in this direction; it is important to ensure enforcement of this Law throughout all phases of the sector;
- LPA should establish a communication strategy to manage expectations from the sector and promote stakeholder engagement and promote the beneficial impacts effectively;
- Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.

8.5.2 Social Conditions

8.5.2.1 Potential Impacts

Impacts on social conditions including sources of impacts and cumulative sources of impacts are shown in Table 8-75.

Table 8-75 Impacts on Social Conditions

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Proportion of population living below the national poverty line	✓ New job opportunities and business development opportunities ✓ Improved living conditions ✓ Loss of income for specific groups (e.g. fishermen) due to newly imposed limitations to their industries ✓ Accidental situations	✓ Increased benefits and pressures from overall economic and social development of Lebanon due to economic growth
Amount of funds received by the Lebanese Government from the sector		
Amount of funds generated by the sector spent on poverty reduction – especially through vocational trainings and education, social welfare programmes, improved living conditions, support programmes for small businesses, etc.		
Increase in employment rate due to the offshore petroleum sector		
Percent local labor working for oil and gas companies or service companies		
Frequency rates of fatal and non-fatal occupational injuries, by sex and migrant status (Ref. SDGs, C080801)from the sector		

8.5.2.2 Main Existing control measures

- OPRL, Article 67: Local content: 1) A Right Holder as well as its subcontractors shall give priority to Lebanese persons in the award of contracts for construction of a Facility and the supply of material, goods and services related to Petroleum Activities when terms and conditions offered by Lebanese suppliers are equal to their competitors. 2) A Right Holder as well as its subcontractors shall employ qualified personnel of Lebanese nationality whenever available. Right Holder shall also organize and fund the training of Lebanese personnel associated with Petroleum Activities.
- PAR, Article 148: If the Right Holder in the course of Petroleum Activities causes a) limitation in or disturbance of activities and rights, fishing fields or occupied land; or b) limitations in aquaculture activities; or c) fishing or aquaculture equipment to be moved to less favorable locations as seen from a maritime resource management or commercial point of view; then the **Right Holder shall compensate** the physical or legal person affected by such demonstrable disturbance or damage. The same applies with regard to liability and claims if the vessel(s) or craft(s), equipment, catch or harvest of a physical or legal person is polluted, damaged or lost due to Petroleum Activities.

- PAR, Article 157: The Right Holder shall ensure that the Operator gives preferential treatment to the procurement of Lebanese originating goods and services when such goods and services are internationally competitive with regard to quality, availability, price and performance. Lebanese originating goods and services are those that in substance or measured by value added are predominantly manufactured, constructed or performed in Lebanon, by Lebanese or by an entity owned and controlled by Lebanese.
- PAR: Emergency Response Plan.
- EPA, Article 20 on Recruitment and Training stipulates that: as of the beginning of the Exploration Phase, not less than eighty per cent (80%) of the aggregate number of employees of the Right Holders (including the Operator) shall be Lebanese nationals.
- Environmental standards and health and safety standards
- The establishment of the sovereign wealth fund.
- Having a modern fiscal regime.
- National Oil Spill Contingency Plan.

8.5.2.3 Assessment of Impacts

Development of any important economic sector, like the petroleum sector, will bring important impacts on the Lebanese society – both positive and negative. This is why it is important to understand the key drivers of change in social conditions in order to enhance positive impacts and mitigate negative ones.

It is also important to understand that Lebanese society will actively respond to change in any social conditions linked to development of the petroleum sector – regardless of the scenario we take into account. This reaction might be based on actual opportunities and positive self-interest of the society to exploit them. However, in some situations it might also be based on unrealistic expectations, which could lead to long-term disappointment. Some first signs of such unfounded expectation are already visible in Lebanon today – for example, increased interest for high level education in petroleum sector linked studies despite the fact that neither quantities or type of hydrocarbons are known today.

Subsequently, substantial responsibility lies on the shoulders of responsible authorities to communicate realistic and evidence-based information to Lebanese society. Only with open and transparent flow of realistic information can expectations of the Lebanese society be managed and directed to fully exploit this important opportunity.

In any case, both positive and negative impacts, as well as expectations of Lebanese society vary greatly based on scenarios. In Scenario 1 all impacts will be so small that they will actually bring no impact on social conditions. Scenario 2 could already bring tangible impacts, while it is Scenario 3 which brings important impacts on social conditions. If we look at scenarios from source of impact point of view, we can conclude the following.

It is expected that development petroleum sector will increase employment, especially as it is required by legislation that 80% of the workforce should be employed locally. This is the key expectation which triggered increased interest for high level education in petroleum sector linked studies mentioned before. However, the estimated number of new employments varies greatly between scenarios.

In Scenario 1 no new employment opportunities are expected, as already exiting workforce within the sector and supporting industries can cover such demand. This means that even todays expectations can be under scenario 1 considered unrealistic, and if they remain persistent and uncontrolled, they can lead into a subsequent negative impact linked to creation of a group of highly trained but unemployable workforce within Lebanon, further increasing the process of emigration of highly educated Lebanese citizens. In Scenario 2 several hundred new employments are expected, but due to still rather limited development of the petroleum sector this process is not expected to bring major shifts to the labor market. In Scenario 3 several thousand new employments are expected within the petroleum sector itself, as well as several thousand more within sector supporting industries. This is the scenario in which not only labor market, but the whole Lebanese society can expect important change in social conditions. On the other hand, Scenario 3 is also the scenario which demands most attention by Lebanese government and authorities responsible for education and labor market. They need to prepare Lebanese society to be able to cope with this new demand.

It is also expected that development of the petroleum sector will improve living conditions due to the following main reasons:

- Development of the petroleum sector is expected to spur overall economic development of Lebanon. Increased employment will improve income of families of workers within the sector, supporting industries as well as in other sectors under secondary impact. Subsequently, this process will reduce proportion of population living below the national poverty line.
- Development of the petroleum sector will allow Lebanon to switch from oil to gas driven energy supply in quantities at least covering national demand. This will lead to stable power supply, reduced need for power generators and therefore reduced pollution due to exhaust fumes from generators (especially in densely populated areas), as well as reduced cost of energy in Lebanon. Subsequently, this process will improve overall living conditions and improve health of Lebanese society.
- Development of the petroleum sector will allow Lebanon to establish a sovereign wealth fund. Its main task will be to fund further development of Lebanese economy and society and invest in "green industries", leading to further improvement of living conditions in Lebanon.
- Development of the petroleum sector will (partially financed by the petroleum sector itself, partially by Lebanese Government and partially by sovereign wealth fund) spur overall development of transport and communal infrastructure in Lebanon.

Subsequently, this process will improve overall living conditions and improve health of Lebanese society.

However, it shall be emphasized that all stated expectations will be fully realized only in case of Scenario 3 and only partially in case of Scenario 2, while in case of Scenario 1 none of above expectations will be realized.

In Scenario 2, only limited number of new employments are expected, focus on domestic power supply and subsequent stable power supply, reduced need for power generators and therefore reduced pollution due to exhaust fumes from generators (especially in densely populated areas), as well as reduced cost of energy in Lebanon. Also, Lebanese government will no longer need to invest in purchase of hydrocarbons on international market and will be able to assign these funds to development of Lebanese economy and society. Other described positive impacts on social conditions are expected to be realized in a very limited extent.

But even Scenario 3 hides a trap of "missed opportunity" linked to the operationalization and guidance of the sovereign wealth fund. In case sovereign wealth fund will not guide investments towards development of Lebanese economy and society, its positive impacts can be dramatically reduced.

In addition to all stated expected positive impacts on social conditions, two important negative impacts could also occur. The first one is linked to loss of income for specific groups (e.g. fishermen) due to newly imposed limitations to their industries. Introduction of any new economic sector to Lebanon inevitably occupies space and changes dynamics between economic sectors sharing Lebanese waters. Economic sectors like shipping, infrastructure and fishing will have to adapt to petroleum sector. However, levels of adaptation and limitations are different. In shipping and infrastructure, only spatial distribution of all three sectors must be respected, while development of the petroleum sector will in general offer new development opportunities to shipping and infrastructure sectors. On the other hand, fishing sector is quite different. Development of the petroleum sector might limit or restrict its activities, as well as negatively impact the fishing stock.

Similar to other impacts, the significance and likelihood of occurrence varies greatly from scenario to scenario. But in difference to other impacts mentioned in this chapter, which affect almost all Lebanese society, this impact is linked to a specific target group of fishing communities. While in Scenarios 1 and 2 expected impact is, due to rather limited development of the petroleum sector, still in the range of a minor impact (most likely limited to individual fishing communities), in Scenario 3 it overgrows this level and becomes national level impact.

However, existing control measures (PAR) already requires compensations in such cases, but its modalities are still not in place. Thus, it is important that the petroleum sector establishes appropriate modality for compensations, as this will create a well guided, predictable and secure workspace for further potential negotiations with this specific target group, as well as limit "exposure" of the petroleum sector towards potential law suits from impacted target groups.

The other important potential negative impact is linked to accidental situations. These have, in light of all already existing control measures, already been taken under serious consideration.

Risks of hazards from offshore operations could result from accidental events such as fires or explosions, loss of stability /loss of station or structural failure. Floating installations are of more concern because they can lose stability and buoyancy following collisions, loss of control of ballast systems and environmental action. They can also lose station through failures of anchors and tethers or engine problems. Floating production installations also have a higher rate of hydrocarbon releases (HCRs) in comparison to fixed installations.

The actual impacts depend on many factors, including the volume and type of hydrocarbon spilled, and sea and weather conditions. A response Plan has been previously developed to mitigate for such accidental events. Also, operators are bilged to follow all health and safety standards in order to prevent accidental events, as well as to ensure safe work environment for employees.

However, current operational capacities and capabilities of responsible authorities in Lebanon are not sufficient to implement the NOSCP and monitor operator's compliance with ERP. This is why substantial responsibility lies on the shoulders of responsible authorities and the Lebanese government to use the time which the petroleum sector will need to fully develop and address stated issues systematically and to the fullest extent possible.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on social conditions during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-76.

Table 8-76 Significance Rating of Impacts on Social Conditions

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Increased employment	1	+	No impact		No impact	
	2	+	B – Beneficial P - Possible	Beneficial	B – Beneficial P - Possible	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Improved living conditions	1	+	No impact		No impact	
	2	+	B – Beneficial U - Unlikely	Beneficial	B – Beneficial U - Unlikely	Beneficial
	3	+	B – Beneficial A – Almost	Beneficial	B – Beneficial A – Almost	Beneficial

Main Impacts	Sce nari	Directi on	Consequence Rating	Significance Rating with	Consequenc e Rating	Significance Rating with Planned Control
			Certain		Certain	
Reduced cost of energy in Lebanon	1	+	No impact		No impact	
	2	+	B – Beneficial U - Unlikely	Beneficial	B – Beneficial U - Unlikely	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Reduced proportion of population living below the national poverty line	1	+	No impact		No impact	
	2	+	B – Beneficial P - Possible	Beneficial	B – Beneficial P - Possible	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Loss of income for specific groups (e.g. fishermen) due to newly imposed limitations to their industries	1	-	2 – Minor A – Almost Certain	Medium - Acceptable (with EMS in place)	2 – Minor U – Unlikely	Low - Acceptable
	2	-	2 – Minor A – Almost Certain	Medium - Acceptable (with EMS in place)	2 – Minor U – Unlikely	Low - Acceptable
	3	-	3 – Moderate A – Almost Certain	High - Unacceptable	2 – Minor U – Unlikely	Low - Acceptable
Accidental situations and subsequent increase in fatal and non-fatal occupational injuries	1	-	4 – Major U - Unlikely	Medium - Acceptable (with EMS in place)	4 – Major R - Remote	Medium - Acceptable (with EMS in place)
	2	-	4 – Major U - Unlikely	Medium - Acceptable (with EMS in place)	4 – Major R - Remote	Medium - Acceptable (with EMS in place)
	3	-	4 – Major U - Unlikely	Medium - Acceptable (with EMS in place)	4 – Major R - Remote	Medium - Acceptable (with EMS in place)

8.5.2.4 *Proposed Mitigation Measures*

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- Ensure transparent and realistic communication between the petroleum sector and Lebanese society.
- To deliver accurate expectations of the general population, responsible authorities must raise the awareness on the topic.
- All potential limitations to other industries (e.g. fisheries) must be well communicated to impacted target groups and compensated.

- Ensure transparent governance and operation of sovereign wealth fund.
- Promote Corporate Social Responsibility (CSR) practices in the sector.
- Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.
- Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.
- Ensure safety critical equipment and processes are in place and operational prior to start of activities.
- Develop a national grievance mechanism.

8.5.3 Health

8.5.3.1 Potential Impacts

Impacts of E&P activities on health including sources of impacts and cumulative sources of impacts are shown in Table 8-77.

Table 8-77 Impacts on Health

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Increase in population with cardiovascular system diseases, respiratory system diseases, cancers and disabilities attributable to offshore petroleum sector	✓ Airborne health effects due to emissions from drilling rigs/platforms and all supporting activities of the petroleum sector ✓ Improved living conditions ✓ Waterborne and food chain related health effects due to discharges of drilling fluids and cuttings and produced water into the sea and HC releases in accidental events	✓ Cumulative impacts from other sectors/ activities (sources air emissions and discharges)

8.5.3.2 Main Existing control measures

- Adopting BAT
- Environmental standards and health and safety standards
- National Oil Spill Contingency Plan
- PAR: Emergency Response Plan

8.5.3.3 Assessment of Impacts

Individual activities of the petroleum sector will in different phases have negative impacts on public health, mainly from:

- Airborne health effects due to air emissions from drilling rigs/platforms and all supporting activities of the petroleum sector and

- Waterborne and food chain related health effects due to discharges of drilling fluids and cuttings and produced water into the sea and HC releases in accidental events.

Both impacts can be dealt through use of BAT principles, through the following mitigation measures:

- Air emissions from petroleum activities to be minimized following BAT principles.
- Avoid discharges to the sea if technically feasible. If discharge options are selected, the highest level of treatment (BAT) before discharge must be ensured and eco-toxicological studies to be conducted as part of EIA studies according to internationally recognized methods and standards.

Significant health impacts can also be linked to accidental situations. Air emissions especially in accidental events such as blowouts may cause adverse health problems such as lung and heart disorders, cancers, asthma, and reproductive problems. On the other hand, public health and safety problems are also common in the event of an oil spill. Acute health effects from the evaporation of volatile oil components can include headaches, nausea, vomiting, eye irritation, worsened asthma symptoms, upper respiratory tract irritation, vertigo, leg and back pains and psychological ailments. Spills can also have psychosocial effects in the communities where they occur. Besides the direct impacts, food (fish and shellfish) and water supplies can become contaminated as the result of a spill of discharges into the sea.

These impacts could be mitigated under existing control measures. As previously discussed, the significance of impacts from accidental events depends on many factors, including the volume and type of hydrocarbon spilled, and sea and weather conditions. A response Plan has been previously developed to mitigate for such accidental events. Also, operators are obliged to follow all health and safety standards in order to prevent accidental events, as well as to ensure safe work environment for employees.

However, current operational capacities and capabilities of responsible authorities in Lebanon are not sufficient to implement the NOSCP and monitor operator's compliance with ERP. This is why substantial responsibility lies on the shoulders of responsible authorities and the Lebanese government to use the time which the petroleum sector will need to fully develop and address stated issues systematically and to the fullest extent possible.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on Health during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-78.

Table 8-78 Significance Rating of Impacts on Health

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Improved living conditions	1	+	No impact		No impact	
	2	+	B – Beneficial L - Likely	Beneficial	B – Beneficial L - Likely	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Airborne health effects due to air emissions from drilling rigs/platforms and all supporting activities of the petroleum sector	1	-	2 – Minor A – Almost Certain	Medium - Acceptable (with EMS in place)	2 – Minor P – Possible	Medium - Acceptable (with EMS in place)
	2	-	2 – Minor A – Almost Certain	Medium - Acceptable (with EMS in place)	2 – Minor P – Possible	Medium - Acceptable (with EMS in place)
	3	-	3 – Moderate A – Almost Certain	High - Unacceptable	3 – Moderate P – Possible	Medium - Acceptable (with EMS in place)
Waterborne and food chain related health effects due to discharges of drilling fluids and cuttings and produced water into the sea and HC releases in accidental events	1	-	2 – Minor P – Possible	Medium - Acceptable (with EMS in place)	2 – Minor U – Unlikely	Low - Acceptable
	2	-	3 – Moderate L - Likely	Medium - Acceptable (with EMS in place)	2 – Minor P – Possible	Medium - Acceptable (with EMS in place)
	3	-	3 – Moderate L - Likely	Medium - Acceptable (with EMS in place)	2 – Minor P – Possible	Medium - Acceptable (with EMS in place)

8.5.3.4 Proposed Mitigation Measures

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- Air emissions from petroleum activities to be minimized following BAT principles.
- Avoid discharges to the sea if technically feasible. If discharge options are selected, the highest level of treatment (BAT) before discharge must be ensured and eco-toxicological studies to be conducted as part of EIA studies according to internationally recognized methods and standards.
- Operators could contribute funds to an independent monitoring program focused on chemical concentrations in edible fish and invertebrate tissue to support human health advisories.

- Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.
- Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.
- Ensure safety critical equipment and processes are in place and operational prior to start of activities.
- Ensure the healthcare sector is able to accommodate health conditions related to the sector (such as psychological or mental impacts due to sustained work offshore, etc.).
- Ensure that a robust health surveillance system is maintained to monitor possible health impacts from the sector as it develops and allow corrective measures to be made in a timely manner.

8.5.4 Education

8.5.4.1 Potential Impacts

Impacts of E&P activities on Education including sources of impacts and cumulative sources of impacts are shown in Table 8-79.

Table 8-79 Impacts on Education

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Graduates with specific skills within the petroleum industry trained and employed	✓ The need of the sector to ensure 80% local employment and subsequent increased need for adequately skilled work-force ✓ Unrealistic expectation of the general public towards the sector and subsequent mass production of highly educated and skilled labor force, which will remain unemployed due to limited needs of the sector	✓ Petroleum sector development will (only in scenario 3) spur economic growth in Lebanon, further increasing the need for adequately skilled work-force by other developing sectors

8.5.4.2 Main Existing control measures

- OPRL, Article 67: A Right Holder as well as its subcontractors shall employ qualified personnel of Lebanese nationality whenever available. Right Holder shall also organize and fund the training of Lebanese personnel associated with Petroleum Activities.
- PAR, Article 155: Qualification and Training of Personnel: The Right Holder and contractor shall give priority to training of Lebanese in order to facilitate the employment of Lebanese at all level of Right Holder's or contractor's organizations. The Right Holder shall in consultation with the Minister, propose and carry out an

effective recruitment and training program for Lebanese personnel for each phase of the Petroleum Activity and at all levels of management, taking into account the safety requirements and the need to maintain reasonable standards of efficiency in the conduct of Petroleum Activities. Such employees may be trained in the Republic of Lebanon or abroad as required by the training programs prepared. The Right Holder shall equally ensure that all personnel, including contractors' personnel have adequate training and experience in dealing with emergency situations.

- EPA, Article 20: The Right Holders shall develop and carry out an effective recruitment and training program for Lebanese personnel in accordance with the law no 132/2010. Operator shall employ, and cause all Contractors and Subcontractors to employ, qualified personnel of Lebanese nationality whenever available. The Right Holders shall fund the training of Lebanese personnel associated with Petroleum Activities. Each Exploration Plan and Development and Production Plan shall include a plan for the hiring and training of persons of Lebanese nationality, including hiring and training of management, engineering and other professional staff.

8.5.4.3 Assessment of Impacts

Development of a new sector always brings increased need for adequately educated and qualified work force and subsequently increases the demand for special profiles provided by the education sector.

This can be beneficial for all involved as long as the educational sector is able to educate enough students to meet the demand of the petroleum sector (especially relevant for scenario 3). If not, gaps need to be filled with suitably educated and skilled workforce from abroad – which is clearly not a preferred option.

On the other hand, an important threat comes from unrealistic expectations of the general public and uncoordinated admittance to sector relevant educational programs. This can lead to a mass production of highly specialized work force by the educational sector, which cannot be employed due to limited needs of the developing petroleum sector and subsequently create social and labor market problems.

It shall be taken into account that today Lebanon already educates adequate numbers of graduates from sector specific educational programs to meet part of estimated needs of the sector – especially since the petroleum sector will develop over a period of time (e.g. 10 years).

Thus, in case of Scenario 1, current supply of needed workforce is already available. On the other and, in case of Scenario 2 and especially Scenario 3, the demand for workforce will increase through time (in line with sector development tempo). From education point of view this means that responsible authorities in Lebanon have enough time to prepare a strategy linked to development of all relevant sector specific educational programs.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on Education during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-80.

Table 8-80 Significance Rating of Impacts on Education

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Increased need for highly educated and skilled labor force	1	+	B – Beneficial P - Possible	Beneficial	B – Beneficial A – Almost Certain	Beneficial
	2	+	B – Beneficial L - Likely	Beneficial	B – Beneficial A – Almost Certain	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Mass production of highly educated and skilled labor force, which will remain unemployed due to limited needs of the sector	1	-	2 – Minor L - Likely	Medium - Acceptable (with EMS in place)	B – Beneficial A – Almost Certain	Beneficial
	2	-	2 – Minor P - Possible	Medium - Acceptable (with EMS in place)	B – Beneficial A – Almost Certain	Beneficial
	3	-	2 – Minor U - Unlikely	Low - Acceptable	B – Beneficial A – Almost Certain	Beneficial

8.5.4.4 Proposed Mitigation Measures

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- To provide accurate expectations of the general population, responsible authorities must raise the awareness on the actual potential for job creation of the sector.
- Responsible authorities should prepare a strategy linked to development of sector specific educational programs, both from the quality and admittance quantity point of view.
- Sector developers (authorities and companies) can cooperate with educational institutions to guide the type, number and quality of relevant educational programs to avoid flooding the market, while taking into consideration possibility of regional

and international markets. Additional educational programs could focus on other disciplines such as ecotoxicology, human health risk assessment, and fisheries science ...etc.

- Sector developers can develop scholarship and/or internship program for students of sector specific educational programs.

8.5.5 Cultural Heritage

8.5.5.1 Potential Impacts

Impacts of E&P activities on Cultural Heritage including sources of impacts and cumulative sources of impacts are shown in Table 8-81.

Table 8-81 Impacts on Cultural Heritage

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
% of cultural and archaeological heritage sites damaged by offshore petroleum activities and related onshore activities.	✓ Physical damages to undiscovered offshore and onshore cultural and archaeological heritage sites due to positioning and installation of equipment & infrastructure ✓ Physical damages to undiscovered offshore and on-shore cultural and archaeological heritage sites due to discharges of drill cuttings to the sea ✓ Damages to known and undiscovered cultural and archaeological heritage sites due to oil spills and other accidental situations	✓ Cumulative impacts with other economic sectors operating on sea bottom (e.g. infrastructure, fishing, etc.) ✓ Cumulative impacts on the same known and undiscovered cultural and archaeological heritage sites from different operators in different blocks

8.5.5.2 Existing control measures

- Avoiding exiting known cultural heritage and archaeological sites and compliance with their protection regimes according to regulatory requirements (Antiquities System Decision 166/1933 and Cultural properties Law 37/2008)
- PAR: Activities pursuant to a Reconnaissance license must not present a hazard or cause damage to Facilities, or towards pipelines, cables or other subsea structures used for other purposes than Petroleum Activities.
- PAR: The Right Holder has to provide protection from: accidents and physical damage due to his activities; damage or risk of damage to workers; damage to fauna, flora, marine biodiversity and archaeology; marine pollution and pollution to springs that will be discovered during the course of petroleum activities; air pollution; damage to hydrocarbon bearing formations.

- PAR: The Right Holder and Petroleum Administration shall notify each other of any environmentally, archaeologically, historically or similarly protected areas or features which might be affected by the Petroleum Activities.

8.5.5.3 Assessment of Impacts

In prospecting phase - Disturbance to the sea floor and coastal areas during prospecting phase will be limited, and sometimes also linked to accidental situations (e.g. seismic equipment breaking off, etc.). Due to the fact that most of seismic activities have already been conducted, it is assumed that these activities will be carried out to a lesser extent. However, unintentional damages to undiscovered archaeological sites – due to interaction with equipment on sea bed, construction of new on-shore Support Facilities for provision of supplies or dredging activities for ports and onshore support facilities - are possible and if they will occur the damages to archaeological sites can be permanent and irreversible.

Additionally, it was presumed that existing ports and support facilities will be used thus minimizing the described impacts.

In case of major accidents (e.g. vessel sinking) the damages could also be the result of oil spills and subsequent pollution of coastal cultural and archaeological heritage sites. Vessels will be carrying the amounts of oil needed for their operation, thus oil spills will be of a small magnitude.

In exploration and production phase, positioning of the drilling facilities with mooring systems could cause damages to archaeological sites. It should be taken into account that the possibility of finding archaeological sites is much greater on the continental shelf. Subsequently, the choice of well location is important in "coastal blocks".

Preliminary investigations of undiscovered cultural and archaeological heritage sites shall be carried out after the selection of the drill-site (before EIA is prepared for the Exploration plan). If this is respected than impacts of the exploration phase can be considered even positive, as it will contribute to increased identification and protection of submerged archaeological sites.

However, if the mitigation measure is not respected, then other activities – such as drilling and discharge of drill cuttings and fluids (if they are allowed) could have important negative impacts on submerged undiscovered archaeological sites. Vibrations caused by drilling could physically harm them, while uncontrolled discharge of cuttings could cover or physically damage them.

In exploration phase unintentional damages to undiscovered archaeological sites – due to construction of new on-shore Support Facilities for provision of supplies – are possible and if they will occur the damages to archaeological sites can be permanent and irreversible. The same applies also in production phase, where unintentional damages to archaeological sites – due to construction of new on-shore Support Facilities for provision of supplies, installation of subsea systems, on-shore processing facilities, transmission network, export pipelines and LNG terminals (on-shore or offshore) – are possible and if they will occur the damages to archaeological sites can also be permanent and irreversible.

During sector development, the issue of new on-shore support facilities and infrastructure locations/corridors should be considered through spatial or other sectorial plans prepared for them.

In case of accidents (e.g. oils spills, collisions, etc.) the damages could also be the result of oil spills and subsequent pollution of coastal cultural and archaeological heritage sites. Additionally, impacts on coastal archaeology and cultural heritage are associated with smothering and damage from clean-up operations. This is why it is important that such sites are taken into account when response strategies are developed.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on Cultural Heritage during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-82.

Table 8-82 Significance Rating of Impacts on Cultural Heritage

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Physical damages to undiscovered offshore and onshore cultural and archaeological heritage sites due to positioning and installation of equipment & infrastructure	1	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	B – Beneficial A – Almost Certain	Beneficial
	2	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	B – Beneficial A – Almost Certain	Beneficial
	3	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	B – Beneficial A – Almost Certain	Beneficial
Physical damages to undiscovered offshore and on-shore cultural and archaeological heritage sites due discharges of -drill cuttings to the sea	1	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	No impact	No impact
	2	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	No impact	No impact
	3	-	4 – Major P - Possible	High - Unacceptable	No impact	No impact
Damages to known and undiscovered cultural and	1	-	3 – Moderate U – Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate R – Remote	Medium - Acceptable (with EMS in place)

Main Impacts	Scen ario	Directio n	Consequence Rating	Significance Rating with Planned	Consequence Rating	Significance Rating with Planned Control Measures and
archaeological heritage sites due to oil spills and other accidental situations	2	-	3 – Moderate U – Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate R – Remote	Medium - Acceptable (with EMS in place)
	3	-	3 – Moderate U – Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate R – Remote	Medium - Acceptable (with EMS in place)

8.5.5.4 Proposed Mitigation Measures

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- Before conducting any sea floor disturbing activities, work sites shall be surveyed by marine archaeologists to identify any underwater archaeological sites and shipwrecks. Specifications required for such surveys to be defined by DGA and LPA; Based on findings, buffer zones might be required around the identified sites. A marine archaeologist shall be present on-vessel during Environmental and Natural Resource Surveys (NRSs)
- In case of discoveries, the formal procedure for protection of archaeological sites must be followed, according to existing legislation, or as specified by DGA.

8.5.6 Tourism

8.5.6.1 Potential Impacts

Impacts of E&P activities on education including sources of impacts and cumulative sources of impacts are shown in Table 8-83.

Table 8-83 Impacts on Education

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Change in tourist arrivals	✓ Development of the sector will produce more foreign visits ✓ Physical presence of platforms, infrastructure and onshore facilities placed in visual range of important tourism areas ✓ Accidental situations and subsequent reduction of tourist visiting Lebanon	✓ Increased benefits and pressures from tourism due to overall increase of tourist arrivals

8.5.6.2 *Main Existing control measures*

- Law 444/2002: it is strictly prohibited to discharge or sink or burn in Lebanese territorial waters materials that, directly or indirectly, will d) reduce the recreational value and tourism potential of the sea and the Lebanese coasts
- National Oil Spill Contingency Plan
- PAR: Emergency Response Plan
- Offshore blocks are located 3 NM away from the shore

8.5.6.3 *Assessment of Impacts*

It is important that development of any new sector (like petroleum sector) in Lebanon opens new opportunities for the tourism sector, while on the other hand protects Lebanese tourism potentials. It is often expected that development of the petroleum sector will automatically increase the number of foreign visitors. However, this expectation relies to a great extent on the fact that Influx of foreign workers will be in any scenario limited, as 80% of the workforce has to be Lebanese.

Of course, expected positive impacts of the Scenario 3 are much higher than those of Scenarios 1 and 2. Not only due to the fact that the need for foreign work force will be higher, but also because in Scenario 3 the overall economic development potential of Lebanon becomes much larger. And in such favorable economic conditions Lebanon could exploit the opportunity to boost its tourism offer and launch "visit Lebanon" campaigns in countries from which companies and foreign workers come from. And in this moment protection of Lebanese tourism potential gains its importance.

On the other hand, there are two predominant potential negative impacts on tourism:

- Degradation of tourism potentials, landscape and visual amenity due to physical presence of platforms, infrastructure and support facilities, which could be easily further connected with urbanization. In this case physical presence of drilling rigs (temporarily), platforms, infrastructure and onshore facilities (permanently) placed in visual range of important tourism areas and potentials are of concern. Of course, the level of expected impacts increases in line with growth of petroleum sector and assessed scenarios. While in case of Scenario 1 impact on tourism is negligible, its importance grows in Scenario 2 and even more so in Scenario 3.
- Accidental situations and subsequent reduction of tourist visiting Lebanon – Tourism is a very fragile economic sector, highly dependable on tourism image and status of the destination. In case of a serious accidental situation the country image could be destroyed very easily, and this could seriously endanger Lebanese tourism efforts and impact them for years to come. This is why the impact is the same for all three scenarios, and also the reason why scoring doesn't change even with all mitigation measures in place. It is an extremely sensitive industry in which even miss-information can cause serious impacts.

To make sure that both oil & gas and tourism sectors can co-exist, it is important to ensure active participation of both sectors in the spatial planning and project planning phases, as vast majority of negative impacts can be avoided. The issue of new on-shore support facilities and infrastructure locations/corridors should be considered through Spatial Plans and SEAs.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on Education during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-84.

Table 8-84 Significance Rating of Impacts on Tourism

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Increased number of foreign visitors due to development of the sector	1	+	B – Beneficial U - Unlikely	Beneficial	B – Beneficial U - Unlikely	Beneficial
	2	+	B – Beneficial P – Possible	Beneficial	B – Beneficial P – Possible	Beneficial
	3	+	B – Beneficial L - Likely	Beneficial	B – Beneficial L - Likely	Beneficial
Degradation of tourism potentials, landscape and visual amenity due to physical presence of platforms, infrastructure and support facilities	1	-	1- Negligible A - Almost Certain	Medium - Acceptable (with EMS in place)	1- Negligible L - Likely	Low - Acceptable
	2	-	2 - Minor A - Almost Certain	Medium - Acceptable (with EMS in place)	2 - Minor L - Likely	Medium - Acceptable (with EMS in place)
	3	-	2 - Minor A - Almost Certain	Medium - Acceptable (with EMS in place)	2 - Minor L - Likely	Medium - Acceptable (with EMS in place)
Accidental situations and subsequent reduction of tourist visiting Lebanon	1	-	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)
	2	-	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)
	3	-	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)

8.5.6.4 Proposed Mitigation Measures

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- Drilling rigs/platforms should be positioned as far from the coastline as possible, however still practicable for the operator.
- Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.
- Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.
- Monitoring of chemical concentrations in edible fish and invertebrate tissue. A transparent seafood contaminant monitoring program would increase confidence in locally sourced seafood and enhance Lebanon's restaurant and tourist image.
- In order to increase positive impacts, the Ministry of Tourism and other responsible agencies can focus their tourism promotional campaigns on foreign workers origin countries.
- Master Plans and Detail Urban Plans to be prepared in coastal areas where not available as a measure to sustainably plan potential petroleum induced growth.

8.5.7 Landscapes and visual amenity

Impacts of E&P activities on Landscapes and Visual Amenity including sources of impacts and cumulative sources of impacts are shown in Table 8-85.

8.5.7.1 Potential Impacts

Table 8-85 Impacts on Landscapes and Visual Amenity

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
% of nationally classified landscapes exposed to potential impacts	✓ Physical presence of drilling rigs, platforms, infrastructure and onshore facilities placed in visual range of important landscape areas ✓ Increased urbanization of the coastline (consequential impact)	✓ Cumulative impacts with other economic sectors contributing to urbanization

8.5.7.2 Main Existing control measures

- Compliance with SDATL (National Spatial Land Use Plan)
- Flaring or venting shall be subject to a permit from MoEW
- Offshore blocks are located 3 NM away from the shore line

8.5.7.3 Assessment of Impacts

As discussed in the previous chapter, it is important that Lebanon protects its Landscapes and visual amenity, as one of most recognizable tourism, as well as cultural heritage potentials. These can be mostly impacted by physical presence of drilling rigs (temporarily), platforms, infrastructure and onshore facilities (permanently) placed in visual range of important landscape areas. Of course, the level of expected impacts increases in line with growth of petroleum sector in line with assessed scenarios. While in case of scenario 1 landscapes and visual amenity is not a major issue, its importance grows in scenario 2 and even more so in scenario 3.

The same applies also to the issue of increased urbanization of the coastline, as a consequence impact. While, scenario 1 does not pose a serious problem, scenario 2 urbanization solutions should be kept in mind, however, it is the scenario 3 where most significant negative impacts can be expected.

It is important during the planning phase to consider the following measures:

- Opting to "move" sea-based operations away from main tourism and landscape areas.
- Opting to exploit existing industrial sites, "brown-field" sites or other less attractive locations for placing on-shore operations.
- Investigating technical alternatives (types of platforms, etc.) with lower visibility impacts.

Lebanese Government could also opt in Scenarios 2 and 3 to limit development of such industries or allow them to develop only in line with domestic HC production capacities in order to limit their negative impacts.

During sector development, the issue of new on-shore support facilities and infrastructure locations/corridors should be considered through Spatial Plans and SEAs. In this way the Lebanese Government could use spatial planning as a tool to limit development of such industries, as well as to select proper locations and ensure appropriate buffer for new industries.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on Landscapes and visual amenity during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-86.

Table 8-86 Significance Rating of Impacts on Landscapes and visual amenity

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Degradation of landscape and visual	1	-	1 - Negligible A - Almost Certain	Medium - Acceptable (with EMS in	1 - Negligible L - Likely	Low - Acceptable

Main Impacts	Scenario	Direction	Consequence Rating	Significance Rating with Planned	Consequence Rating	Significance Rating with Planned Control Measures and
amenity due to physical presence of platforms, infrastructure and support facilities				place)		
	2	-	2 - Minor A - Almost Certain	Medium - Acceptable (with EMS in place)	2 - Minor P - Possible	Medium - Acceptable (with EMS in place)
	3	-	3 - Moderate A- Almost Certain	Medium - Acceptable (with EMS in place)	2 - Minor L - Likely	Medium - Acceptable (with EMS in place)
Increased urbanization of the coastline (consequential impact)	1	-	3 - Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate R - Remote	Low - Acceptable
	2	-	3 - Moderate L - Likely	Medium - Acceptable (with EMS in place)	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)
	3	-	3 - Major A - Almost Certain	High - Unacceptable	3 - Moderate L - Likely	Medium - Acceptable (with EMS in place)

8.5.7.4 Proposed Mitigation Measures

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- Drilling rigs/platforms should be positioned as far out from the coastline as possible, however still practicable for the operator.
- When selecting a location, preference should be given to brown-field locations and areas with no/less landscape value.
- Master Plans and Detail Urban Plans to be prepared in coastal areas where not available as a measure to sustainably plan potential petroleum induced growth.

8.5.8 Infrastructure

8.5.8.1 Potential Impacts

Impacts of E&P activities on Infrastructure including sources of impacts and cumulative sources of impacts are shown in Table 8-87.

Table 8-87 Impacts on Infrastructure

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
✓ Increase in number and capacity of hazardous waste management facilities ✓ Impacts on sub-sea infrastructure due to offshore petroleum activities ✓ Change in capacity of transport infrastructure to cope with demand	✓ Interaction of equipment on the sea bed or burial of existing infrastructure due to discharge of drill cuttings to the sea ✓ Increased pressure on existing infrastructure and support services ✓ Increased investments in infrastructure projects ✓ Accidental events	✓ Cumulative impacts due to increased pressure on existing infrastructure and support services due to overall economic development in Lebanon ✓ Cumulative impacts with other sectors operating on the sea bottom (e.g. infrastructure, cultural heritage, fishing, etc.)

8.5.8.2 *Main Existing control measures*

- PAR: Activities pursuant to a Reconnaissance license must not present a hazard or cause damage to Facilities, or towards pipelines, cables or other subsea structures used for other purposes than Petroleum Activities.
- EPA, Article 3 includes that LPA shall provide such assistance to the Right Holders as they may reasonably request in order to obtain information with respect to current and existing infrastructure and activities in the Block that are unrelated to Petroleum Activities (including telecommunication cables and areas reserved for naval activities of the State).
- Existing international and national submerged infrastructure corridors with known buffer zones and standard operating procedures in case of accidental situations.

8.5.8.3 *Assessment of Impacts*

Impacts linked to submerged infrastructure are similar to those related to impacts on submerged archaeology and linked to physical interaction with equipment on the sea bed. These can be avoided if corridors of existing submerged infrastructure are taken into account in the planning phase and preliminary investigations of sea-bottom are carried out.

Regarding existing capacities of Lebanese infrastructure to cope with demand, it is important to understand that currently Lebanon's existing infrastructure faces many challenges. In international context it shows very poor infrastructure ranking (113th out of 137 countries in terms of quality of infrastructure (WEF, Global competitiveness report, 2017-2018)). Only 15% of roads are considered to be in good condition, with high traffic congestion on main highways and a general lack of public transportation. Demand exceeds capacity at the Beirut International Airport with a 6 million travelers' capacity versus an 8 million travelers demand. Ports face a high dwell time with dwell time at Beirut Port being 13 days and an inefficient integration between different ports and roads. Subsequently, the source of impact *"Increased pressure on existing infrastructure and support services"* becomes an important one – less so in Scenarios 1 and 2 (due to rather limited development of the petroleum sector), however much more important in Scenario 3 where pressures will come not only from petroleum sector, but also from other economic sectors developing in parallel with it. Additionally, we need to point out that it was presumed that existing ports and support facilities will be used to the greatest extent possible – in this case additionally increasing all described impacts.

Plans to improve infrastructure are currently already underway. Two major infrastructure projects are currently being studied under the recent Public Private Partnership (PPP) Law through the High Council for Privatization and PPP. These are the expansion of Beirut International Airport and the Khalde – Okaybe expressway to by-pass the highly congested Beirut and Jounieh areas. Public transport infrastructure is also at various stages of planning including a Bus Rapid Transit (BRT) and feeder buses project and the coastal railway between Beirut and Tripoli, and between Tripoli and the Syrian border. If implemented, these projects could significantly alleviate traffic and enhance overall Lebanese competitiveness and trading ability with neighboring countries. It shall also be noted that exiting Right of Way (RoW) of the coastal railway should be considered when designing the locations of oil and gas onshore facilities and pipelines to avoid any potential conflict.

As described, development of the petroleum sector will *allow "Increased investments in infrastructure projects"*. From this point of view, petroleum sector could be an important driver of further development of Lebanese infrastructure – bringing important beneficial impacts not only to the infrastructure sector but to all Lebanese society and economy.

But even in case of such favorable development, scenario 3 brings important challenges which must be dealt with. The issue of improved infrastructure should be considered through Spatial or other sectorial plans prepared for them. This will require active spatial and transport policy, high level of cooperation between responsible authorities, as well as appropriate funding.

In case of accidents, the damages to existing infrastructure could also be the result of collisions, vessel sinking, and in case of ports also various spills linked to them, as well as impacts associated with smothering and damage from clean-up operations. This is why it is important that such sites are also taken into account when response strategies are developed.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on Infrastructure during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-88.

Table 8-88 Significance Rating of Impacts on Infrastructure

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Interaction of equipment on the sea bed or burial of existing infrastructure due to discharge of drill cuttings to the sea	1	-	1 - Negligible P - Possible	Low - Acceptable	1 - Negligible U - Unlikely	Low - Acceptable
	2	-	2 - Minor P - Possible	Medium - Acceptable (with EMS in place)	2 - Minor U - Unlikely	Low - Acceptable
	3	-	2 - Minor L - Likely	Medium - Acceptable (with EMS in place)	2 - Minor U - Unlikely	Low - Acceptable
Increased pressure on existing infrastructure and support services	1	-	2 - Minor L - Likely	Medium - Acceptable (with EMS in place)	1 - Negligible L - Likely	Low - Acceptable
	2	-	2 - Minor A – Almost Certain	Medium - Acceptable (with EMS in place)	2 - Minor L - Likely	Medium - Acceptable (with EMS in place)
	3	-	3 - Moderate A – Almost Certain	High - Unacceptable	2 - Minor A – Almost Certain	Medium - Acceptable (with EMS in place)
Increased investments in infrastructure projects	1	+	B – Beneficial U - Unlikely	Beneficial	B – Beneficial U - Unlikely	Beneficial
	2	+	B – Beneficial P – Possible	Beneficial	B – Beneficial P – Possible	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Accidental events	1	-	1 - Negligible U - Unlikely	Low - Acceptable	1 - Negligible U - Unlikely	Low - Acceptable
	2	-	1 - Negligible P - Possible	Low - Acceptable	1 - Negligible U - Unlikely	Low - Acceptable
	3	-	2 - Minor P - Possible	Medium - Acceptable (with EMS in place)	2 - Minor U - Unlikely	Low - Acceptable

8.5.8.4 Proposed Mitigation Measures

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- Before conducting any sea floor disturbing activities, work sites shall be surveyed to identify any underwater submerged infrastructure.
- Oil-based revenues to support development of public infrastructure.
- Asses existing infrastructure services to specify its adequacy to cater increased demand and use. If new infrastructure services are to be established the planning process shall be conducted in collaboration with other sectors in the coastal region, such as tourism to optimize the use of the new infrastructure to achieve benefits to other sectors as well.
- Since oil and gas E&P will lead to higher use of road networks, thus more traffic, supply bases should be assigned in secondary areas that do not already suffer from major traffic problems like Beirut City. Some projects need to consider detailed traffic assessment studies.

8.5.9 Shipping

8.5.9.1 Potential Impacts

Impacts of E&P activities on Shipping including sources of impacts and cumulative sources of impacts are shown in Table 8-89.

Table 8-89 Impacts on Shipping

Impact Indicator	Sources of Impacts (Activities)	Cumulative Sources of Impact
Disturbance to shipping activities from the offshore petroleum sector	✓ Interference with assigned shipping lanes/routes ✓ Increased demand for shipping and related support services ✓ Accidental situations and collisions	✓ Cumulative impacts due to increased pressure on existing infrastructure and support services due to overall economic development in Lebanon

8.5.9.2 Main Existing control measures

- PAR, Article 6: Vessels and crafts used for or involved in Petroleum Activities shall comply with applicable international and Lebanese laws and regulations regarding Petroleum Activities and navigation. The vessels and crafts shall abide by instructions given by the competent Lebanese authorities and by the competent Lebanese naval vessels, patrol boats or crafts.
- PAR, Article 15: Operations conducted pursuant to a Reconnaissance license must not unnecessarily or unreasonably impede or prevent the navigation of other vessels or crafts, fishing, aviation or other lawful activities.

- EPA, Article 3 includes that LPA shall provide such assistance to the Right Holders as they may reasonably request in order to obtain information with respect to current and existing infrastructure and activities in the Block that are unrelated to Petroleum Activities (including telecommunication cables and areas reserved for naval activities of the State).
- Existing shipping corridors with known buffer zones and standard operating procedures in case of accidental situations.

8.5.9.3 Assessment of Impacts

Development of the petroleum sector with its development areas could lead to "Interference with assigned shipping lanes/routes". Especially in case of substantial hydrocarbon findings and long-term operations (e.g. installation of the exploitation platform) existing shipping lanes/routes might change. Both, significance and likelihood of this impact grows with development potential of individual scenario – meaning low significance and likelihood in Scenario 1, medium significance and likelihood in Scenario 2 and higher significance and likelihood in Scenario 3. As actual locations of petroleum activities are at this stage still not known, it is even more important to take existing shipping lanes/routes into account in the planning phase (for selection of micro-locations) before EIA is prepared for the Exploration plan. If this is respected than impacts will be reduced only to impacts linked to potential accidental situations.

With ongoing exploration activities, there will be an increase in the demand for shipping for importing required material and equipment, as well as transporting them offshore. This could spur further development of this sector in Lebanon and create new employment opportunities. However, such beneficial impacts will be in case of scenario 1 very limited, in case of scenario 2 already visible, but will become highly significant only in Scenario 3.

As increased shipping activities occur in the sea, the risk of incidents and collisions increases. Such risks could be low in Scenario 1, however in Scenarios 2 and 3 the risks of colliding ships and severity of any collision accident becomes higher. This is why it is important that such sites are also taken into account when response strategies are developed.

The consequence rating, likelihood of occurrence, significance rating and acceptability of the impacts on Shipping during E&P different scenarios before and after additional mitigation measures are in place are summarized in Table 8-90.

Table 8-90 Significance Rating of Impacts on Shipping

Main Impacts	Scenario	Direction	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures	Consequence Rating / Likelihood of Occurrence	Significance Rating with Planned Control Measures and Additional Proposed Mitigation Measures
Interference with assigned shipping lanes/routes	1	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	2 – Minor P - Possible	Medium - Acceptable (with EMS in place)
	2	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)
	3	-	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)	3 – Moderate P - Possible	Medium - Acceptable (with EMS in place)
Increased demand for shipping and related support services	1	+	B – Beneficial U - Unlikely	Beneficial	B – Beneficial U - Unlikely	Beneficial
	2	+	B – Beneficial P – Possible	Beneficial	B – Beneficial P – Possible	Beneficial
	3	+	B – Beneficial A – Almost Certain	Beneficial	B – Beneficial A – Almost Certain	Beneficial
Accidental situations and collisions	1	-	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)	2 – Minor U - Unlikely	Low - acceptable
	2	-	4 – Major U - Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)
	3	-	4 – Major U - Unlikely	Medium - Acceptable (with EMS in place)	3 – Moderate U - Unlikely	Medium - Acceptable (with EMS in place)

8.5.9.4 *Proposed Mitigation Measures*

The assessment of residual impacts considers the following additional proposed mitigation/enhancement measures:

- Re-instate the VTMS (vessel traffic management system) to control and monitor all vessel movement.
- Require ships in Lebanese waters to install IVMS for proper monitoring to avoid any collisions and accidents.
- Coordination with the concerned governmental agencies to ensure offshore developments do not interfere with shipping routes.

8.6 IMPACTS DURING DECOMMISSIONING PHASE

Possible Impacts

There are international agreements relating to decommissioning that address removal and deep-sea disposal. For example, the International Maritime Organization (IMO) has developed guidelines and standards for the removal of offshore installations and sets out conditions to protect navigation and maintain safety[12]. IMO standards state that installations or structures of less than 4,000 tones, excluding the deck and superstructure, and in less than 75 meters of water should be removed entirely at decommissioning. Additionally, no installation or structure should be installed after January 1, 1998 unless the facility is designed to be entirely removed. The standards indicate that exceptions will be considered on a case-by-case basis for installations or structures installed before 1998 that cannot be fully removed for demonstrable reasons of technical or financial feasibility, but these facilities must be partially removed to provide a clear water column depth of 55 meters.

An OSPAR decision recognizes entire removal of the facility from the offshore locations for re-use, recycling, or final disposal on land as the preferred option for the decommissioning of offshore facilities. Alternative disposal options may be considered if justified on the basis of an alternative options assessment. This assessment should consider facility type, disposal methods, disposal sites, and environmental and social impact, including interference with other sea users, impacts on safety, energy and raw material consumption, and emissions.

Article 20 'Removal of Installations' of the Offshore Protocol of Barcelona Convention stipulates that:1) The operator shall be required by the competent authority to remove any installation which is abandoned or disused, in order to ensure safety of navigation, taking into account the guidelines and standards adopted by the competent international organization. Such removal shall also have due regard to other legitimate uses of the sea, in particular fishing, the protection of the marine environment and the rights and duties of other Contracting Parties. Prior to such removal, the operator under its responsibility shall take all necessary measures to prevent spillage or leakage from the site of the activities; 2) The competent authority shall require the operator to remove abandoned or disused pipelines in accordance with paragraph 1 of this Article or to clean them inside and abandon them or to clean them inside and bury them so that they neither cause pollution, endanger navigation, hinder fishing, threaten the marine environment, nor interfere with other legitimate uses of the sea or with the rights and duties of other Contracting Parties. The competent authority shall ensure that appropriate publicity is given to the depth, position and dimensions of any buried pipeline and that such information is indicated on charts and notified to the Organization and other competent international organizations and the Parties.

In general, decommissioning of offshore fixed or bottom-founded platforms is perceived as technically difficult, costly and posing a number of environmental and safety risks (International Association of Oil and Gas Producers (OGP) 2003). Decommissioning of a

[12] Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone, 1989 (Resolution A.672 (16))

floating structure, by their nature, would be relatively easy in comparison as the majority of the infrastructure can simply be disconnected and floated away.

For offshore pipelines, the most common international practice is to abandon the pipeline in place. Prior to abandonment, pipelines are purged until the hydrocarbon levels are undetectable. In some cases, after the pipeline is purged, the pipe may be recovered as scrap. In general, the environmental impacts of abandoning a pipeline in place are minimal, as compared with those of removing it such as emissions and sea floor disturbance and disturbance to benthic communities that overlie the subsea pipeline. (Scandpower Risk Management Inc., 2004).

Before any demolition work starts, it is important to carry out a thorough review of the whole decommissioning process. The operator, preferably with the help of personnel with local knowledge of the specific installation, should identify waste types, hazardous substances and other environmental problems that may arise on the platform. It is useful if experts from the decommissioning facility on land can be present during this process. Any hazardous waste that is accessible offshore must be labelled and safely packaged for transport to shore. Pipelines and other equipment on the platform must be inspected to ensure that no gas or oil is left in the system before pipelines are plugged.

Various marine organisms start to grow on platform legs and other subsea structures after they have been in the sea for only a few months, and the quantity of fouling is much larger after 30–40 years in the sea. Mussels, barnacles, benthic algae and sea cucumbers quickly colonize installations, followed by soft corals and after some years colony-forming stony corals. The species that colonize a particular installation will depend on a number of factors such as recruitment potential, currents, water depth, distance from land and latitude. The option of converting platforms to artificial reefs to be placed in areas where stakeholders can benefit from the introduced fish habitat could also be considered.

Marine fouling should be removed from the installation while it is still offshore if this is technically possible. The open sea usually functions as a satisfactory recipient where the material decomposes naturally. In more enclosed, shallow waters, however, this may result in an excessive load of organic material and oxygen depletion on the seabed. Disposal of the material on land and composting is a possibility, but often results in odor problems[13].

During demolition work onshore, it is important to safeguard worker health and to avoid or minimize radioactive releases to water, air and soil. Employees must use suitable protective clothing during this work. To protect the external environment, it is particularly important to avoid the spread of particles. Particles may be deposited on vegetation or in water, and thus enter various stages of the food chain, where they may raise the level of radioactivity in meat and fish used for human consumption.

Naturally occurring radioactive substances in scale, sludge and other deposits on oil and gas platforms may be found in many different parts of the processing equipment, including valves, wellheads, risers, separators, hydro-cyclones and piping. They may also be present in

[13] Decommissioning of Offshore Installations, Climate and Pollution Agency, Oslo, 2011.

subsea systems and pipelines from such systems to the processing installation they are linked to. The same applies to wellhead platforms.

Decommissioning of offshore installations can cause problems both for the fisheries and for aquaculture industry, including fish farming, but of rather different kinds. For the fisheries, any problems are largely related to the offshore phase of decommissioning, and include restrictions on access to areas.

Risks to the reputation of fish products on different markets could be a problem both for the fisheries and the aquaculture. Reputation is a sensitive factor, and easily influenced in a negative direction. Pollution incidents could have a major impact, especially at local level. Experience shows that it takes a long time to restore a good reputation. There are no special arrangements for compensating for this type of loss other than the normal compensation rules. This issue should therefore be taken into special consideration if permits are to be issued for areas where fisheries and aquaculture are important, and monitoring of chemicals concentrations in edible fish shall be conducted.

Regarding transport to onshore facilities, transport operations are of short duration and will take place along designated routes. Any negative impacts on the fisheries are therefore expected to be very limited. There may be conflicts with fisheries interests if an installation has to be kept at anchor en route for some time before decommissioning operations can continue. The extent of the problems will depend on the size of the restricted area, how long restrictions last for, and the geographical position.

If explosive charges are used for platform removal, then there is the potential for impacts to fishes, marine mammals, and sea turtles. It is assumed that if explosives are used, the decommissioning plan would include monitoring for the presence of marine mammals prior to any underwater detonations. This monitoring is standard industry procedure and would avoid potential impacts of explosives on marine mammals and turtles (Klima et al., 1988; Gitschlag et al., 2000).

Proposed Mitigation Measures

- A preliminary decommissioning plan for offshore facilities should be developed that considers well abandonment, removal of oil from flowlines, facility removal, and sub-sea pipeline decommissioning along with disposal options for all equipment and materials. This plan can be further developed during field operations and fully defined in advance of the end of field life. The plan should include details on the provisions for the implementation of decommissioning activities and arrangements for post decommissioning monitoring and aftercare.
- Licensees should be required to follow international best practice for safe structure removal including monitoring for marine mammals and turtles if explosives are to be used.
- Marine fouling should preferably be removed while the installation is still offshore. Oil, scale, structural water and ballast water should if possible be removed while the installation is still offshore Hazardous waste must be suitably packaged, pipelines must

be plugged, and good routines must be in place for labelling, packaging and sorting waste.

- Decommissioning facilities (on shore) must be designed to allow safe handling of different types of waste, including hazardous waste such as heavy metals and NORM wastes, with no risk of runoff or infiltration into the soil. In addition, a decommissioning facility should have an effective collection system and an on-site treatment plant for contaminated water, including surface water. Each facility must have a sampling and analysis program to monitor releases of the most relevant pollutants. The need for an environmental monitoring program to follow developments in the recipient should also be considered. Other factors that must be closely monitored at decommissioning facilities include noise and releases to air in connection with metal cutting and other operations. Moreover, decommissioning contracts must ensure that the costs of handling hazardous waste are met by the offshore operators.

8.7 Cumulative Impacts

Cumulative impacts occur as a result of a number of activities, discharges and emissions combining or overlapping, potentially creating a significant impact. Potential cumulative impacts could arise as a result of impacts resulting from O&G activities interacting or combining with those from other activities taking place in Lebanon. Significance of all below stated cumulative impacts depends greatly on different E&P scenarios and are most relevant in case of the scenario 3. Most important possible cumulative impacts include:

- Cumulative noise of seismic and drilling activities with other users of the sea:

  Other users the sea may include merchant shipping, fishing and marine scientific research. With a 500 m exclusion zone in place around each drilling rig, the interaction of underwater drilling noise with those noises generated by other users of the sea is unlikely to cause a significant cumulative effect, due to the transitory and temporary nature of the various other activities. In addition, any other vessel in the vicinity, with the exception of those vessels servicing the rig itself, will be passing, and any cumulative effect will be of short duration. Existing and proposed mitigation measures presented in the SEA shall be followed.

- Air Quality

  Other sources of atmospheric emissions include power generation vessels, merchant shipping and fishing vessels. Air pollutant emissions from all offshore sources are expected to have low cumulative local impacts on air quality due to the dispersive nature of the offshore environment. Existing and proposed mitigation measures presented in the SEA shall be followed.

- Seawater Quality

  Sources of discharges to sea include routine discharges of fishing and shipping vessels shall be compliant with MARPOL regulations. Mitigation measures presented in the SEA Report shall be followed. In addition, monitoring of water quality and sea bed sediments quality shall be conducted to make sure that set policies are being followed.

- Marine transportation

  Additional marine transportation caused during different phases of E&P activities will increase vessel activity in offshore Lebanon which mainly includes merchant shipping, fishing and marine scientific research. All vessels shall use appropriate signals in accordance with International Maritime Law (including communications via radio, lights, and flags) to warn other vessels of the exclusion zone; and oil and gas industry operators are required to check in advance with MoPWT that the proposed marine activities will not be carried out in an area and at a time that would conflict with legitimate shipping and fishing operations, and the required licenses from the relevant authorities shall be obtained.

  Surface positioning of vessels should be based on augmented global navigation satellite systems (GNSS), e.g. Differentially Corrected GPS (DGPS) or Clock and Orbit Corrected GPS (also referred to as SDGPS or Precise Point Positioning) that typically yield sub-meter positioning accuracy. It is recommended that two fully independent surface positioning systems should be used and would be operated in line with the Guidelines for GNSS (Global Navigation Satellite System) Positioning in the Oil and Gas Industry, issued jointly by IOGP (International Oil & Gas Producers) and IMCA (International Marine Contractors Association). It describes good practice for the use of global satellite navigation systems (GNSS) in, among other, offshore survey and related activities for the oil and gas industry.

  Additionally, a system for mandatory response of vessels and Vessel Traffic services (VTS) shall be provided for the supervision and management of marine transportation.

- Improved living conditions

  It is expected that development of the petroleum sector in case of scenarios 2 and 3 will spur overall economic development of Lebanon, enable new employment opportunities, reduce poverty, ensure stable domestic power supply, reduce the cost of energy, eliminate air pollution linked to power generators (especially in densely populated areas), support local development and subsequently improve living conditions in Lebanon.

8.8 POTENTIAL TRANSBOUNDARY IMPACTS

Decree No. 639/2014, related to the Accession to the Barcelona Convention Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM), stipulates in Article 29 that: within the framework of this Protocol, the Parties shall, before authorizing or approving plans, programs and projects that are likely to have a significant adverse effect on the coastal zones of other Parties, cooperate by means of notification, exchange of information and consultation in assessing the environmental impacts of such plans, programs and projects. Additionally, Article 45 of Decree No. 10289/2013 stipulates that: the Minister of Energy and Water shall, upon approval of the proposed Petroleum Activities, inform the appropriate representative in jurisdictions which may be affected of the decision, and give account of what measures have been taken to address the significant environmental effects beyond the Lebanese jurisdiction.

Countries that might be significantly affected from E&P activities offshore Lebanon are mainly Syria and Cyprus. Thus, the SEA recommends informing and consulting these countries through official channels to validate mitigation measures and discuss regional cooperation opportunities.

In general, the following activities have the potential to cause transboundary impacts:

- Noise from seismic activities will be limited in scale and of short duration; however, noise may have impacts on marine mammals in the neighboring country within a range of a several hundred meters of a typical airgun array, particularly if they swim beneath the array. Details on impacts from noise from reconnaissance activities and mitigation measures are presented in the SEA Report.
- Noise from drilling activities could affect marine fauna in neighboring countries.
- Accidental oil/chemical spills are the main concern of transboundary impacts. Any oil/chemical spill likely to have impacts in waters of a neighboring country shall be communicated, through appropriate channels, to the relevant authorities.
- The possibility of transboundary impacts from a gas blowout would be reservoir specific. Atmospheric emissions could potentially have transboundary effects, although they would be dependent on the type and volume of gas released into the atmosphere in addition to the accident location.
- Oil and condensate spills could also affect neighboring countries.
- Disposal of discharges from drilling activities.

Existing and proposed mitigation measures provided in the SEA Report related to the above-mentioned impacts shall be implemented to mitigate such impacts at the national and transboundary level.

Environmental Regional Cooperation (with countries in good relations with Lebanon, and through appropriate channels) is required to reduce the likelihood and mitigate the consequences of any possible transboundary impact. Potential Areas for Environmental Regional Cooperation include:

- Cooperation in the area of emergency response and the preparation of joint contingency plan with competent institutions in the adjoining countries.
- Environmental Policies of Joint Interest (discharge of muds and cuttings, produced water, protection of cetaceans and marine habitats);
- Communications with neighboring countries before commencing seismic surveys to avoid cumulative impacts from simultaneous operations;
- Environmental training and sharing of know-how and expertise.

8.9 OIL SPILL MODELLING AND THE NATIONAL OIL SPILL CONTINGENCY PLAN

It is worth mentioning in the SEA study that, in line with Article 29 of Environmental Protection Law 444/2002, on the protection of the marine coast and environment from pollution, Lebanon has developed the draft NOSCP which defines the response to maritime oil spills in the Maritime Public Domain of the Republic of Lebanon including the Territorial Sea and the Exclusive Economic Zone (EEZ) as well as from the shoreline. In addition, it suggests the response to oil spills entering the Lebanese EEZ from external sources.

The objectives of the National Oil Spill Contingency Plan, is to match and amplify the International Maritime Organization (IMO) objectives for a NOSCP, and as such, it:

- Establishes a viable operational organization with representation from all concerned agencies.
- Identifies the national high-risk areas.
- Identifies priority coastal areas for protection and clean up.
- Provides a minimum level and appropriate types of pre-positioned pollution response equipment in accordance with article 6(2) of the OPRC Convention.
- Prevents the spread of further pollution from identified oil spills.
- Controls the spill source and clean-up existing pollution.
- Employs Net Environmental Benefit Analysis (NEBA) to ensure that the chosen recovery strategies do not cause further damage to the environment.

8.9.1 Oil Spill Modelling

Oil spill modelling was conducted and used to forecast the fate and impact of an oil spill based on the properties of the oil and local prevailing conditions and prepare an adequate response plan relevant to each potential scenario. The models assess the probability of occurrence, the areas of impact and the response strategy for the different possible accidental events threatening the marine life.

Scenarios relevant to E&P Activities and their environmental impacts are detailed in the section below.

1. Scenario 1 assumes a possible Well Blowout of Condensate that might occur in the Northern Area. Results of the model indicate low potential shoreline oiling impacts to the North of Saida and the rest of Lebanon. On the contrast, a higher probability of oiling is expected to reach the Southern Area of Tartus in Syria within the first 48 to 120 hours. With that being said, and with strong wind currents running from South to North, there is an extremely elevated chance that oil will cross Syrian waters and contaminate an estimated area of 854 km^2. The scenario reveals minor threats over around 8 Coastal Protected Areas including the Marine Natural Reserve of Palm Island, Byblos and Enfeh Peninsula and a significant number of High Priority Sites (Salinas, Ras Enfeh, Medfoun Rocky Area, Nahr el Kaleb…).

2. Scenario 2 studies the case of a Well blowout of crude oil in the Center or the middle of the Lebanese Coast. It is accompanied, as the model indicates, by a significant shoreline impact along the Lebanese Coastline and a trespass to the northern Syrian borders mostly from Saida to Latakia in Syria in less than 33 hours. The total oiling area is estimated at around 5,044 km^2 and the spill may also impact Cyprus from the West. Similar to Scenario 1, there is a high probability that certain Protected Areas and High Priority Ecological and Cultural Sites such as Salinas, Ras Enfeh, Byblos and many other are highly impacted by the spill scenario.
3. Scenario 3 highlights on the implications of a possible Well blowout of condensate in the South. Run with condensate, the model reflects a possible shoreline impact on the majority of the Lebanese Coastline until Tartus in Syria, North of Lebanon. The most probable impact was revealed to affect the coastline from Beirut to the South of Saida. Regardless, even the latter might not be extremely significant with a maximum oiling area of 509 km^{2}as, with the winds pushing the oil from South the North, the oil is very unlikely to cross International Boundaries to the South. Thus, the probability of reaching Natural Reserves and Protected Areas is very limited and High Priority Sites are also barely affected.
4. An oil spill offshore and outside of the Lebanese Waters is assessed in Scenario number 5. The model shows two possible areas of shoreline oiling, the first extending 50 Km to the north of Beirut and the second stretching around 20 Km to the north of the southern border. Regardless, with the oil assumed light, the probabilities of impact are so low that could be considered as negligible. The spill will unlikely affect the shoreline and the High Priority zones.

In general, all scenarios reflected the impact of Oil Spills on many environmental and social factors and more specifically on:

- Birds along the coastline
- Fisheries
- Coastal Historical Sites and Key Touristic Sites
- Ports and Harbors
- High Priority Sites and Protected Areas

8.9.2 Prevention Methods

Effective prevention measures would essentially include continuous monitoring of all occurring petroleum activities, ensuring regular maintenance and inspections to guarantee safe operation of equipment, developing personnel capabilities by imposing regular personnel training and improving standard operating procedures adopted specifically to each operation phase of production, transportation, storage and marketing.

The OPRL and PAR provides HSE requirements for prevention of spills.

8.9.3 Preparedness

NOSCP follows a structured approach known as tiered response system to establish oil spill preparedness and response. Response Capabilities are directly related to available response personnel, response equipment and support requirements. Depending on the severity of the situation and the availability of the needed resources, tiers can be classified, based on the resources required to respond to the incident and not the scale of the incident, as follows:

1. Tier 1: Possible Containment of the spill using on-site available resources.

   Under this Tier, local operators and facilities will respond to spills taking place at the facility. The response is managed locally, and the impact is very limited. Available Facility plans and appropriate equipment and resources should be capable of covering small spills in specific areas.

2. Tier 2: Additional Resources required for spill containment. The response capability should be increased by introducing more technical/regional resources for the spill mitigation. Similar to Tier 1, the spill is managed locally but requires additional regional support. Facility Plans should be capable of accessing additional resources

3. Tier 3: Major National/International intervention and efforts needed.

   Tier 3 necessitates national and international resources intervention that would lead to mobilization and deployment of national response resources, and access to the necessary funding. Available/Local resources may not be enough to respond to the large-scale spill.

Accordingly, oil ports, facilities and offshore installations should establish their own emergency response plans including oil spill contingency plans. A Shoreline Response Plan should also be developed in order to consider the possible impact of spills on the shoreline and to plan necessary mitigating actions.

All levels of response personnel should undergo Oil Spill Training, which is supplemented by response exercises designed to elaborate on roles and responsibilities.

8.9.4 Response

Establishing the needed response plan for the scenario is crucial to the success of the oil spill containment. The first steps of an oil spill response include the following:

1. Notification and Activation
2. Initial Response
3. Spill Tier Allocation and implementation

8.9.5 National Response Strategy

The priorities of all response plans include the safety of the public, the control of the pollution source, the containment of the caused pollution and the mitigation of the related effects.

In general, however, and depending on the conditions of the spills, a response strategy for each of the spill scenarios has been developed.

1. Oil Spill from Onshore Storage Facilities

   The response strategy includes source control along with continuous monitoring and emphasizes on containing the oil and recovering it from the sea. Dispersant are most likely inefficient if the oil is heavy and dangerous to the marine life in the case of shallow waters.

2. Oil Spill from Offshore Facilities and Installations

   After controlling the source, the efficiency of the dispersant used should be monitored and assessed. To contain and recover the oil, in-situ burning shall be the last resort given its environmental side effects cannot be overlooked. The shoreline should be protected and cleaned-up if oil was beached

The response strategy is typically selected based on the oil type, sea state, size of the oil spill, proximity of the shoreline, water depth and environmental sensitivity. The strategy also requires an efficient collaboration between two or more of the below mentioned entities:

- Joint Maritime Operations Chamber (JMOC)
- Ministry of Public Works and Transport
- Lebanese Petroleum Administration
- Ministry of Environment
- Lebanese Armed Forces
- Ministry of Interior and Municipalities
- Ministry of Energy and Water (with DG Oil and Lebanese Oil Terminals)
- Ministry of Agriculture
- Higher Relief Council
- Ministry of Finance
- Ministry of Information
- Ministry of Public Health
- Ministry of Culture – Directorate General of Antiquities
- Ministry of Labor
- Ministry of Justice
- National Center for Scientific Research
- Civil Defense
- Coast Guard
- Lebanese Red Cross
- Ministry of Foreign Affairs
- Ministry of Telecommunications
- Ministry of Industry

Response teams of operators and the government should include fisheries scientists and marine wildlife experts to ensure that the necessary data collection methods are used to document the effects of spills and to supervise wildlife rescue and early rehabilitation activities.

8.9.6 Implementation of NOSCP as an effective mitigation measure

The NOSCP recommends and describes the elements of an Incident Command Structure (ICS) and assign the managerial roles, responsibilities and functions of each entity in the response plan. It is, however, a necessity to enact this plan in a decree to ensure its operationalization as well as to develop Standard Operating Procedures (SOPs) to ensure a successful implementation of the NOSCP and to give guidelines for relevant ministries.

The scope and the purpose of the SOPs should be established and continuously updated after being submitted to a periodic review. The SOP developed should be assumed valid and effective.

From a legal perspective, the developed NOSCP is in relation to Lebanon's general obligations and commitment to many International Conventions such as IMO International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), the Convention for the Protection of the Mediterranean Sea against pollution and the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources, the United Nations Convention on the law of the Sea and the International Convention for the Prevention of pollution from Ships. All the latter require countries to take measures to prevent and combat pollution of the Sea and implement contingency plans against pollution.

On a national level, the NOSCP is prepared in implementation of legislations such as the Environmental Protection Law No. 444/2002 and the Petroleum Activities Regulations in Decree No. 10289/2014 enforcing the protection of marine environment from pollution and shoreline protection activities and the preparation and regular update of the Emergency Response Plan.

9. ANALYSIS OF ALTERNATIVES

Alternatives can be defined as different means or methods to achieve a pre-defined objective. Best practice in the preparation of a strategic environmental assessment study requires that a reasonable range of alternatives be considered and analyzed.

Alternatives are presented, analyzed and compared in this section. Since the selection of some alternatives depends on technical factors that are not defined at this stage of the Plan, advantages and disadvantages of options are provided to facilitate the selection at later stages when the data needed for the selection of options is available.

The Analysis of Alternatives has considered the following:

- Drilling technologies
- Waste management alternatives
- Gas export options
- On-shore bias vs. Offshore bias
- Year-round activities vs. Restricted windows for activities
- Recommended blocks to be opened in future licensing rounds

9.1 DRILLING TECHNOLOGIES

Considering deep water conditions, the below detailed offshore drilling rigs can be contracted for drilling in Lebanese Waters. Out of the proposed options, the rig type to be chosen however, is highly dependent on several factors mainly the exact water depth and the depth of the targeted zone, cost and availability and weather conditions in the location. Other possible drilling technologies and offshore platforms such as Fixed Platforms, Jack-up Units and Gravity Structures were not taken into consideration as they are not applicable given the existing conditions.

9.1.1 Tension Leg Platforms

Tension Leg Platforms are floating offshore platforms suitable for offshore Drilling and Production in water depth ranging between 300 and 1500 meters. Pontoon-like pillars filled with air are placed just below the platform that is vertically held stable by a mooring system composed from a set of tension legs attached to the seafloor. The foundation, which is the link between the Platform and the seafloor, is typically laid on the seafloor and stabilized by concrete piles driven into the seafloor. It is usually built onshore and then towed to the defined location making the installation process a little difficult. Although this type of platforms present improved motion characteristics compared to Semisubmersibles, its vertical mooring system does not provide active control of horizontal position which is often considered as a main limitation.

Advantages:

- Improved motion characteristics and vertical control.
- Suitable in hostile environments and areas prone to regular volatility of the oceanic conditions.
- High efficiency levels in deep high seas operational areas.

Disadvantages:

- Installation of the platform itself can be a risky operation.
- The structure is weight sensitive and can be affected by the load on the platform.
- Direct impact to the near surrounding areas.

9.1.2 SPAR- Single Point Anchor Reservoir

Single Point Anchor Reservoir is a floating caisson with multiple mooring lines or anchors lines that connect the platform to the sea floor. It typically consists of a long vertical cylindrical hull made from steel or concrete surrounded by a shroud and supporting a fixed rig platform that is held above the water level. The structure can fully engage in drilling and production operations in water depth up to 3,000 meters. It derives its stability from its mooring system and from the fact that its center of buoyancy is always above its center of gravity. SPAR is moored to the seabed and the deck can accommodate a full drilling rig and other needed equipment for different petroleum operations such as production, processing and storage.

Advantages:

- Operates in deep waters up to 3,000 meters.
- Stability is guaranteed since the structure's center of buoyancy is above the center of gravity.
- The hull provides favorable controlled motions in comparison with other floating structures.
- The installation process is reversible making the relocation of the platform economically feasible.

Disadvantages:

- Might show sensibility and weakening after long period of waves affecting the structure's buoyancy and stability.
- High construction, transportation and installation costs due to the large structure size.

9.1.3 Semi-Submersible

A Semi-Submersible Platform is a bottom-supported drilling unit that depends on wave action and pontoons for its buoyancy. The platform containing the drilling equipment and other needed installations is connected to the pontoons by structural steel columns keeping the deck above the sea level. Right before drilling, the pontoons are partially filled with water and submerged to a predetermined depth to ensure stability. The rig by itself would be partially submerged but still floats above the drill site.

Position is maintained by a combination of a dynamic positioning system and several anchors weighing around ten tons each. As these units typically float on water, transportation of such vessels is not a difficult operation. Regardless, they still require to be barged as most of them are not equipped with a self-propelling system.

Advantages:

- Limited damage to the seabed.
- Operates drilling at water depth up to around 3,000 meters.
- Can withstand severe conditions and rough water environments.
- Can be positioned by anchors and a dynamic positioning system providing high stability.

Disadvantages:

- Lack of deck load capacity & high sensitivity to load change.
- High operation costs compared to other platforms.
- Possible risk of gas blowout.
- Needs to be towed from a location to another which can be time consuming.

9.1.4 Drill Ships

Drill Ships are marine vessels specially designed for offshore drilling operations in deep and ultra-deep waters. They typically integrate on the middle of its deck, a drilling platform and derrick in addition to the other needed equipment. Characterized by their ease of mobility, drill ships are equipped with electric motors integrated into the ships' computer systems allowing them to propel themselves from location to another without relying on an outside vessel.

When drilling in shallow waters, drill ships are moored to the seafloor to ensure stability. In greater water depth, the ships will switch to a dynamic-positioning system which depends on thrusters that automatically adjust and compensate for wind and waves' changes to keep the ship stable.

Advantages:

- Operates in Ultra-Deep Waters with a depth up to 3,800 meters.
- Easily mobile as most Drill ships are self-propelling.
- Adopts two Positioning systems ensuring its stability.

Disadvantages:

- Might be affected by waves, wind and currents during drilling.
- High operation & maintenance costs.
- High underwater noise levels which can affect the marine fauna.
- Requires more personnel to operate and maintain equipment than other platforms.

From an environmental stand, anchored and moored rigs have insignificant impact on the sea bed but produce very high underwater noise levels that can negatively influence marine fauna. Although some of these impacts cannot be fully avoided, they can be reduced to acceptable levels by mitigation actions. The selection of the rig type will then also be related to the environmental conditions of the site which include the type of marine animals/species present, the expected operation time and the impact of concern which can be different for each block.

The general environmental impact of the above-mentioned rig types are summarized in Table 9-1.

Table 9-1 Description of Environmental Impacts of Different Rig Types

Rig Type	Water Depth	Weather Conditions	Environmental Impact
Tension Leg Platform	Moderate depth up to 1,500 meters	Moderate to Hard	-Significant impact on the seabed due to the concrete piles driven into the seafloor - Less Emissions than Dynamically Positioned Platforms
SPAR Platform	Deep up to 3,000 meters	Moderate	-Impact a small area of the seabed due to anchors/wire ropes disturbing the seafloor -Less Emissions than Dynamically Positioned Platforms
Semi-Submersible	Deep up to 3,000 meters	Moderate to Hard	-Limited impact on the seabed -High Underwater Noise Levels
Drill Ships	Deep to ultra-Deep up to 3,800 meters	Moderate	-Limited impact on the seabed -High Underwater Noise Levels -High Fuel Consumption leading to a significant amount of emissions

In the assessment of environmental impacts from different rig types, rig types were combined into two main groups based on the similar environmental effects. The assessment results based on the impact assessment methodology adopted in the SEA report are provided in Table 9-2.

Table 9-2 Assessment of Potential Impacts from Drilling Rig Alternatives

Component / Activity	Scenario	Air Quality	Climate change	Sedimentation on sea bed	Phyto & zoo benthos	Sensitive marine habitats
Mobilization and positioning in place of Drilling ship **Tension Leg Platforms / SPAR**	S1	1A	4A	3A	2L	2A
	S2	1A	4A	3A	3L	3A
	S3	1A	4A	3A	3L	3A
Mobilization and positioning in place of Drilling ship **Drill Ships/ Semi-Submersible Platforms**	S1	1A	4A	2A	3L	1A
	S2	1A	4A	2A	3L	2A
	S3	1A	4A	2A	3L	2A

Despite the difference in expected quantities in air emissions for the two drill rigs groups, the overall impact assessment results on air quality and climate change were similar, however the impacts on sedimentation on sea bed and on sensitive marine habitats were more significant from Tension Leg Platforms and Single Point Anchor Reservoir (SPAR).

The preferred alternative from an environmental point of view is the use of either Drill Ships or Semi-Submersible Platforms.

9.2 WASTE MANAGEMENT ALTERNATIVES

Key Waste Streams of concern that could potentially be generated during the exploration, production and decommissioning phases that are considered in the assessment include:

1. Water-based drilling fluids and cuttings
2. Oil/ Synthetic based drilling fluids and cuttings
3. Produced water
4. NORM wastes
5. Cementing Waste

The assessment and quantification of waste amounts provided in this section relies on the study "Strategic Options Paper concerning Waste Management in Oil and Gas Offshore Activities during E&P" dated 7 August 2018 conducted by GFA/ELARD as part of the PROMARE Project.

For quantification purposes, the following main assumptions were made:

- Up to two exploration wells could be drilled in a single year; contractual drilling depths of 4,400 meters from the sea bottom are used for calculations purposes
- Production rates of hydrocarbons were assumed to range from a lower estimate of 0.2 tcf/year for gas (with no oil production) and a higher estimate of 1.1 tcf/year of gas and up to 13 million barrels of oil per year

Table 9-3 summarizes the quantities of drilling wastes that could be generated per well and per year (assuming two wells per year between 2019 and 2024). It also provides an estimate of interim storage requirements for 1-year and 5-year storage prior to treatment or final disposal. It is to be noted that in the development of a discovery, drilling of wells (both for production and injection wells) could occur at a higher rate per year.

Table 9-3 Estimates of Exploratory Drilling Wastes Generation and Storage Requirements

Waste Type (Exploration)	Total Waste per Well [m³]	Waste Volume per Well [m³]	Annual Volume of Waste [m³]	Storage Area for 1 year [m²]	Storage Area for 5 years [m²]
Wet Drill Cuttings from WBF	7,642.60	432.60	865.20	1,300	6,500
Dirty WBF (that can no longer be reused for the drilling activity)		7,210.00	14,420.00	21,630	108,150
Wet Drill Cuttings from OBF	2,671.50	1,153.60	2,307.20	3,460	17,300
Dirty OBF (that can no longer be reused for the drilling activity)		1,517.90	3,035.80	4,555	22,775
Wet Drill Cuttings from SBF [2]	5157.05	793.10	1,586.20	2,379	11,897
Dirty SBM (that can no longer be reused for the drilling activity)		4,363.95	8,727.90	13,092	65,460

Generation of produced water is estimated to range between 415 m³/day (151,416 m³/year) and 2,074 m³/day (757,082 m³/year) for the lower production scenario and could reach up to 100,000 m³/day (36,500,000 m³/year) for a higher production scenario. To put things into perspective, total produced water discharges into the Norwegian Continental Shelf (NCS) amounted to 130 million cubic meters in 2012 from 65 oil and gas producing fields at 226 million standard cubic meters of oil equivalent (39% being oil). The highest average daily discharge from single field was 76,700 m^3 in the NCS.

9.2.1 *Waste Characterization*

9.2.1.1 *Water Based Drilling Fluids*

While Water Based Drilling Fluids have an aqueous liquid phase component, rendering them less harmful if disposed in the aquatic environment when compared to oil-based or synthetic-based drilling fluids, they do contain a wide range of chemicals and additives that are used to provide desired characteristics to the drilling fluids. These include weighing materials, viscosifiers, dispersants, filtrate reducers, cutting tool lubricants, emulsifiers, corrosion inhibitors, and scale inhibitors, to list a few types. Therefore while water-based muds (WBMs) have a reputation of being environmentally friendly, such statement normally requires confirmation via toxicity tests and the like if such fluids are to be disposed in the marine environment after use.

Based on preliminary calculations, around 7,210 m^3 of residual water based drilling fluids could be generated per well. During exploration phase, and assuming 2 exploration wells per year are drilled, this would amount to 14,420 m^3 per year of water based drilling fluids to be disposed of. If a commercial discovery is made leading to field development activities, development drilling could include for a single field, for indicative purposes, 10 to 15 wells (could be more or less, depending on design of the wells, intended production rate, and whether injection wells are included as part of the development plan). However typically such fluids are reused from well to well to the extent possible; nevertheless it is expected that the generated volumes of drilling fluids would be higher.

9.2.1.2 *Water Based Drill Cuttings*

Water Based Drill Cuttings are the solids that remain after separation of the drilling fluids. The composition of drilling cuttings would be a function of both the constituents of drilling fluids and the geological formations through which the well has been drilled. Environmental concerns associated with the discharge of water-based drilling cuttings are related to the toxicity level of its constituents, possibility of NORM in the cuttings, as well as possible impacts related to increased turbidity in the water column, long-range dispersion of fine particles in the sea that could affect the pelagic community, and deposition of cuttings on the sea bed, which could affect biota.

Based on preliminary calculations, around 420 m^3 of water-based drill cuttings could be generated per well. During exploration phase, and assuming 2 exploration wells per year are drilled, this would amount to 840 m^3 per year of water based drilling cuttings to be disposed of. If a commercial discovery is made leading to field development activities, development drilling could include for a single field, for indicative purposes, 10 to 15 wells (could be more or less, depending on design of the wells, intended production rate, and whether injection wells are included as part of the development plan) and therefore between 8,400 m³ and 13,000 m³ of cuttings could be generated during the drilling campaign.

9.2.1.3 *Oil Based and Synthetic Based Drilling Fluids*

Oil-based and synthetic based drilling fluids have a non-aqueous liquid phase component, rendering them potential more harmful than water-based drilling fluids if disposed in the aquatic environment. Strict restrictions (including prohibition of discharge) related to the discharge of such fluids in the sea are generally applied by most regulators. It shall be noted that differentiation between OBM and SBM is not made in the SEA, although it is generally considered that SBM is less harmful to the environment than OBM.

Based on preliminary calculations, around 1,500 m³ of spent oil-based drilling fluids could be generated per well and 4,400 m³ of spent synthetic-based drilling fluids (in between the volume expected to be generated for water-based and oil-based drilling fluids). During exploration phase, and assuming 2 exploration wells per year are drilled, twice these amounts could be generated per year. If a commercial discovery is made leading to field development activities, development drilling could include for a single field, for indicative purposes, 10 to 15 wells (could be more or less, depending on design of the wells, intended production rate, and whether injection wells are included as part of the development plan). However typically such fluids are reused from well to well to the extent possible; nevertheless it is expected that the generated volumes of drilling fluids would be higher.

9.2.1.4 *Oil-Based and Synthetic-Based Drill Cuttings*

Oil-based and synthetic-based drill cuttings are the solids that remain after separation of the drilling fluids. The composition of drilling cuttings would be a function of both the constituents of drilling fluids and the geological formations through which the well has been drilled. Environmental concerns associated with the discharge of oil-based and synthetic-based drill cuttings are related to the toxicity level of its constituents, particularly given the non-aqueous type of its liquid phase, possibility of NORM in the cuttings, as well as possible impacts related to increased turbidity in the water column, long-range dispersion of fine particles in the sea that could affect the pelagic community, and deposition of cuttings on the sea bed, which could affect biota.

Based on preliminary calculations, around 1,155m³ of oil-based drill cuttings and 795 m³ of synthetic-based drill cuttings could be generated per well depending on the drilling fluid used. During exploration phase, and assuming 2 exploration wells per year are drilled, twice these volumes would be generated per year. If a commercial discovery is made leading to field development activities, development drilling could include for a single field, for indicative purposes, 10 to 15 wells (could be more or less, depending on design of the wells, intended production rate, and whether injection wells are included as part of the development plan).

9.2.1.5 *Produced Water and Hypersaline Produced Water*

Oil and gas reservoirs contain "formation water" which occurs naturally within the pores of the formation and commonly appears at the surface during production as a mixture of oil, gas and water. The remaining water from the separation process is called "produced water". The amount of natural formation water in gas reservoirs is commonly lower than in oil fields. However, the volume of produced water is commonly the largest waste stream generated by oil and gas fields during production.

Main concerns associated with handling of produced water are salinity, oil content and NORM from the formation (whereas the NORM is attached mainly to the suspended solid matter). In some locations the salinity of the produced water could be considerably higher and under certain conditions Produced Water could be hypersaline.

Based on preliminary calculations, it is estimated that between 8,450 m^3/day and 98,600 m^3/day of produced water could be generated depending on production rates of gas and oil and formation characteristics.

9.2.1.6 *NORM Waste*

Naturally Occurring Radioactive Material (NORM) as a waste is commonly generated during production, but under certain circumstances also during exploration and commonly accumulates into plant equipment and components of the oil and gas industry. These NORM hazardous wastes (also addressed as a dangerous good - UN-class 7) shall be managed in such a way that they do not affect Human Health and the Environment. The primary radioisotopes of concern in the oil and gas industry are related to the Uranium-Radium decay series (^{238}U) and the Thorium (^{232}Th) decay series but also to Potassium-40 (^{40}K) and to the Uranium-Actinium Series (^{235}U). Particularly their daughter nuclides (progeny) are present in subsurface formations from which hydrocarbons are produced and may become mobilized in the fluid phases of the formation. The main types of NORM wastes commonly generated are:

- Scales, films and deposits in exploration and production equipment
- Hydrocarbon-sludge and sediments from cleaning and pigging activities of oil installations
- "Black Dust" from transition gas pipeline cleaning activities containing mercury and lead-210 (^{210}Pb)
- Produced water could also exhibit relatively high levels of NORM

There is a large variety of different solid NORM and sludge that could be generated, which typically requires individually different treatment methods, posing a challenge to operators and governments on how to best address this waste management issue.

9.2.1.7 *Waste Characterization*

Cementing wastes are generated from cementing activities and usually include wash water, mixing water, additional fluids and cement paste. Residual quantities after cementing activities are completed require disposal.

Based on preliminary calculations conducted, it is estimated that about 10 m^3 of solid wastes and 100 m^3 of aqueous wastes would be generated per well. During exploration phase, and assuming 2 exploration wells per year are drilled, then about 20 m^3 of solid wastes and 200 m^3 of aqueous wastes would be generated per year. If a commercial discovery is made leading to field development activities, development drilling could include for a single field, for indicative purposes, 10 to 15 wells (could be more or less, depending on design of the wells, intended production rate, and whether injection wells are included as part of the development plan).

9.2.2 *Impacts assessment*

The assessment of environmental impacts from the different alternatives for the management of drilling fluids and cuttings and cementing waste in the exploration phase and for the management of drilling fluids and cuttings, produced water, NORM wastes and cementing waste in the production phase are presented in Table 9-4 and Table 9-5 respectively. It shall be noted that impacts from waste disposal alternatives consider operational impacts (i.e. excluding impacts from construction).

Table 9-4 Assessment of Potential Impacts from Waste Management Alternatives during Exploration Phase

Component / Activity	Scenario	Air Quality	Climate change	Seawater Quality	Sedimentation on sea bed	Sediments Quality	Phyto & zoo benthos	Nekton	Cetaceans, turtles and seals	Sensitive marine habitats
Discharge of drill cuttings & fluids										
• Onshore Disposal	S1	1A	4A						2P	
	S2	1A	4A						3P	
	S3	1A	4A						3P	
• Discharge of water based drill cuttings & fluids to the Sea in the continental shelf/slope	S1			2A	3A	2A	1L	1L	3P	3A
	S2			3A	3A	3A	2L	2L	3P	3A
	S3			3A	4A	4A	3L	2L	3P	3A
• Discharge of water based drill cuttings & fluids to the Sea in the deep sea	S1			2A	2A	2A	1L	1L	3P	2A
	S2			3A	2A	3A	2L	2L	3P	2A
	S3			3A	3A	3A	2L	2L	3P	2A
• Discharge of oil/synthetic-based drill cuttings & fluids to the Sea in the continental shelf/slope	S1			2A	4A	3A	3L	3A	3P	3A
	S2			3A	4A	4A	3L	3A	3P	4A
	S3			3A	5A	5A	4L	3A	3P	4A
• Discharge of oil/synthetic-based drill cuttings & fluids to the Sea in the deep sea	S1			2A	2A	3A	3L	3A	3P	2A
	S2			3A	2A	3A	3L	3A	3P	3A
	S3			3A	3A	3A	3L	3A	3P	3A
• Exporting Waste	S1	1A	4A						2P	

Component / Activity	Scenario	Air Quality	Climate change	Seawater Quality	Sedimentation on sea bed	Sediments Quality	Phyto & zoo benthos	Nekton	Cetaceans, turtles and seals	Sensitive marine habitats
	S2	1A	4A						2P	
	S3	1A	4A						2P	
Cementing Waste										
• Ship-to-shore for treatment/reuse/disposal	S1	1A	4A						2P	
	S2	1A	4A						3P	
	S3	1A	4A						3P	
• Discharge to the Sea in the continental shelf/slope	S1			2A	3A	2A	1L	1L	3P	3A
	S2			3A	3A	3A	2L	2L	3P	3A
	S3			3A	3A	3A	2L	2L	3P	3A
• Discharge to the Sea in the deep sea	S1			2A	2A	2A	1L	1L	3P	2A
	S2			3A	2A	3A	2L	2L	3P	2A
	S3			3A	3A	3A	2L	2L	3P	2A
• Exporting	S1	1A	4A						2P	
	S2	1A	4A						2P	
	S3	1A	4A						2P	
• Re-injection	S2	1A					5L			
	S3	1A					5L			

Table 9-5 Assessment of Potential Impacts from Waste Management Alternatives during Production Phase

Component / Activity	Scenario	Air Quality	Climate change	Seawater quality	Sedimentation on sea bed	Sediments Quality	Phyto & zoo benthos	Nekton	Phyto & zoo plankton	Sea Mammals, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats
Discharge of drill cuttings & fluids												
• Ship to shore and disposal	S2	2A	4A							4A		3A
	S3	2A	4A							4A		3A
• Re-injection	S2						4L					
	S3						4L					
• Discharge of water based drill cuttings & fluids to the Sea in the continental shelf/slope	S2			3A	3A	3A	2L	2L	2L	3A	3A	
	S3			**4A**	**4A**	**4A**	3L	3L	2L	**3A**	**4A**	
• Discharge of water based drill cuttings & fluids to the Sea in the deep sea	S2			2A	3A	3A	2L	2L	2L	3A	3A	
	S3			4A	4A	4A	2L	2L	2L	3A	3A	
• Discharge of oil/synthetic-based drill cuttings & fluids to the Sea in the continental shelf/slope	S2			3A	3A	3A	3A	3A	3A	4A	4A	
	S3			**4A**	**5A**	**5A**	**4A**	**4A**	**4A**	**4A**	**5A**	
• Discharge of oil/synthetic-based drill cuttings & fluids to the Sea in the deep sea	S2			3A	3A	3A	3A	3A	3A	4A	3A	
	S3			4A	4A	4A	4A	4A	4A	4A	4A	
• Export	S2	1A	4A							4A		
	S3	1A	4A							4A		
Produced Water discharge												

Component / Activity	Scenario	Air Quality	Climate change	Seawater quality	Sedimentation on sea bed	Sediments Quality	Phyto & zoo benthos	Nekton	Phyto & zoo plankton	Sea Mammals, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats
• Discharge to the sea	**S2**			**4A**		**4A**		**4A**	**4A**	**5A**		
	S3			**4A**		**4A**		**4A**	**4A**	**5A**		
• Re-injection	**S2**	1A					**5L**					
	S3	1A					**5L**					
Norm Waste Discharge												
• Ship to shore and disposal of NORM waste	**S2**	1A	4A							4A		3A
	S3	1A	4A							4A		3A
• Exporting	**S2**	1A	4A							4A		3A
	S3	1A	4A							4A		3A
• Re-injection	**S2**	1A					5L					
	S3	1A					5L					
Cementing waste												
• Ship-to-shore for treatment/reuse/disposal	**S2**	2A	4A							4A		3A
	S3	2A	4A							4A		3A
• Re-injection	**S2**						4L					
	S3						4L					
• Discharge to the Sea in the continental shelf/slope	**S2**			3A	3A	3A	2L	2L	2L	3A	3A	
	S3			**4A**	**4A**	**4A**	3L	3L	2L	**3A**	**4A**	
• Discharge to the Sea in the deep sea	**S2**			2A	3A	3A	2L	2L	2L	3A	3A	
	S3			4A	4A	4A	2L	2L	2L	3A	3A	
• Exporting	**S2**	1A	4A							4A		
	S3	1A	4A							4A		

9.2.2.1 *Drilling Mud and Cuttings Waste Management Alternatives*

The analyzed options for the disposal of drilling fluids and cuttings are:

1. Export
2. Ship-to-shore for treatment and disposal
3. Injection
4. Discharge to sea (in the continental shelf/slope or in the deep sea)

9.2.2.1.1 Discharge to the Sea

There is increased concern in several jurisdictions about the potential environmental impacts of drilling wastes discharges (both fluids and cuttings, irrespective of the mud type) on the marine environment. While discharge of water based drilling fluids and cuttings is less problematic than oil-based drilling fluids and cuttings (which is now forbidden in many jurisdictions), their discharge is often subject to strict permitting requirements. Main concern is about the toxicity of the fluid constituents on marine organisms, but also about suspended solids that could be attached to the mud and cause physical disturbance to the marine environment.

Based on the impact assessment results presented in the previous two tables, the discharge of water based and oil/synthetic based drilling fluids and cuttings during exploration and development drilling is expected to have significant environmental impacts on all or most of the following environmental components: seawater quality, sedimentation on sea bed, sediments quality, phyto & zoo benthos, nekton, cetaceans, turtles and seals and sensitive marine habitats. The significance of expected impacts is higher from oil/synthetic based drilling fluids and cuttings discharge and from discharge in the continental slope area.

Although this option has the least cost of disposal and has no infrastructure or land requirements, it is the option with the most significant environmental impacts and has the least in-country value, as it is not likely to require any services from Lebanese suppliers and would not lead to employment of Lebanese personnel, it also requires high effort to regulator to ensure compliance of discharge to permit conditions and it is likely to face the high public opposition particularly driven by marine scientific community in Lebanon.

9.2.2.1.2 Reinjection

Reinjection of drilling fluids and cuttings would only be available during development drilling. Such an option is not available during the exploration phase.

Reinjection of water based or oil/synthetic based drilling fluids and cuttings generated during development drilling is likely to have the least significant environmental impacts among other options, these impacts are mainly related to phyto and zoo benthos in the location of reinjection.

However, this option is subject to technical feasibility and availability of reservoirs for injection purposes.

9.2.2.1.3 Export options

The option of export of drilling cuttings and fluids is likely to have the least environmental impacts on the Lebanese environment, that are mainly related to air emissions from transportation and collision with sea mammals. It is also likely to have the highest level of public acceptability among the Lebanese population. However it would lead to very low In-Country Value as limited services or products from Lebanese origin would be required and it is the highest-cost alternative.

9.2.2.1.4 Ship to shore for Treatment/Disposal

Shipping of drilling cuttings and fluids for treatment onshore is expected to have limited impacts on the marine environment that are mainly caused by transport vessels movement (impacts on air quality, GHGs and collisions) in addition to impacts on terrestrial ecology.

This option would lead to **highest in-country value** among the options with at least portions of the investments required to establish such facilities (whether floating for dredging purposes or fixed for construction purposes) being implemented by Lebanese contractors; operation of such facilities could also employ some Lebanese staff (though staffing of such facilities could be limited to dozen of staff only)

However, this option is not likely to be available during exploration phase (at least not before a commercial discovery is made), unless operators would be willing to invest themselves in temporary treatment facilities; siting landfill sites for ultimate disposal could also be a challenge in Lebanon; minimization of landfill requirements should always be an objective given limited availability of land for landfilling in Lebanon. It could also lead to some public opposition as local population could perceive that offshore oil and gas wastes are being brought onshore for treatment and therefore pose an additional waste management burden to Lebanon; a clear communication strategy would be needed to accurately inform the population and alleviate risks from public opposition.

9.2.2.2 *Produced Water*

The analyzed options for the handling and disposal of produced water are:

- Offshore injection
- Discharge to sea (direct discharge after advanced treatment for recovery of constituents versus treatment to strictly to achieve discharge conditions)

9.2.2.2.1 Reinjection

Reinjection is typically the most adopted solution for disposal of offshore produced water as it has the lowest environmental impacts that are only related to impacts on to phyto and zoo benthos in the location of reinjection.

However, this option is subject to technical feasibility and availability of reservoirs for injection purposes.

9.2.2.2.2 Discharge to the Sea

Discharge to the sea is expected to have significant environmental impacts on seawater quality, sediments quality, nekton, phyto and zoo plankton, sea mammals, turtles and seals and likely to face high public opposition, particularly driven by marine scientific community in Lebanon. It also has the least in-country value, as it is not likely to require any services from Lebanese suppliers and would not lead to employment of Lebanese personnel and it requires efforts to regulator to ensure compliance of discharge to permit conditions. However, it is the option with the least cost of disposal and has no infrastructure or land requirements, there is no transfer of wastes, and is readily available for implementation.

9.2.2.3 *NORM Waste*

The analyzed options for the handling and disposal of NORN waste are:

- Export
- Ship to shore for storage/treatment/disposal
- Injection
- Discharge to sea

9.2.2.3.1 Export

As per the Basel Convention, export of radioactive wastes is not allowed. This option is therefore not considered to be possible.

9.2.2.3.2 Ship to shore for Storage/Treatment/Disposal

It is common that NORM wastes be handled in specialized facilities that abide by international standards, including distance from receptors, and other criteria to minimize exposure of people to radioactivity. A NORM treatment center could be composed of various components, depending on the types of NORM wastes. Such components may include specialized landfills, descaling of NORM-contaminated equipment and treatment of the removed scale through stabilization/solidification or thermal treatment, mechanical treatment by milling/grinding of scale and produced sand followed by underground injection.

The main advantages of such onshore NORM handling facilities are having low environmental impacts if adequately sited and designed and having high In-Country Value, however, this option is subject to availability of land and public acceptability

9.2.2.3.3 Reinjection

Main advantages of reinjection offshore are having the **lowest environmental impacts** and minimizing people's exposure to NORM wastes, however, this option is subject to technical feasibility and availability of reservoirs for injection purposes.

9.2.2.3.4 Discharge to the Sea

Discharge to the sea of NORM wastes is only allowed if NORM levels are <10 Bq/g. Discharge to the sea meeting international standards is the strategic option with the least cost of disposal, has no infrastructure or land requirements, there is no transfer of wastes and is readily available for implementation; however, Is likely to have significant impacts on the marine environment and health and requires high effort to regulator to ensure compliance to permit conditions, besides, it is likely to face high public opposition particularly driven by marine scientific community in Lebanon.

9.2.2.4 *Cementing Waste Management Alternatives*

The analyzed options for the disposal of drilling fluids and cuttings are:

1. Export
2. Ship-to-shore for treatment/reuse/disposal
3. Injection
4. Discharge to sea (in the continental shelf/slope or in the deep sea)

9.2.2.4.1 Discharge to the Sea

Two main options for discharge in the sea have been analyzed. The first considers that cementing wastes have been processed and treated offshore to ultimately being stabilized and solidified. The resulting stabilized blocks are then disposed into the sea (in a controlled manner, i.e. selecting sites for disposal of the blocks based on their ecological sensitivity).

Disposal of stabilized/solidified cementing wastes into the marine environment offer the following advantages:

- It is likely to have low impacts on the marine environment; it might even have positive impacts since stabilized blocks could act as artificial reefs for marine organisms
- It has no infrastructure or land requirements, there is no transfer of wastes
- Costs are likely to be affordable
- It is likely to obtain less public opposition than direct discharge in the sea; it could be an acceptable option to the public if properly communicated

However this option requires high efforts by the regulator to ensure compliance to permit conditions (that actually the cementing wastes were stabilized and not discharged directly in the sea and that they are not disposed in an ecologically sensitive area).

Disposal of cementing wastes after mechanical pre-treatment of aqueous wastes directly into the marine environment offer the following advantages:

- It is the option with the least cost of disposal
- It has no infrastructure or land requirements, there is no transfer of wastes, and is readily available for implementation

However this option:

- Is likely to have significant impacts on the marine environment should permit conditions not be followed strictly by operators
- Has the least in-country value, as it is not likely to require any services from Lebanese suppliers and would not lead to employment of Lebanese personnel
- Requires high effort to regulator to ensure compliance of discharge to permit conditions
- Is likely to face the highest public opposition particularly driven by marine scientific community in Lebanon

9.2.2.4.2 Reinjection

Reinjection of cementing wastes would only be available during development drilling. Such an option is not available during the exploration phase. Given the analysis, it is not recommended to bring offshore wastes for re-injection onshore given environmental risks (particularly risks to groundwater pollution), complexity to regulator to monitor compliance, associated costs, and high risks of public opposition.

Reinjection of cementing wastes generated during development drilling along with other wastes (as it could not be re-injected alone) is likely to have low environmental impacts, likely to be accepted by the Lebanese population with limited to no opposition and could be affordable as part of a development plan for a field. However this option is subject to technical feasibility and availability of reservoirs for injection purposes.

9.2.2.4.3 Export options

Export of cementing wastes would lead to the least impacts on the Lebanese environment when exported directly from the rig, it is likely to have the highest level of public acceptability among the Lebanese population and given the relatively small quantities expected to be generated per well, and despite the relatively high cost per ton (average 800 USD/m3), total cost would be acceptable (roughly USD 80,000 per well)

However exporting cementing wastes would lead to very low In-Country Value as limited services or products from Lebanese origin would be required.

9.2.2.4.4 Ship to shore for Treatment/Disposal

Shipping cementing wastes for direct landfilling is not recommended due to the scarcity of land in Lebanon as well as the expected high level of public opposition. It is preferable to avoid landfilling as an ultimate disposal option, even for residues.

However treatment onshore, preferably within the supply base since area needed for storage (assuming one year storage) and treatment of these wastes is less than 2000 m2 and could be made available, followed by stabilization/solidification of residues and disposal of solidified blocks in the sea (acting as artificial reefs), has low environmental impacts (could also have beneficial impacts from artificial reef effect) and would lead to highest in-country value.

9.2.3 Recommendations

9.2.3.1 Water-Based Drill Fluids

The following recommendations with respect to the management of water-based drill fluids are proposed:

During exploration phase:

1. Operators should demonstrate that they can achieve maximum separation of water-based drilling fluids from cuttings based on best available technology and a maximum rate of reuse of the drilling fluids within a single drilling operation, and where possible, unused drilling fluids are used for the drilling of subsequent exploratory well(s); the intent is to minimize the need for disposal of spent water-based drilling fluids

2. Spent water-based drilling fluids that can no longer be re-used, or which components can no longer be economically recovered for re-use, and in the absence of appropriate infrastructure for their treatment and disposal in Lebanon, should be disposed of outside Lebanon, in ways that are acceptable to the industry, and following required procedures for their transfer abroad (as per Basel Convention requirements)

<u>During development and production phases</u> (the first recommendation remains valid at all times):

1. The preferred options for the disposal of spent water-based drilling fluids during development drilling or production (i.e. once a commercial discovery has been made) are reinjection offshore or treatment onshore always following minimization of waste generation

9.2.3.2 *<u>Water-Based Drill Cuttings</u>*

The following recommendations with respect to the management of water-based drill cuttings are proposed:

<u>During exploration phase:</u>

1. Acceptable options (provided necessary environmental approvals via the EIA process or Basel convention for export) for the management and disposal of water-based drill cuttings are (1) processing of drill cuttings, stabilization/solidification followed by controlled disposal offshore, (2) ship to shore for treatment, recovery of residues, and controlled disposed at sea of stabilized residues, (3) shipment outside Lebanon for treatment/disposal (as per Basel Convention requirements).

2. Direct disposal of water-based drill cuttings in the sea is not allowed, except for the riserless section of the well subject to impact assessment to help define mitigation measures to minimize the impacts on the benthic environment.

During development and production phases:

1. The preferred options for the disposal of water-based drill cuttings during development drilling or production (i.e. once a commercial discovery has been made) are reinjection offshore or treatment offshore or onshore with ultimate disposal of stabilized cuttings in the sea to act as artificial reefs.

2. Disposal of water-based drill cuttings in the sea generated during development drilling is not allowed, except for the riserless section of the well subject to impact assessment to help define mitigation measures to minimize the impacts on the benthic environment.

9.2.3.3 *Oil-Based and Synthetic Based Drilling Fluids*

The following recommendations with respect to the management of oil-based and synthetic based drilling fluids are proposed:

During exploration phase:

1. Given the complexity of handling spent oil-based and synthetic-based drilling fluids as opposed to water-based drilling fluids, operators shall always use water-based drilling fluids unless safety of the well could be jeopardized; maintaining well-integrity and safety supersedes environmental protection objectives in this case
2. When the need to use oil-based or synthetic-based drilling fluids cannot be avoided, operators should demonstrate that they can achieve maximum separation of drilling fluids from cuttings based on best available technology and a maximum rate of reuse of the drilling fluids within a single drilling operation, and where possible, unused drilling fluids are used for the drilling of subsequent exploratory well(s); the intent is to minimize the need for disposal of spent drilling fluids
3. Spent oil-based and synthetic-drilling fluids that can no longer be re-used, or which components can no longer be economically recovered for re-use, and in the absence of appropriate infrastructure for their treatment and disposal in Lebanon, should be disposed of outside Lebanon, in ways that are acceptable to the industry, and following required procedures for their transfer abroad (as per Basel Convention requirements);
4. Direct discharge of oil-based and synthetic-based (Non-Aqueous based) drilling fluids in the sea is strictly prohibited in Lebanese waters.

<u>During development and production phases</u> (recommendations 1, 2 and 4 remain valid at all times):

1. The preferred options for the disposal of spent oil-based or synthetic-based drilling fluids during development drilling or production (i.e. once a commercial discovery has been made) are reinjection offshore or treatment ashore

9.2.3.4 *Oil-Based and Synthetic-Based Drill Cuttings*

The following recommendations with respect to the management of oil-based and synthetic-based drill cuttings are proposed:

<u>During exploration phase:</u>

1. Acceptable options (provided necessary environmental approvals via the EIA process or Basel convention for export are obtained) for the management and disposal of oil-based and synthetic-based drill cuttings are (1) processing of drill cuttings, stabilization/solidification followed by controlled disposal offshore, (2) ship to shore for treatment, recovery of residues, and controlled disposed at sea of stabilized residues, (3) shipment outside Lebanon for treatment/disposal (as per Basel

Convention requirements), (4) disposal onshore in underground salt caverns, if available and feasible.

2. Disposal (after treatment) of oil-based and synthetic-based drill cuttings in the sea is not allowed

<u>During development and production phases:</u>

1. The preferred options for the disposal of oil-based and synthetic-based drill cuttings during development drilling or production (i.e. once a commercial discovery has been made) are reinjection offshore or treatment offshore or onshore with ultimate disposal of stabilized cuttings in the sea to act as artificial reefs.
2. Disposal of oil-based and synthetic-based drill cuttings in the sea generated during development drilling is not allowed.
3. As a general policy, and as soon as a commercial discovery is made in Lebanon, a central waste management facility should be established in Lebanon.

9.2.3.5 *Produced Water*

The following recommendations with respect to the management of produced water and hypersaline produced water are proposed:

1. Produced water generated offshore should not be brought onshore for handling/treatment or disposal
2. The preferred option for the handling of produced water is reinjection offshore; it has also possible benefits in terms of enhanced production
3. Only in the case that re-injection offshore is technically not feasible, discharge in the sea is allowed following strict conditions; it is recommended to follow OSPAR's risk based approach to the Management of Produced Water discharges from offshore installations in the marine environment
4. Operators should have in place contingency measures to address upset scenarios and for instance in the case of reinjection being the base disposal solution, a treatment facility should also be available to treat the produced water to the desired standards in case the base solution fails
5. In case discharge to the sea is the only option available, **treated produced water cannot be discharged in the continental shelf or continental slope, or near any other sensitive ecosystem.**

9.2.3.6 *Norm Waste*

The following recommendations with respect to the management of NORM wastes are proposed for consideration by the Lebanese Government:

1. During exploration, if NORM wastes are generated, the Lebanese Atomic Energy Commission (LAEC) should be immediately notified and these wastes should be brought to shore for storage at sites approved by LAEC; LAEC is the Lebanese authority responsible for the handling of such wastes
2. The Lebanese government should be prepared to have a state-of-the-art NORM handling facility, adequately sited, and capable to store, treat and dispose of NORM wastes generated by the petroleum sector
3. Provided LAEC provides its authorization, re-injection of NORM wastes in offshore well is an acceptable solution when technically feasible
4. Disposal of NORM wastes to the sea shall not be allowed.

9.2.3.7 *Cementing Waste*

The following policy statements with respect to the management of cementing wastes are proposed for consideration by the Lebanese Government:

During exploration phase:

1. Operators should demonstrate that they have applied all means during design of the drilling campaign to minimize the generation of cementing wastes
2. Acceptable options (provided necessary environmental approvals via the EIA process or Basel convention for export are obtained) for the management and disposal of cementing wastes are (1) treatment onshore, preferably at the supply base, stabilization and solidification of residues and controlled disposal at the sea, (2) treatment offshore, stabilization and solidification of residues and controlled disposal at the sea, (3) shipment outside Lebanon for treatment/disposal (as per Basel Convention requirements), (4) disposal onshore in underground salt caverns, if available and feasible.
3. Direct disposal (after pre-treatment) of cementing wastes in the sea is not allowed.

During development and production phases:

1. Re-injection of cementing wastes along with other waste streams is an acceptable option during development.

9.3 GAS EXPORT OPTIONS

The Impact assessment in the SEA report considered the following alternatives for the export of gas:

- Export pipelines
- Offshore LNG terminal (located in the continental shelf/slope or in deep sea)
- Onshore LNG terminal

The assessment of environmental impacts from the above mentioned gas export alternatives is presented in Table 9-6.

Table 9-6 Assessment of Potential Impacts from Gas Export Alternatives

Component / Activity	Scenario	Air Quality	Climate change	Seawater	Sedimentation on sea bed	Above water noise	Phyto & zoo benthos	Sea Mammals, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats	Fisheries	Health	Shipping	Landscape and Visual Amenity
Export of Via pipelines	S3	2A	5A				2A		2A	2L				
Offshore LNG terminal **in the continental shelf/slope**	S3	3A	5A	3A	5A	2P	3A	4A			4A	3P	3A	2A
Offshore LNG terminal in **in deep sea**	S3	3A	5A	3A	3A	2P	3A	4A	3A		4A	3P	3A	2A
Onshore LNG terminal	S3	3A	5A			2A				4A		4P		3P

As presented in the table above the option of constructing and operating an LNG terminal whether onshore or offshore is expected to have unacceptable impacts on air quality and climate change compared to acceptable impacts for the export of gas via pipelines. The impacts on marine environment are significant for the alternative of offshore terminal especially if constructed in the continental shelf/slope, while an onshore LNG terminal is expected to have significant impacts on Terrestrial Ecology and coastal habitats and health.

The preferred SEA alternative for the export of gas is through pipelines.

9.4 ON-SHORE BIAS VS. OFFSHORE BIAS

The Impact assessment in the SEA report considered the option of having onshore facilities in addition to the option of having offshore facilities to allow comparison between the possible environmental impacts of both cases.

Onshore versus offshore facilities are considered for the gas processing facilities (LNG terminals are considered above).

The assessment of environmental impacts for onshore and offshore facilities is presented in Table 9-7.

Table 9-7 Assessment of Potential Impacts from Offshore and Offshore Facilities

Component / Activity		Scenario	Air Quality	Climate change	Seawater quality	Sedimentation on sea bed	Above water noise	Phyto & zoo benthos	Sea Mammals, turtles and seals	Sensitive marine habitats	Terrestrial Ecology and coastal habitats	Fisheries	Health	Shipping	Landscape and Visual Amenity
Development options	Onshore processing facilities	S2	2A	5A	3A	4A	2A	2A	4A	2A	4A	3A	3P		3P
		S3	3A	5A	3A	5A	2A	3A	4A	3A	4A	4A	4L		4A
	Offshore processing facilities **in the continental shelf/slope**	S2	2A	5A	3A	4A	2P	2A	4A	2A		3A	3P	2A	2A
		S3	3A	5A	3A	5A	2P	3A	4A	3A		4A	3L	2A	2A
	Offshore processing **in deep sea**	S2	2A	5A	3A	3A	2P	2A	4A	2A		3A	3P	2A	2A
		S3	3A	5A	3A	3A	2P	3A	4A	3A		4A	3L	2A	2A

Impacts on air quality and climate change are expected to be similar from onshore and offshore facilities (in scenario 3). However, offshore facilities are expected to have significant environmental impacts on: seawater quality, sedimentation on sea bed, phyto & zoo benthos, sea mammals, turtles and seals, sensitive marine habitats and fisheries. Onshore facilities would have more significant impacts on terrestrial ecology and coastal habitats, health and landscape and visual amenity but also on the marine environment and the continental shelf since produced water would be generated onshore and would need to be disposed of.

The SEA preferred option for processing facilities is offshore facility in deep sea. Multi-phase processing facilities should not be brought to shore or to the continental shelf to avoid significant impacts on the marine environment, fisheries and public health.

9.5 YEAR-ROUND ACTIVITIES VS. RESTRICTED WINDOWS FOR ACTIVITIES

This section aims to provide guidance on periods and locations to be avoided by petroleum activities due to the presence of sensitive marine species, however, given the lack of data on the geographic presence of species offshore and the timing of their presence, it is highly recommended that such information be obtained through scientific research at the earliest stage possible from exploration and production activities. EIA studies prepared for different phases of petroleum activities should specify such restricted areas and time periods.

Table 9-8 provides available information on the presence of marine fauna including Birds, Cetaceans, Sea Turtles and Pinnipeds in Lebanon.

Table 9-8 Marine Species Seasonality

Species	Restrictions					
	Species of conservation concern	Presence in Lebanon (wintering, migration, breeding…)	Geographic presence offshore	Geographic presence onshore	Timing	Comments
Birds	186 coastal and marine species observed near the coast of which 144 have marine affinity	List of species is extensive. Majority of the bird species are migratory were large numbers are observed during migration seasons along the coastal zone and also inland along water bodies.	No data.	All over the Lebanese coastline.	On passage during the spring and migration season (Mid-February to Mid-May; and Mid-August to Mid-November).	Ramadan-Jaradi, G.., Ramadan-Jaradi, M. & Bara, T. (2008). The revised checklist of the birds of Lebanon (Sandgrouse 30 (1) 22-69.
Cetaceans	Short-beaked common dolphin (*Delphinus delphis*)	No data	No data	Off Beirut and others coastal areas	No data	Least concern (IUCN Redlist)
	Common bottlenose dolphin (*Tursiops truncates*)			Off Beirut and others coastal areas		Least concern (IUCN Redlist)
	Fin whale (*Balaenoptera physalus*)			Occasional sightings		Endangered (IUCN Redlist)
	Cuvier's beaked whale (*Ziphius cavirostris*)			Occasional sightings		Least concern (IUCN Redlist)
	Risso's dolphin (*Grampus griseus*)			Occasional sightings		Least concern (IUCN Redlist)
	Striped dolphin (*Stenella coeruleoalba*)			Occasional sightings		Least concern (IUCN Redlist)
Sea Turtles	Loggerhead turtle (*Caretta caretta*)	Wintering, breeding	No data	Breeding at various sites: Palm Island Nature Reserve, Chekka, Jbeil,	Breeding: May - August	Vulnerable (IUCN Redlist)
	Green turtle (*Chelonia mydas*)	Wintering, breeding	No data			Endangered (IUCN Redlist)

Species	Restrictions					
				Ramlet el Bayda, Manssouri, Tyre		
	Leatherback turtle (*Dermochelys coriacea*)	Migration, occasional	No data	Not Applicable (They don't breed in Lebanon).	Not Applicable (They do not breed in Lebanon)	Vulnerable (IUCN Redlist)
	Hawksbill Sea turtle (*Eretmochelys imbricata*)	Occasional	No data			Critically endangered (IUCN Redlist)
	The African Softshell Turtle (*Trionyx triunguis*)	Occasional	No data			Vulnerable (IUCN Redlist)
Pinnipeds/ Monk seal	Mediterranean Monk Seal (*Monachus monachus*)	Resident, Breeding	No data	Raouche, Tabarja…	Resident, present all year.	Endangered (IUCN Redlist).

9.6 BLOCKS TO BE OPENED IN THE NEXT LICENSING ROUND

Based on the impact assessment results (chapter 8), and from an environmental and ecological perspective, it has been highly recommended that petroleum activities (especially drilling and sea bed disturbing activities) shall be avoided in the continental shelf and continental slope. While the continental shelf is outside the offshore blocks, the continental slope forms part of the near shore blocks. In the event that drilling in the continental slope/shelf is not avoidable, in-depth baseline surveys (including detailed eco-toxicological assessments) need to be conducted to assess risk levels and obtain approval from Ministry of Environment.

The SEA recommends that deep offshore blocks be opened for licensing before near shore blocks. It is recommended that, if these blocks are to be licensed, in-depth, baseline surveys (including eco-toxicological studies) and stricter controls shall be adopted, as applicable.

10. ENVIRONMENTAL MANAGEMENT FRAMEWORK

10.1 Mitigation Strategies

Mitigation refers to the "elimination, reduction or control of the adverse effects of the policy, plan or program, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means". Priority is given to impact avoidance, followed by minimization and then compensation.

The existing control measures and the proposed mitigation measures for potential adverse impacts from different phases of offshore petroleum activities are summarized in Table 10-1, Table 10-2, Table 10-3, Table 10-4 and Table 10-5.

Table 10-1 Mitigation of Environmental Impacts from Reconnaissance Activities

Component	Mitigation Measures	Responsibility
Air Quality and Climate Change	**Main Existing Control Measures**	
	Adopting BAT (Air Quality Law # 78/2018 & Decree #10289/2013/PAR)	Operators
	Compliance with Ambient Air Quality Standards (Decision No. 52/1/1996), Emission Limit Values for power generation (Decision No. 8/1/ 2001) and relevant international standards.	Operators
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Emergency response plan (ERP) is required according to PAR	Operators
	Proposed Mitigation Measures	
	Use of Low-Sulfur Fuel instead of normal diesel for power generation	Operators
	Ratification of MARPOL Annex 6 to decrease emissions from vessels (refer to Table 8-4 for main requirements)	Government of Lebanon/MoE
Seawater and Sediments	**Main Existing Control Measures**	
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge. The measures in these Annexes shall be adopted for the prevention of pollution by oil, chemical substances, sewage and garbage.	Operators
	Barcelona Convention and its protocols (1976) provide mechanisms to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators

Component	Mitigation Measures	Responsibility
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment (but require application decrees).	Operators
	National Oil Spill Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Operators are required to prepare Emergency Response Plans (ERP) prior to starting any activity.	Operators
	Vessel Monitoring System (VMS) that helps avoiding collision between vessels.	MoPWT
	Proposed Mitigation Measures	
	Treat Wastes and Fluids before Discharge.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	MOE to publish a list of approved oil dispersants allowed to be used in oil spill response (in line with NOSCP).	MoE
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Install equipment during non-productive Seasons.	Operators
	Ensure VMS system is operational.	MoPWT
	Main Existing Control Measures	
Marine Biological Environment	Strict compliance with ACCOBAMS recommendations during reconnaissance activities; Operators should demonstrate how ACCOBAMS guidelines were taken into consideration in the design and implementation of such activities. The guidelines necessitate the employment of the following: - Big Air Bubble Curtains: a system that produces air bubbles under water breaking the propagation of sound waves - Little Air Bubble Curtain: A little bubble curtain can be customized and placed much closer to the big bubble curtain, it may consist of a rigid frame placed around of the source. Several configurations are possible. - Hydro Sound Damper: a technology consisting of fishing nets with small balloons filled with gas and foam (ensure Hydro Sound Damper equipment is retrieved and accounted for so that it does not contribute to marine debris) - Noise Mitigation Screen: a double-layered screen filled with air and bubbles - Visual monitoring protocol - Passive Acoustic Monitoring protocol (PAM): regularly used during a range of operations whether static or mobile to facilitate the detection of marine mammal species during times of limited visibility or darkness.	Operators

Component	Mitigation Measures	Responsibility
	- Marine Mammal Observation protocol - Soft start protocol: Noise emissions should begin at low power, increase gradually until full power is reached. The soft start procedure should be of 20 min duration at least. - Use of Acoustic Mitigation Devices (AMD): Prior to the beginning of the work, AMD should be used to drive away groups or individuals of marine mammals. -	
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols 1976 prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	Convention on Biological Diversity develops strategies for the conservation and the sustainable use of biological diversity.	Operators
	The African-Eurasian Water-bird Agreement AEWA is an international agreement aiming to coordinate efforts to conserve bird species migrating between the regions.	Operators
	The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.	Operators
	The National Biodiversity Strategy and Action Plan (NBSAP).	Operators
	Decision 1044/1-2014 sets general conditions to protect cetaceans. Decision 396/1-2014 defines restrictions and regulations to limit and ban seabirds catching.	Operators
	Proposed Mitigation Measures	
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Conduct activities during non-productive Seasons.	Operators
	The following procedures from IAGC /IOGP monitoring and mitigation measures for cetaceans during marine seismic survey geophysical operations should be adopted: • Procedure for commencement of operations • Procedure for interruptions to ongoing operations • Procedure for testing source elements	Operators
	Take into consideration Standard Airgun Mitigation Procedure from JNCC guidelines for minimizing the risk of injury to marine mammals from geophysical surveys.	Operators
	Operators to demonstrate that underwater noise levels and high risk areas are reduced to the minimum possible extent during drilling using ALARP methodology	Operators
	Minimize cumulative effects from airguns operations through coordination with other similar activities in the East-Med.	MoEW/LPA/ Operators

Component	Mitigation Measures	Responsibility
	Avoid activities in the vicinity of protected areas/areas proposed for protection and establishing a buffer zone around such areas. Buffer zones shall be determined in EIA studies.	Operators/LPA/MoE
	Compliance with protected areas management plans.	Operators
	Establish a code of conduct for operating in proximity to protected and sensitive areas.	Operators
	Strict adherence to MARPOL requirements.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure towed equipment is free of alien species.	Operators
	Ensure strict compliance with the Ballast Water Convention requirements and capacity of MoPWT to monitor such compliance.	Operators/ MoPWT
Coastal Environment	**Main Existing Control Measures**	
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) provide mechanisms to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.	Operators
	The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements.	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Operators are required to submit ERPs and ensure readiness to comply with ERP prior to initiating any activities.	Operators
	Proposed Mitigation Measures	
	Optimize travel trips and travel routes when transporting chemicals and wastes.	Operators
	Transport of chemicals shall fulfil the requirements of IMDG Code for	Operators

Component	Mitigation Measures	Responsibility
	Dangerous Goods.	
	EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.ge disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.	Operators
	Chemical storage shall follow international standard in terms of packaging and labelling of products (GHS, CLP).	Operators
	Each chemical must have its SDS.	Operators
	Operators should develop a database to register chemical products. (quantity, uses, specific stored requirements, risks, PPE, etc.)	Operators
Fisheries	**Main Existing Control Measures**	
	Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore reconnaissance activities shall be followed.	Operators
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) have instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	Convention on Biological Diversity develops strategies for the conservation and the sustainable use of biological diversity.	Operators
	The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.	Operators
	The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.	Operators
	The National Biodiversity Strategies and Action Plan (NBSAP).	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	Proposed Mitigation Measures	
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed	Operators

Component	Mitigation Measures	Responsibility
	project area. Conduct activities during non-productive Seasons.	
	Treat wastes and fluids before discharge.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Monitoring of chemical concentrations in edible fish and invertebrate tissue.	MoPH/ Operators
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Limit Exclusion Zones to Safety Zones	MoEW/LPA/ Operators
	In the case of a survey planned in an area of intensive fishing, discussions with Fisheries Associations shall be initiated as early as possible, and, in any case, at least 45 days before the planned date in order that the implications can be fully considered. A clear communication plan shall be developed and a fair compensation scheme in case of loss of equipment shall be proposed.	LPA/ Operators
	Employment of on-board fisheries liaison personnel from the local community (subject to the completion of adequate safety training). These on-board personnel communicate with those operating vessels in the nearby area in order to advise of survey vessel movements over the next 24 to 48 hours, allowing close coordination with local fishers in order that the impacts on their activities and area restrictions are minimized.	Operators
	Maintain exclusion zones around survey vessels and its towed streamer arrays to avoid interruption of commercial fishing operations.	Operators
Ambient Noise Levels	**Main Existing Control Measures**	
	MoE Decision No. 52/1/1996, National maximum allowable noise levels and the permissible noise exposure standards.	Operators
	Offshore blocks are located more than 3 nm away from the shoreline.	GoL
	Locations for onshore support facilities should be selected in compliance with the National Land Use Master Plan.	Operators/LPA
	Proposed Mitigation Measures	
	No additional mitigation measures are proposed.	-

Table 10-2 Mitigation of Environmental Impacts during Exploration Phase

Component	Mitigation Measures	Responsibility
	Main Existing Control Measures	
Air Quality and Climate Change	Application of the Best Available Techniques (BAT) as stipulated by the Air Quality Protection law (78/2018) to minimize the impact on air quality.	Operators
	Compliance with Ambient Air Quality Standards (Decision No. 52/1/1996), Emission Limit Values for power generation (Decision No. 8/1/ 2001) and relevant international standards	Operators
	An emission permit is to be obtained from MoE as per law 78/2018 (in the absence of the permit, such permission is obtained via the EIA process)	Operators
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Emergency response planning is required according to PAR	Operators
	Flaring or venting and all types of Air Emissions release is subject to a permit from Ministry of Energy and Water and Emergency Flaring requires registration and reporting to the Minister within 24 hours from occurrence.	Operators
	The Ministry of Environment's Decision Number 99-1/2013 regarding the submission of information on Green House Gas emissions for all facilities.	Operators
	Proposed Mitigation Measures	
	Ensure enforcement of BAT as required by Law 78/2018 (Air Quality Protection Law) and Decree No. 10289/2012 (PAR); this requires proper training of MoE and LPA personnel on BAT applicable to the offshore oil and gas industry and the review of BAT demonstration in EIA studies; MoE needs to ensure that BAT is integrated in design of facilities, implemented and properly maintained during operation	Operators/MoE
	Use of Green diesel instead of Marine Gasoil where technically feasible; green diesel has a significantly lower sulfur content	Operators
	Fuel efficiency measures shall be taken in the selection process for platform, support vessels and helicopters, where possible.	Operators
	Ratification of MARPOL Annex 6 to decrease emissions from vessels. (refer to Table 8-4 for main requirements)	Government of Lebanon/MoE
	Regular check for leaks with latest technology and take prompt action	Operators
	Explore possibilities for the implementation of Decree No. 167/2017 that provides incentives for environmental investments and assess its applicability to the offshore E&P sector	Operators/LPA/MoE
	Main Existing Control Measures	
Seawater and Sediments	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to	Operators

Component	Mitigation Measures	Responsibility
	regulate garbage and marine debris discharge.	
	Barcelona Convention and its protocols (1976) have instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Operators are required to prepare ERPs and demonstrate readiness to implement it prior to initiating any activity.	Operators
	The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.	Operators
	Proposed Mitigation Measures	
	Operators to strictly comply with the waste management recommendations in section 9.2.3	Operators
	Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea.	Operators
	Use of Silt Curtains allowing suspended matter to settle before removal of the curtains.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure safety critical equipment and processed are in place and operational prior to start of drilling activities	Operators
	MOE to publish a list of approved oil dispersants allowed to be used in oil spill response (in line with NOSCP).	MoE
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Conduct activities during non-productive Seasons.	Operators
	Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea.	Operators
	Avoid drilling on the Continental Slope.	Operators
	If activities in the continental slope/shelf are not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment.	Operators
Marine Biological Environment	**Main Existing Control Measures**	
	The Ballast Water Management Convention (2004) establishes standards, procedures and guidelines for the management and control of ships' ballast water and sediments.	Operators
	Recommendations of ACCOBAMS Guidelines and suggested mitigation	Operators

Component	Mitigation Measures	Responsibility
	measures for noise control for offshore petroleum activities shall be followed. The guidelines necessitate the employment of the following: - Big Air Bubble Curtains: a system that produces air bubbles under water breaking the propagation of sound waves - Little Air Bubble Curtain: A little bubble curtain can be customized and placed much closer to the big bubble curtain, it may consist of a rigid frame placed around of the source. Several configurations are possible. - Hydro Sound Damper: a technology consisting of fishing nets with small balloons filled with gas and foam (ensure Hydro Sound Damper equipment is retrieved and accounted for so that it does not contribute to marine debris) - Noise Mitigation Screen: a double-layered screen filled with air and bubbles - BEKA shells: double steel wall with intern and outer bubble curtains and acoustic decoupling - Visual monitoring protocol - Passive Acoustic Monitoring protocol (PAM): regularly used during a range of operations whether static or mobile to facilitate the detection of marine mammal species during times of limited visibility or darkness. - Marine Mammal Observation protocol - Soft start protocol: Noise emissions should begin at low power, increase gradually until full power is reached. The soft start procedure should be of 20 min duration at least. - Use of Acoustic Mitigation Devices (AMD): Prior to the beginning of the work, AMD should be used to drive away groups or individuals of marine mammals. -	
	Barcelona Convention and its protocols (1976) establishes instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	The African-Eurasian Water-bird Agreement AEWA is an international agreement aiming to coordinate efforts to conserve bird species migrating between the regions.	Operators
	The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	National Oil Spills Contingency Plan delineates a response system to	Operators/

Component	Mitigation Measures	Responsibility
	mitigate the impacts of oil spills.	Concerned authorities as per the NOSCP
	Operators are required to develop an ERP and demonstrate readiness to implement it prior to starting any activity.	Operators
	The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.	Operators
	The National Biodiversity Strategy and Action Plan (NBSAP).	Operators
	Decision 1044/1-2014 sets general conditions to protect cetaceans.	Operators
	Decision 396/1-2014 defines restrictions and regulations to limit and ban seabirds catching.	Operators
	Proposed Mitigation Measures	
	Strict adherence to MARPOL requirements.	Operators
	Strict adherence to the Ballast Water Convention.	Operators
	Ensure operators consider applicable ACCOBAMS recommendations for noise reduction and demonstrate that underwater noise levels and high risk areas are reduced to the minimum possible extent during drilling using ALARP methodology	Operators/MoE
	Avoid drilling and production facilities in environmental and socially sensitive areas, including the continental shelf and slope; drilling and production in protected areas are prohibited.	Operators
	Operators to strictly comply with the waste management recommendations in section 9.2.3	Operators
	Conduct risk assessments in line with international best practice for drilling and production facilities and ensure that safety critical equipment and processes are in place prior to start of activities.	Operators/LPA
	Optimize travel trips and travel routes when transporting chemicals and wastes	Operators
	Develop a Chemical Management Framework at the national level and Chemical Management Plans for activities.	Operators
	Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods.	Operators
	Mapping of sea-grass meadows in Lebanese shallow waters shall be conducted prior to activities.	MoE
	EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.	Operators
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Conduct activities during non-productive Seasons.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure MoPWT has the resources to supervise compliance with Ballast Water Convention	GoL/MoPWT

Component	Mitigation Measures	Responsibility
	If activities in the continental slope/shelf are not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment.	Operators
	Drilling and production within protected areas are prohibited	Operators
	Avoid activities in the vicinity of protected areas/areas proposed for protection and establishing a buffer zone around such areas. Buffer zones shall be determined in EIA studies.	Operators
	Compliance with protected areas management plans.	Operators
	Establish a code of conduct for operating in proximity to protected and sensitive areas.	Operators
	Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea.	Operators
Coastal Environment	**Main Existing Control Measures**	
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.	Operators
	The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Operators are required to prepare ERPs and demonstrate readiness for their implementation prior to initiating any activities.	Operators
	Proposed Mitigation Measures	
	Optimize travel trips and travel routes when transporting chemicals and wastes	Operators
	Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods.	Operators
	EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.	Operators

Component	Mitigation Measures	Responsibility
	Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea.	Operators
	Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure that safety critical equipment and processes are in place and operational prior to start of drilling	Operators/LPA
	Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.	Operators
	Update the management plan of the Tyre Coast Nature Reserve to define the management approach within the protected zone of the territorial waters as stipulated in the Reserve's establishment law.	MoE
Fisheries	**Main Existing Control Measures**	
	• Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore petroleum activities shall be followed (listed above in the table).	Operators
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.	Operators
	The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.	Operators
	The National Biodiversity Strategy and Action Plan (NBSAP).	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	Proposed Mitigation Measures	
	Operators to strictly comply with the waste management recommendations in section 9.2.3	Operators
	Optimize travel trips and travel routes when transporting chemicals and wastes	Operators
	Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods.	Operators
	EIA studies shall detail the procedure to be adopted during transport of	Operators

Component	Mitigation Measures	Responsibility
	dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.	
	Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.	Operators
	Chemical storage shall follow international standard in terms of packaging and labelling of products (GHS, CLP).	Operators
	Each chemical must have its SDS.	Operators
	Operators should develop a database to register chemical products. (quantity, uses, specific stored requirements, risks, PPE, etc.)	Operators
	Monitoring of chemical concentrations in edible fish and invertebrate tissue.	MoPH/ Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure that safety critical equipment and processes are in place and operational prior to start of drilling	Operators/LPA
	Limit Exclusion Zones to Safety Zones	MoEW/LPA/ Operators
	At the time of submitting a well plan for approval, operators shall inform fishermen through the Fisheries Associations. In addition, in the case of a well-planned in an area of intensive fishing, discussions with the Fisheries Associations must be initiated as early as possible, and preferably not less than 90 days before planned commencement of drilling.	Operators
	Regional baseline studies should be conducted by independent scientists/resource agencies to the extent possible prior to any licenses being offered so that sensitive resources can be better defined in each block	MoE/MoEW/LPA
Ambient Noise Levels	**Main Existing Control Measures**	
	MoE Decision No. 52/1/1996, National maximum allowable noise levels and the permissible noise exposure standards.	Operators
	Offshore blocks are located more than three (3) nm away from the shoreline.	Operators
	Locations for onshore support facilities should be selected in compliance with the National Land Use Master Plan.	Operators/LPA
	Proposed Mitigation Measures	
	No additional mitigation measures are proposed.	-

Table 10-3 Mitigation of Environmental Impacts during Production Phase

Component	Mitigation Measures	Responsibility
Air Quality and Climate Change	**Main Existing Control Measures**	
	Demonstration of the use of Best Available Technologies (BAT) is required by the Air Quality Law #78/2018.	Operators
	Air emissions release is subject to a permit obtained from the Ministry of Environment under the Air Quality Law # 78/2018.	Operators
	The Ministry of Environment's Decision Number 99-1/2013 regarding the submission of information on Green House Gas emissions for all facilities.	Operators
	Application of the Best Available Techniques (BAT) as stipulated by the Air Quality Protection law (78/2018) to minimize the impact on air quality	Operators
	Compliance with Ambient Air Quality Standards (Decision No. 52/1/1996), Emission Limit Values for power generation (Decision No. 8/1/ 2001) and relevant international standards	Operators
	Flaring or venting and all types of Air Emissions release is subject to a permit from Ministry of Environment and Water and Emergency Flaring requires registration and reporting to the Minister within 24 hours from occurrence.	Operators
	National Oil Spill Contingency Plan.	Operators/ Concerned authorities as per the NOSCP
	Operators are required to prepare an ERP and demonstrate readiness to implement it prior to start of any activities.	Operators
	Proposed Mitigation Measures	
	Ensure enforcement of BAT as required by Law 78/2018 (Air Quality Protection Law) and Decree No. 10289/2012 (PAR); this requires proper training of MoE and LPA personnel on BAT applicable to the offshore oil and gas industry and the review of BAT demonstration in EIA studies; MoE/LPA needs to ensure that BAT is integrated, implemented and properly maintained during operation	Operators
	Use of Green diesel instead of Marine Gasoil where technically feasible; green diesel has a significantly lower sulfur content	Operators
	Fuel efficiency measures shall be taken in the selection process for platform, support vessels and helicopters.	Operators
	Controlling and reducing fugitive emissions in the design, operation, and maintenance of offshore facilities through the selection of appropriate valves, flanges, fittings and seals	Operators
	Ratification of MARPOL Annex 6 to decrease emissions (refer to Table 8-4 for main requirements)	Government of Lebanon/MoE
	Compliance with USEPA regulations regarding Leak Detection and Repair (LDAR), namely: 40 CFR Part 60 Subpart OOOO; 40 CFR Part 60 Subpart OOOOa, and the final Rule: Federal Register Vol.81 No. 107, June 3, 2016, EPA 40 CFR Part 60 (Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources)	Operators

Component	Mitigation Measures	Responsibility
	Enactment of the draft decree related to National Fund for the Environment.	Government of Lebanon/MoE
	Regular check for leaks with latest technology and take prompt action	Operators
	Implementation of the Paris Agreement	Operators/MoEW
	Operators should offset a portion of their emissions during production (15% is recommended as a minimum, in line with NDC commitments); such offset could be done by directly financing renewable energy projects and energy efficiency initiatives, reforestation (or enhancement of carbon sinks) and/or contributing in local funds (such as the BDL scheme of NEEREA or any subsequent similar frameworks, including the National Fund for the Environment) or any combination of the above; if development plans lead to excessive GHG emissions negatively affecting Lebanon's national commitments, then offset plans should compensate the additional emissions in a way to ensure meeting the unconditional emissions reduction targets set by the government	Operators
	Enhance the capacity of the MoE to ensure that BAT is integrated in the design of production facilities and is properly implemented	GoL/MoEW/LPA
	GHG emissions reduction demonstrations are mandatory as part of EIA studies (demonstrating that GHG emissions were reduced to the maximum extent possible before incremental emissions reduction costs become excessive)	Operators
	Mandatory GHG emissions reporting from operators	Operators
	Explore possibilities for the implementation of Decree 167/2017 that provides incentives for environmental investments and assess its applicability to the offshore E&P sector	Operators/LPA/MoE
	Ensure Energy efficiency concepts are integrated in design, operations and maintenance of production facilities	Operators
	Consider introduction of renewable energy technologies to the E&P activities.	Operators
	On the longer term, and as production fields become available, carbon capture and sequestration initiatives should be considered as part of their development and production plans.	Operators
Seawater and Sediments	**Main Existing Control Measures**	
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements.	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related	Operators

Component	Mitigation Measures	Responsibility
	to the protection of marine environment and the requirements for discharge permits.	
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Operators need to prepare an ERP and demonstrate readiness to implement it prior to starting any activity.	Operators
	The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.	Operators
	Proposed Mitigation Measures	
	Operators to strictly comply with the waste management recommendations in section 9.2.3.	Operators
	Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea.	Operators
	Use of Silt Curtains allowing suspended matter to settle before removal of the curtains.	Operators
	Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure safety critical equipment and processes are in place and operational prior to start of activities	Operators/LPA
	MOE to publish a list of approved oil dispersants allowed to be used in oil spill response (in line with NOSCP).	MoE
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Conduct activities during non-productive Seasons.	Operators
	Avoid drilling activities in the continental slope.	Operators
	Avoid discharge of drill cuttings and fluids in the continental slope.	Operators
	Avoid activities and equipment installation on the continental slope (except for pipelines).	Operators
	If activities in the continental slope/shelf are not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment.	Operators
Marine Biological Environment	**Main Existing Control Measures**	
	The Ballast Water Management Convention (2004) establishes standards, procedures and guidelines for the management and control of ships' ballast water and sediments.	Operators
	Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore petroleum activities shall be followed. The guidelines necessitate the employment of the following: - Big Air Bubble Curtains: a system that produces air bubbles	Operators

Component	Mitigation Measures	Responsibility
	under water breaking the propagation of sound waves - Little Air Bubble Curtain: A little bubble curtain can be customized and placed much closer to the big bubble curtain, it may consist of a rigid frame placed around of the source. Several configurations are possible. - Hydro Sound Damper: a technology consisting of fishing nets with small balloons filled with gas and foam (ensure Hydro Sound Damper equipment is retrieved and accounted for so that it does not contribute to marine debris) - Noise Mitigation Screen: a double-layered screen filled with air and bubbles - BEKA shells: double steel wall with intern and outer bubble curtains and acoustic decoupling - Visual monitoring protocol - Passive Acoustic Monitoring protocol (PAM): regularly used during a range of operations whether static or mobile to facilitate the detection of marine mammal species during times of limited visibility or darkness. - Marine Mammal Observation protocol - Soft start protocol: Noise emissions should begin at low power, increase gradually until full power is reached. The soft start procedure should be of 20 min duration at least. - Use of Acoustic Mitigation Devices (AMD): Prior to the beginning of the work, AMD should be used to drive away groups or individuals of marine mammals.	
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	The African-Eurasian Water-bird Agreement AEWA is an international agreement aiming to coordinate efforts to conserve bird species migrating between the regions.	Operators
	The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Operators are required to develop an ERP and demonstrate readiness	Operators

Component	Mitigation Measures	Responsibility
	to implement it prior to start of any activities.	
	The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.	Operators
	The National Biodiversity Strategy and Action Plan (NBSAP).	Operators
	Proposed Mitigation Measures	
	Strict adherence to MARPOL requirements.	Operators
	Strict adherence to the Ballast Water Convention.	Operators
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Conduct activities during non-productive Seasons.	Operators
	Ensure operators consider applicable ACCOBAMS recommendations for noise reduction and demonstrate that underwater noise levels and high risk areas are reduced to the minimum possible extent during drilling using ALARP methodology	Operators/MoE
	Operators to strictly comply with the waste management recommendations in section 9.2.3	Operators
	Optimize travel trips and travel routes when transporting chemicals and wastes	Operators
	Mapping of sea-grass meadows in Lebanese shallow waters shall be conducted prior to activities.	MoE
	Adopt international standards in the transportation of chemicals to minimize the risks of spills	Operators
	Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods.	Operators
	EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.	Operators
	Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure safety critical equipment and processes are in place and operational prior to start of activities	Operators/LPA
	Ensure MoPWT has needed capacity to monitor compliance with Ballast Water Convention	GoL/MoPWT
	Avoid activities on the continental slope (except pipeline laying).	Operators
	If activities in the continental slope/shelf are not avoidable, detailed eco-toxicological assessments need to be conducted to assess risk levels and obtain approval from Ministry of Environment.	Operators
	Drilling and production within protected areas are prohibited	Operators
	Avoid activities in the vicinity of protected areas/areas proposed for protection and establishing a buffer zone around such areas. Buffer zones shall be determined in EIA studies.	Operators/MoE

Component	Mitigation Measures	Responsibility
	Update the management plan of the Tyre Coast Nature Reserve to define the management approach within the protected zone of the territorial waters as stipulated in the Reserve's establishment law.	MoE
	Compliance with protected areas management plans.	Operators
	Establish a code of conduct for operating in proximity to protected and sensitive areas.	Operators
	Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea.	Operators
	Use of Silt Curtains allowing suspended matter to settle before removal of the curtains.	Operators
	Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf.	Operators
Coastal Environment	**Main Existing Control Measures**	
	MARPOL Annex I provide regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	The Ramsar Convention on Wetlands of International importance is an international agreement that sets regulations for the conservation and sustainable use of wetlands.	Operators
	The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for discharge permits.	Operators
	National Oil Spills Contingency Plan delineates a response system to mitigate the impacts of oil spills.	Operators/ Concerned authorities as per the NOSCP
	Operators are required to prepare an ERP and demonstrate readiness to implement it prior to start of any activities.	Operators
	Proposed Mitigation Measures	
	Optimize travel trips and travel routes when transporting chemicals and wastes	Operators
	Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods.	Operators
	EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of	Operators

Component	Mitigation Measures	Responsibility
	chemicals and intervene in case of accidents.	
	Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.	Operators
	Land Treatment of Spoils and Waste Materials from Dredging Operations and avoid disposal at Sea.	Operators
	Use of Silt Curtains allowing suspended matter to settle before removal of the curtains.	Operators
	Disposal of Spoils and Waste Materials from Dredging Operations beyond the Continental Shelf.	Operators
	Consider ecologically sensitive areas in the routing and siting of such systems	Operators
	Update the management plan of the Tyre Coast Nature Reserve to define the management approach within the protected zone of the territorial waters as stipulated in the Reserve's establishment law.	MoE
	Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area. Conduct activities during non-productive Seasons.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure safety critical equipment and processes are in place and operational prior to start of activities	Operators/LPA
Fisheries	**Main Existing Control Measures**	
	• Recommendations of ACCOBAMS Guidelines and suggested mitigation measures for noise control for offshore petroleum activities shall be followed (listed above in the table).	Operators
	MARPOL Annex I provides regulations governing engine room oil and diesel waste and the discharges from all types of ships. Annex II of the MARPOL details the discharge criteria for the elimination of pollution by noxious liquid substances and chemicals. MARPOL Annex IV and V introduce requirements to control pollution by sewage from ships and to regulate garbage and marine debris discharge.	Operators
	Barcelona Convention and its protocols (1976) establish instruments to prevent, abate and monitor water pollution from ships and onshore recourses including discharges and wastes.	Operators
	The draft Law for Integrated Coastal Zone Management of the Lebanese Coastal Zone establishes policies for coastal zone protection.	Operators
	The Ministry of Environment's decision Number 8-1/2001 limits the effluent discharges to the sea.	Operators
	The National Biodiversity Strategy and Action Plan (NBSAP).	Operators
	Decree No. 10289/2013 (PAR) determines Environmental protection requirements and protected areas requirements	Operators
	Law No. 444 /2002 for Environmental Protection entails articles related to the protection of marine environment and the requirements for	Operators

Component	Mitigation Measures	Responsibility
	discharge permits.	
	Proposed Mitigation Measures	
	Operators to strictly comply with the waste management recommendations in section 9.2.3	Operators
	Optimize travel trips and travel routes when transporting chemicals and wastes.	Operators
	Transport of chemicals shall fulfil the requirements of IMDG Code for Dangerous Goods.	Operators
	EIA studies shall detail the procedure to be adopted during transport of dangerous goods by sea to prevent accidental spillage of chemicals and intervene in case of accidents.	Operators
	Operators should prepare a chemicals management plan entailing handling, storage, transportation and response in case of accidents.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with the ERP.	MoPWT/MoEW/LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW/LPA/ Operator
	Ensure that safety critical equipment and processes are in place and operational prior to start of activities	Operators/LPA
	Monitoring of chemical concentrations in edible fish and invertebrate tissue.	MoPH/Operators
	Limit Exclusion Zones to Safety Zones	MoEW/LPA/ Operators
	At the time of submitting a well plan for approval, operators shall inform fishermen through the Fisheries Associations. In addition, in the case of activities planned in an area of intensive fishing, discussions with the Fisheries Associations must be initiated as early as possible, and preferably not less than 90 days before planned commencement of activity.	Operators
Ambient Noise Levels	**Main Existing Control Measures**	
	MoE Decision No. 52/1/1996, National maximum allowable noise levels and the permissible noise exposure standards.	Operators
	Offshore blocks are located more than three (3) nm away from the shoreline.	-
	Locations for onshore facilities should be selected in compliance with the National Land Use Master Plan.	Operators/MoEW/LPA
	Proposed Mitigation Measures	
	Select locations of onshore facilities in line with the National Land Use Master Plan (petroleum related facilities should be located in areas designated as industrial and not in residential areas)	Operators/MoEW/LPA
	Enclose the noise source at onshore facilities and add noise barriers or noise berms, as applicable	Operators

Component	Mitigation Measures	Responsibility
	The combined sound pressure level of equipment shall not exceed 85 dBA[14] at a distance of 1 m from the equipment in all directions.	Operators
	Noise modelling study shall be prepared as part of the environmental impact assessment study for the processing facilities and LNG terminals.	Operators
	Frequency of helicopter trips should be scheduled in a way to avoid significant noise impacts to nearby receptors at the point of take-off and landing	Operators

Table 10-4 Mitigation of Environmental Impacts during Decommissioning

Mitigation Measures	Responsibility
Main Existing Control Measures	
PAR (Decree No.10289/ 2013) requirements for the preparation of a plan for the cessation of petroleum activities and the decommissioning of facilities including an EIA study	Operators
PAR (Decree No. 10289/ 2013) decommissioning measures in the event of cessation of production before a plan for decommissioning has been approved	Operators
Proposed Mitigation Measures	
A preliminary decommissioning plan for offshore facilities should be developed that considers well abandonment, removal of oil from flowlines, facility removal, and sub-sea pipeline decommissioning along with disposal options for all equipment and materials. This plan can be further developed during field operations and fully defined in advance of the end of field life. The plan should include details on the provisions for the implementation of decommissioning activities and arrangements for post decommissioning monitoring and aftercare.	Operators
Licensees should be required to follow international best practice for safe structure removal including monitoring for marine mammals and turtles if explosives are to be used.	Operators
Marine fouling should preferably be removed while the installation is still offshore. Oil, scale, structural water and ballast water should if possible be removed while the installation is still offshore Hazardous waste must be suitably packaged, pipelines must be plugged, and good routines must be in place for labelling, packaging and sorting waste.	Operators
Decommissioning facilities (on shore) must be designed to allow safe handling of different types of waste, including hazardous waste such as heavy metals and NORM wastes, with no risk of runoff or infiltration into the soil. In addition, a decommissioning facility should have an effective collection system and an on-site treatment plant for contaminated water, including surface water. Each facility must have a sampling and analysis program to monitor releases of the most relevant pollutants. The need for an environmental monitoring program to follow developments in the recipient should also be considered. Other factors that must be closely monitored at decommissioning facilities include noise and releases to air in connection with metal cutting and other operations. Moreover, decommissioning contracts must ensure that the costs of handling hazardous waste are met by the offshore operators.	Operators

[14] Based on IFC EHS.

Table 10-5 Mitigation of Socio-Economic Impacts

Component	Mitigation Measures	Responsibility
Social Conditions	**Main Existing Control Measures**	
	OPRL, Article 67on Local content requirements.	LPA/Operators
	PAR, Article 148: If the Right Holder in the course of Petroleum Activities causes a) limitation in or disturbance of activities and rights, fishing fields or occupied land; or b) limitations in aquaculture activities; or c) fishing or aquaculture equipment to be moved to less favorable locations as seen from a maritime resource management or commercial point of view; then the Right Holder shall compensate the physical or legal person affected by such demonstrable disturbance or damage. The same applies with regard to liability and claims if the vessel(s) or craft(s), equipment, catch or harvest of a physical or legal person is polluted, damaged or lost due to Petroleum Activities.	Operators
	PAR, Article 157: The Right Holder shall ensure that the Operator gives preferential treatment to the procurement of Lebanese originating goods and services when such goods and services are internationally competitive with regard to quality, availability, price and performance. Lebanese originating goods and services are those that in substance or measured by value added are predominantly manufactured, constructed or performed in Lebanon, by Lebanese or by an entity owned and controlled by Lebanese.	Operators
	PAR: Emergency Response Plan.	Operators
	EPA, Article 20 on Recruitment and Training stipulates that: as of the beginning of the Exploration Phase, not less than eighty per cent (80%) of the aggregate number of employees of the Right Holders (including the Operator) shall be Lebanese nationals.	LPA/Operators
	Environmental standards and health and safety standards	Operators
	The establishment of the sovereign wealth fund.	GoL
	Having a modern fiscal regime.	GoL/MoF
	National Oil Spill Contingency Plan.	Operators/ Concerned authorities as per the NOSCP
	Proposed Mitigation Measures	
	Ensure transparent and realistic communication between the petroleum sector and Lebanese society.	LPA
	To provide realistic expectations of the general population, responsible authorities must raise the awareness on the topic.	GoL/LPA
	All potential limitations to other industries (e.g. fisheries) must be well communicated to impacted target groups and compensated. For this the petroleum sector must establish appropriate modality.	LPA/MoA
	Ensure transparent governance and operation of sovereign wealth fund.	GoL

Component	Mitigation Measures	Responsibility
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.	MoPWT/MoEW /LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW /LPA
	Promote Corporate Social Responsibility (CSR) practices in the sector.	LPA/ Operators
	Ensure safety critical equipment and processes are in place and operational prior to start of activities.	Operators/LPA
	Develop a national grievance mechanism.	GoL/LPA
Health	**Main Existing Control Measures**	
	Adopting BAT	Operators
	Environmental standards and health and safety standards	Operators
	National Oil Spill Contingency Plan	Operators/ Concerned authorities as per the NOSCP
	PAR: Emergency Response Plan	Operators
	Proposed Mitigation Measures	
	Air emissions from petroleum activities to be minimized following BAT principles.	Operators
	Avoid discharges to the sea if technically feasible. If discharge options are selected, the highest level of treatment (BAT) before discharge must be ensured and eco-toxicological studies to be conducted as part of EIA studies according to internationally recognized methods and standards.	Operators
	Monitoring of chemical concentrations in edible fish and invertebrate tissue to support human health advisories.	Operators/MoPH
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.	MoPWT/MoEW /LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW /LPA
	Ensure safety critical equipment and processes are in place and operational prior to start of activities.	Operators/LPA
	Ensure that a robust health surveillance system is maintained to monitor possible health impacts from the sector as it develops and allow corrective measures to be made in a timely manner.	GoL
	Ensure the healthcare sector is able to accommodate health conditions related to the sector (such as psychological or mental impacts due to sustained work offshore, etc.)	GoL
Education	**Main Existing Control Measures**	
	OPRL, Article 67: A Right Holder as well as its subcontractors shall employ qualified personnel of Lebanese nationality whenever available. Right Holder shall also organize and fund the training of	Operators/LPA

Component	Mitigation Measures	Responsibility
	Lebanese personnel associated with Petroleum Activities.	
	PAR, Article 155: Qualification and Training of Personnel: The Right Holder and contractor shall give priority to training of Lebanese in order to facilitate the employment of Lebanese at all level of Right Holder's or contractor's organizations. The Right Holder shall in consultation with the Minister, propose and carry out an effective recruitment and training program for Lebanese personnel for each phase of the Petroleum Activity and at all levels of management, taking into account the safety requirements and the need to maintain reasonable standards of efficiency in the conduct of Petroleum Activities. Such employees may be trained in the Republic of Lebanon or abroad as required by the training programs prepared. The Right Holder shall equally ensure that all personnel, including contractors' personnel have adequate training and experience in dealing with emergency situations.	Operators
	EPA, Article 20: The Right Holders shall develop and carry out an effective recruitment and training program for Lebanese personnel in accordance with the law no 132/2010. Operator shall employ, and cause all Contractors and Subcontractors to employ, qualified personnel of Lebanese nationality whenever available. The Right Holders shall fund the training of Lebanese personnel associated with Petroleum Activities. Each Exploration Plan and Development and Production Plan shall include a plan for the hiring and training of persons of Lebanese nationality, including hiring and training of management, engineering and other professional staff.	Operators
	Proposed Mitigation Measures	
	To provide realistic expectations of the general population, responsible authorities must raise the awareness on the actual potential for job creation of the sector.	LPA
	Responsible authorities should prepare a strategy linked to development of sector specific educational programs, both from the quality and admittance quantity point of view.	LPA
	Sector developers can cooperate with educational institutions to guide the type, number and quality of relevant educational programs to avoid flooding the market, while taking into consideration possibility of regional and international markets. Additional educational programs could focus on other disciplines such as ecotoxicology, human health risk assessment, and fisheries science …etc.	LPA/Operators
	Sector developers can develop scholarship and/or internship program for students of sector specific educational programs.	LPA/Operators
Cultural Heritage	**Main Existing Control Measures**	
	Avoiding exiting known cultural heritage and archaeological sites and compliance with their protection regimes according to regulatory requirements (Antiquities System Decision 166/1933 and Cultural properties Law 37/2008)	Operators
	PAR: Activities pursuant to a Reconnaissance license must not present a hazard or cause damage to Facilities, or towards pipelines, cables or other subsea structures used for other purposes than Petroleum Activities.	Operators

Component	Mitigation Measures	Responsibility
	PAR: The Right Holder has to provide protection from: accidents and physical damage due to his activities; damage or risk of damage to workers; damage to fauna, flora, marine biodiversity and archaeology; marine pollution and pollution to springs that will be discovered during the course of petroleum activities; air pollution; damage to hydrocarbon bearing formations.	Operators
	Proposed Mitigation Measures	
	Before conducting any sea floor disturbing activities, work sites shall be surveyed by marine archaeologists to identify any underwater archaeological sites and shipwrecks. Specifications required for such surveys to be defined by DGA and LPA; Based on findings, buffer zones might be required around the identified sites.	Operators
	A marine archaeologist shall be present on-vessel during Natural Resource Surveys (NRSs)	Operators
	In case of discoveries the formal procedure for protection of archaeological sites must be followed, according to existing legislation, or as specified by DGA.	Operators
Tourism	**Main Existing Control Measures**	
	Law 444/2002: it is strictly prohibited to discharge or sink or burn in Lebanese territorial waters materials that, directly or indirectly, will d) reduce the recreational value and tourism potential of the sea and the Lebanese coasts	Operators
	National Oil Spill Contingency Plan	Operators/ Concerned authorities as per the NOSCP
	PAR: Emergency Response Plan	Operators
	Offshore blocks are located 3 NM away from the shore	-
	Proposed Mitigation Measures	
	Drilling rigs/platforms should be positioned as far from the coastline as possible, however still practicable for the operator.	Operators
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.	MoPWT/MoEW /LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW /LPA/ Operator
	Monitoring of chemical concentrations in edible fish and invertebrate tissue. A transparent seafood contaminant monitoring program would increase confidence in locally sourced seafood and enhance Lebanon's restaurant and tourist image.	Operators/MpPH
	In order to increase positive impacts, the Ministry of Tourism and other responsible agencies can focus their tourism promotional campaigns on foreign workers origin countries.	MoT
	Master Plans and Detail Urban Plans to be prepared in coastal areas where not available as a measure to sustainably plan potential petroleum induced growth.	CDR

Component	Mitigation Measures	Responsibility
Landscapes and visual amenity	**Main Existing Control Measures**	
	Compliance with SDATL (National Spatial Land Use Plan)	Operators
	Flaring or venting shall be subject to a permit from MoEW	Operators
	Offshore blocks are located 3 NM away from the shore line	-
	Proposed Mitigation Measures	
	Drilling rigs/platforms should be positioned as far out from the coastline as possible, however still practicable for the operator.	Operators
	When selecting a location, preference should be given to brown-field locations and areas with no/less landscape value.	Operators
	Master Plans and Detail Urban Plans to be prepared in coastal areas where not available as a measure to sustainably plan potential petroleum induced growth.	CDR
General Economy	**Main Existing Control Measures**	
	The establishment of the sovereign wealth fund	GoL
	Having a modern fiscal regime	GoL/MoF
	OPRL, Article 67 on Local content requirements	Operators
	PAR, Article 148: If the Right Holder in the course of Petroleum Activities causes a) limitation in or disturbance of activities and rights, fishing fields or occupied land; or b) limitations in aquaculture activities; or c) fishing or aquaculture equipment to be moved to less favorable locations as seen from a maritime resource management or commercial point of view; then the Right Holder shall compensate the physical or legal person affected by such demonstrable disturbance or damage. The same applies with regard to liability and claims if the vessel(s) or craft(s), equipment, catch or harvest of a physical or legal person is polluted, damaged or lost due to Petroleum Activities.	Operators
	PAR, Article 157: The Right Holder shall ensure that the Operator gives preferential treatment to the procurement of Lebanese originating goods and services when such goods and services are internationally competitive with regard to quality, availability, price and performance. Lebanese originating goods and services are those that in substance or measured by value added are predominantly manufactured, constructed or performed in Lebanon, by Lebanese or by an entity owned and controlled by Lebanese.	Operators
	EPA, Article 20 on Recruitment and Training stipulates that: as of the beginning of the Exploration Phase, not less than eighty per cent (80%) of the aggregate number of employees of the Right Holders (including the Operator) shall be Lebanese nationals.	Operators
	PAR: Emergency Response Plan.	Operators
	Proposed Mitigation Measures	
	Develop a robust revenue management mechanism; establishment of a Sovereign Wealth Fund is stipulated in the OPRL;	GoL

Component	Mitigation Measures	Responsibility
	Develop a local content and local supply development strategy to operationalize the existing policies;	Operators
	Promote transparency and accountability to mitigate social and economic risks and particularly the risk of corruption in the sector which could negatively affect the economic growth and prevent the country to reach its optimal goals behind the oil and gas sector; the adoption of Transparency Law in the Offshore Oil and Gas sector (Law 84/2018) is an excellent step in this direction; it is important to ensure enforcement of this Law throughout all phases of the sector;	GoL/MoEW
	LPA should establish a communication strategy to manage expectations from the sector and promote stakeholder engagement and promote the beneficial impacts effectively and in a timely manner;	MoEW/ LPA
	Increase operational capacities and capabilities to implement the NOSCP and monitor operator's compliance with ERP.	MoPWT/MoEW /LPA
	Conduct trainings and exercises e.g. disaster response drills so that the entire team is prepared to work together when a spill occurs.	MoPWT/MoEW /LPA/ Operator
Infrastructure	**Main Existing Control Measures**	
	PAR: Activities pursuant to a Reconnaissance license must not present a hazard or cause damage to Facilities, or towards pipelines, cables or other subsea structures used for other purposes than Petroleum Activities.	Operators
	EPA, Article 3 includes that LPA shall provide such assistance to the Right Holders as they may reasonably request in order to obtain information with respect to current and existing infrastructure and activities in the Block that are unrelated to Petroleum Activities (including telecommunication cables and areas reserved for naval activities of the State).	LPA
	Existing international and national submerged infrastructure corridors with known buffer zones and standard operating procedures in case of accidental situations.	MoPWT/ MoEW/Operators
	Proposed Mitigation Measures	
	Before conducting any sea floor disturbing activities, work sites shall be surveyed to identify any underwater submerged infrastructure.	Operators
	Asses existing infrastructure services to specify its adequacy to cater increased demand and use. If new infrastructure services are to be established the planning process shall be conducted in collaboration with other sectors in the coastal region, such as tourism to optimize the use of the new infrastructure to achieve benefits to other sectors as well.	MoPWT/ MoE/MoEW/Operators
	Since oil and gas E&P will lead to higher use of road networks, thus more traffic, supply bases should be assigned in secondary areas that do not already suffer from major traffic problems like Beirut City.	MoPWT/ Operators
Shipping	**Main Existing Control Measures**	
	PAR, Article 6: Vessels and crafts used for or involved in Petroleum	Operators

Component	Mitigation Measures	Responsibility
	Activities shall comply with applicable international and Lebanese laws and regulations regarding Petroleum Activities and navigation. The vessels and crafts shall abide by instructions given by the competent Lebanese authorities and by the competent Lebanese naval vessels, patrol boats or crafts.	
	PAR, Article 15: Operations conducted pursuant to a Reconnaissance license must not unnecessarily or unreasonably impede or prevent the navigation of other vessels or crafts, fishing, aviation or other lawful activities.	Operators
	EPA, Article 3 includes that LPA shall provide such assistance to the Right Holders as they may reasonably request in order to obtain information with respect to current and existing infrastructure and activities in the Block that are unrelated to Petroleum Activities (including telecommunication cables and areas reserved for naval activities of the State).	LPA
	Existing shipping corridors with known buffer zones and standard operating procedures in case of accidental situations.	MoPWT/ Operators
	Proposed Mitigation Measures	
	Reinstate the VTMS	GoL
	Require ships in Lebanese waters (except for military vessels) to install IVMS for proper monitoring to avoid any collisions and accidents	MoPWT
	Coordination with the concerned governmental agencies to ensure offshore developments do not interfere with shipping routes	Operators/MoEW/LPA

10.2 MONITORING FRAMEWORK

Monitoring of environmental parameters is critical to assess the status of the environment during the E&P activities implementation and for identifying effectiveness of mitigation measures that were formulated to address the potential environmental and socio-economic effects identified in this SEA Study. With the knowledge of baseline conditions, the monitoring program will serve as an indicator for any deterioration in environmental conditions due to implementation of the Plan.

The "state" and "pressure" environmental and socioeconomic indicators proposed in the development of the SEA Framework are the basis of monitoring the changes in the environmental and socio-economic parameters. Entities responsible for the monitoring of these indicators are specified in Table 10-6.

In order to affectively monitor any environmental and socio-economic impacts from the petroleum sector, the competent authorities shall start the data collection and monitoring of environmental and socio-economic parameters which are not being monitored, so that changes in baseline conditions can be detected.

MoE and MoEW/LPA should also ensure that an appropriate activity level monitoring program be devised for evaluating the environmental impacts and efficacy of mitigation measures relating to the key potential environmental issues that were identified as significant. Operators will be required to monitor their activities as per the monitoring program approved by MoE/MoEW, and they shall be responsible for providing additional monitoring of the state of the environment at the locations of the future facilities (identified areas of influence in EIA studies) in order to detect changes in the environment resulting from the Plan. Monitoring records shall be submitted to the competent authorities. Authorities also have supervision/oversight role to ensure effective monitoring by Operators.

It is recommended to adopt OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities (Reference number: 17-02e_revised_offshore_monitoring_guidelines, 2017) including their recommended procedures for sediment and water column monitoring.

Table 10-6 Indicators to be Monitored and Monitoring Responsibility

Sustainability Factor	Indicator	Indicator type	Monitoring Responsibility	Applicable E&P Phase[15]
Ecosystem Protection (Air)	Indicator 1.1: Ambient concentrations of criteria air contaminants (CO, NOx, SO_2, NMVOC, PM) in coastal cities	State	MoE	R, E, P,D
	Indicator 1.2: Emissions of CO, NOx, SO_2, NMVOC, PM from the offshore petroleum sector	Pressure	Operators	R, E, P,D
	Indicator 1.3: Change in concentrations of criteria air contaminants (CO, NOx, SO_2, NMVOC, PM) in coastal cities due to offshore petroleum activities	Impact	Operators (Within their area of influence)	R, E, P,D
Climate Change	Indicator 2.1: Change in emissions of GHGs from the petroleum sector	Impact	Operators	R, E, P,D
	Indicator 2.2: Emissions of CO_2-e from the energy sector	Pressure	MoE	R, E, P,D
	Indicator 2.3: Emissions of CO2-e during exploration activities	Pressure	Operators	E
	Indicator 2.4: Emissions of CO2-e per production unit	Pressure	Operators	P
Acoustic Environment	Indicator 3.1: Ambient noise levels measured in the vicinity of petroleum facilities/ support activities in the coastal area	State	Operators	R, E, P,D
	Indicator 3.2: Increase in ambient noise levels measured in the vicinity of petroleum facilities/ support activities in the coastal area	Impact	Operators	R, E, P,D
	Indicator 3.3: Number of Marine Mammals killed from underwater noise from the petroleum sector	Impact	MoE/CNRS/ Operators (Within their area of influence)	R, E, P,D
	Indicator 3.4: Zone of influence on marine fauna	Pressure	Operators	R, E, P,D
Ecosystem Protection (Marine Environment)	Indicator 4.1: Percent and deviation of discharges to the sea from offshore petroleum activities complying with national and international requirements	Pressure	Operators LPA	R, E, P,D
	Indicator 4.2: Heavy metals in sediments along the Lebanese coast and from different depth ranges	State	MoE/CNRS/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.3: Increase in pollutants' concentrations in sediments attributed to petroleum activities	Impact	MoE/CNRS/ Operators (within their	R, E, P,D

[15] **R:** Reconnaissance activities **E:** Exploration **P:** Production **D:** Decommissioning

Sustainability Factor	Indicator	Indicator type	Monitoring Responsibility	Applicable E&P Phase[15]
			area of influence)	
	Indicator 4.4: Impacts related to sedimentation on the sea bed/turbidity (burial of species, clogging of the valves of the filter feeders, change of sediments particle size, etc.) due to offshore petroleum activities	Impact	Operators (within their area of influence)	R, E, P,D
	Indicator 4.5: Seawater chemical characteristics along the Lebanese coast across the water column	State	MoE/CNRS/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.6: Change in chemical characteristics of seawater attributed to petroleum activities	Impact	MoE/CNRS/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.7: Number of spills reaching the coast	Impact	MoPWT	R, E, P,D
	Indicator 4.8: Occurrence of submarine land slides and related impacts (Tsunamis, change of sediments particle size) due to petroleum activities	Impact	Operators	E, P,D
	Indicator 4.9: Percent area of sensitive/ protected marine habitats affected by petroleum activities	Impact	MoE	R, E, P,D
	Indicator 4.10: **Phyto and zoo benthos** (monitoring through underwater visual observations and sampling): - Species abundance. - Status of a selected indicator species. - Species richness and density. - Diversity indices.	State	MoE/CNRS/ MoA/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.11: Changes in abundance, status, richness and density of **Phyto and zoo benthos** attributed to offshore petroleum activities	Impact	MoE/CNRS/ MoA/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.12: **Nekton - free water fish**: - Identification and counting of species. - Diversity and dominance metrics. - Community characterization	State	MoE/CNRS/ MoA/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.13: Changes in diversity and	Impact	MoE/CNRS/	R, E, P,D

Sustainability Factor	Indicator	Indicator type	Monitoring Responsibility	Applicable E&P Phase[15]
	dominance of **Nekton** attributed to offshore petroleum activities		MoA/ Operators (within their area of influence)	
	Indicator 4.14: **Sea mammals, sea turtles and seals (monitoring** through direct observation from boat): - Species abundance. - Status of indicator species (Selected from IUCN Red List) - Density of species	State	MoE/CNRS/ MoA/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.15: Changes in abundance, status and density of **cetaceans, sea turtles and seals** attributed to offshore petroleum activities	Impact	MoE/CNRS/ MoA/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.16: **Seabirds** (monitoring using direct observation): - Species abundance. - Status of indicator species (Selected from IUCN Red List) - Density of species	State	MoE/CNRS/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.17: Changes in abundance, Status and density of **Seabirds** attributed to offshore petroleum activities	Impact	MoE/CNRS/ Operators (within their area of influence)	R, E, P,D
	Indicator 4.18: Increase in the trend of introduction of invasive species due to petroleum activities	Impact	MoE/CNRS/ MoA/ Operators (in their area of influence)	R, E, P,D
Ecosystem Protection (Coastal Environment)	Indicator 5.1: Percent area of sensitive coastal habitats affected by impacts related to the sector	Impact	MoE	R, E, P,D
Transboundary Environmental Pressures	Indicator 6.1: Number of incidents of transboundary impacts from the offshore petroleum activities	Impact	MoPWT	R, E, P,D
Environmental Governance	Indicator 7.1: Number, effectiveness and extent of capacity building projects for the environmental competent authorities	Impact	LPA	R, E, P,D
	Indicator 7.2: Number of documented conflicts	Impact	(CoM)	R, E, P,D

Sustainability Factor	Indicator	Indicator type	Monitoring Responsibility	Applicable E&P Phase[15]
	among institutions			
	Indicator 7.3: Number of documented environmental and social complaints related to the petroleum sector through established grievance mechanism	Impact	LPA	R, E, P,D
Intermodal environmental parameters (Reducing Waste & Consumption Pressures)	Indicator 8.1: Quantity of hazardous wastes generated from offshore petroleum activities	Pressure	Operators	R, E, P,D
	Indicator 8.2: Percentage of hazardous waste and chemicals generated by the offshore petroleum activities properly managed	Pressure	Operators/ MoE	R, E, P,D
	Indicator 8.3: Percentage of radioactive/NORM waste generated by the offshore petroleum activities properly managed	Pressure	Operators/ LAEC	E, P,D
	Indicator 8.4: Recycling rate, tons of material recycled from offshore petroleum activities	Pressure	Operators/ MoE	R, E, P,D
Intermodal environmental parameters (Exposure to Natural Disasters)	Indicator 9.1: Direct economic loss attributed to disasters in relation to global gross domestic product (GDP) (Ref. SDGs, C110502)	Impact	MoET/DRR	R, E, P,D
	Indicator 9.2: Number of accidents caused by failure in infrastructure related to the sector	Impact	Operators/LPA	R, E, P,D
Social Conditions	Indicator 10.1: Proportion of population living below the national poverty line	State	MoSA	R, E, P,D
	Indicator 10.2: Amount of funds received by the Lebanese Government from the sector	Impact	MOF/LPA	P
	Indicator 10.3: Amount of funds generated by the sector spent on poverty reduction – especially through vocational trainings and education, social welfare programmes, improved living conditions, support programmes for small businesses, etc.	Impact	MoF/SWF	P
	Indicator 10.4: Increase in employment rate due to the offshore petroleum sector	Impact	MoSA/LPA/Operators	R, E, P,D
	Indicator 10.5: Unemployment rate, by sex, age and persons with disabilities (Ref. SDGs, C080502)	State	MoSA	R, E, P,D
	Indicator 10.6: Percent local labour working for oil and gas companies or service companies	Impact	MoL/LPA	R, E, P,D
	Indicator 10.7: Frequency rates of fatal and non-fatal occupational injuries, by sex and migrant status (Ref. SDGs, C080801)from the sector	Impact	MoL	R, E, P,D
	Indicator 10.8: Level of national compliance with labour rights (freedom of association and collective bargaining) based on International Labour Organization (ILO) textual sources and national legislation, by sex and migrant status (Ref. SDGs, C080802)	State	MoL	R, E, P,D
General				

Sustainability Factor	Indicator	Indicator type	Monitoring Responsibility	Applicable E&P Phase[15]
economy	Indicator 11.1: Increase in GDP attributed to the offshore petroleum sector	Impact	MoF/Central Bank	P
	Indicator 11.2: Non-oil based GDP	State	MoF	R, E, P,D
	Indicator 11.3: Oil-based GDP	State	MoF	P
	Indicator 11.4: Consumer Price Index (Inflation)	State	MoF	P
	Indicator 11.5: Foreign Direct Investment	State	MoF	P
	Indicator 11.6: Foreign Exchange Reserves	State	MoF	P
	Indicator 11.7: Balance of trade	State	MoF	P
	Indicator 11.8: Volume of HFO imported for power generation	State	MoEW/Customs	P
	Indicator 11.9: Size of SWF	State	MoF	P
Education	Indicator 12.1: Graduates with specific skills within the petroleum industry trained and employed	Impact	Operators/LPA	R, E, P,D
	Indicator 12.2: Unemployment rate of graduates with sector-related degrees reduced	State	MoEHE	R, E, P,D
Heritage	Indicator 13.1: Current amount of funds available for cultural heritage protection and promotion	State	MoF/MoC/ Operators	R, E, P,D
	Indicator 13.2: % of cultural and archaeological heritage sites damaged by offshore petroleum activities and related onshore activities.	Impact	Operators/ MoC/LPA	R, E, P,D
Health	Indicator 14.1: Increase in population with cardiovascular system diseases, respiratory system diseases, cancers and disabilities attributable to offshore petroleum sector	Impact	MoPH	R, E, P,D
Crime	Indicator 15.1: Number of registered crimes linked to the sector	Impact	MoJ	R, E, P,D
Landscapes and visual amenity	Indicator 16.1: % of nationally classified landscapes exposed to potential impacts	Impact	CDR/DGUP	R, E, P,D
	Indicator 16.2: Deviation of petroleum facilities from the National Land Use Master Plan requirements	Pressure	LPA	R, E, P,D
Fisheries	Indicator 17.1: Change in Fish and aquatic stock and change in chemicals concentrations in edible fish attributed to the offshore petroleum sector	Impact	MoA/CNRS/ Operators	R, E, P,D
	Indicator 17.2: Total area of where fishing activities excluded due to petroleum activities	Impact	Operators/LPA	R, E, P,D
	Indicator 17.3: Fish and aquatic stock (Ref: MoA) Assessment of biological parameters allowing stock assessments of selected pelagic and demersal fish species (Length-weight	State	MoA/CNRS	R, E, P,D

Sustainability Factor	Indicator	Indicator type	Monitoring Responsibility	Applicable E&P Phase[15]
	relationship, Age groups, Gonado-Somatic Index, Exploitation rate)			
	Indicator 17.4: Cooperation in applied research and activate the partnership with the concerned institutions (Ref: MoA)	State	MoA/MoE/ CNRS	R, E, P,D
Shipping	Indicator 18.1: Disturbance to shipping activities from the offshore petroleum sector	Impact	MoPWT	R, E, P,D
Tourism	Indicator 19.1: Change in tourist arrivals	Impact	MoT	R, E, P,D
	Indicator 19.2: Occupancy of coastal/beach resorts and hotels	State	MoT	R, E, P,D
	Indicator 19.3: Recreational and touristic marine activities i.e. water sports, diving	State	MoT	R, E, P,D
Energy	Indicator 20.1: Proportion of population with primary reliance on clean fuels (gas)(Ref. SDGs, C070102) sourced from E&P activities	State	MoEW	R, E, P,D
	Indicator 20.2: Price of unit of energy from E&P activities	State	MoEW	R, E, P,D
	Indicator 20.3: Change in cost to government to avail natural gas for power	Impact	MoEW	R, E, P,D
	Indicator 20.4: Renewable energy share in the total final energy consumption (Ref. SDGs, C070201)	State	MoEW	R, E, P,D
	Indicator 20.5: Proportion of natural gas in fuel mix used for power generation originating from E&P activities	State	MoEW	P
	Indicator 20.6: Change towards achieving the required proportion of natural gas in energy mix originating from E&P activities	Impact	MoEW	P
Infrastructure	Indicator 21.1: Increase in number and capacity of hazardous waste management facilities	Impact	MoE/CDR	R, E, P,D
	Indicator 21.2: Impacts on sub-sea infrastructure due to offshore petroleum activities	Impact	Operators/ MoEW/ MoTI	R, E, P,D
	Indicator 21.3: Change in capacity of transport infrastructure to cope with demand	Impact	MoPWT	R, E, P,D
Industry	Indicator 22.1: Number of petrochemical and energy intensive industry establishments	Impact	MoI	R, E, P,D
	Indicator 22.2: Cost of energy	Impact	MoEW	R, E, P,D
	Indicator 22.3: Number of small-scale industries working in the Petroleum industry and the petroleum services industry	Impact	MoI	R, E, P,D

10.3 CAPACITY BUILDING REQUIREMENTS

Capacity building activities to effectively raise the capacity of stakeholders to implement the requirements of this SEA are proposed:

- Training workshops focusing on improving the understanding of stakeholders about the oil and gas industry, its lifecycle and associated hazards and understanding the requirements of this SEA as well as on core aspects of the offshore oil and gas industry (technologies and BAT, major accident prevention and related safety studies, emergency preparedness and response, chemical management…etc.)
- Training of concerned authorities on the implementation of Environmental Emergency Response e.g. National Oil Spill Contingency Plan and implementing practice drills to ensure effective operationalization. Response teams of operators and the government should include fisheries scientists and marine wildlife experts to ensure that the necessary data collection methods are used to document the effects of emergencies and to supervise wildlife rescue and early rehabilitation activities.
- Provision of necessary monitoring and inspection equipment to stakeholders depending on their needs and related training
- Capacity building and enabling of concerned national entities for oil spill response and management.
- Cross-training of offshore petroleum resources authorities and environmental resource managers so that they share a common vocabulary and vision.
- Training of concerned authorities on monitoring procedures and requirements as well as reporting requirements and the data needed for reporting on different indicators and monitoring results (more importantly for marine environment parameters, GHG and air pollutants)
- Providing training to concerned authorities who will be conducting missions on-board on safety requirements related to offshore O&G activities.
- Study tours to offshore platforms and oil and gas facilities, so stakeholders (including marine resource managers and marine scientists)acquire practical know-how on how to conduct activities (such as inspections, sampling or audits) at such facilities

10.4 REQUIREMENTS FOR EIA STUDIES

Environmental impact assessment studies shall be prepared for petroleum activities according to the requirements of the petroleum and environmental legislation, namely: Law No. 132/2010 (OPRL), Decree No. 10289/2013 (PAR), Decree No. 43- Annex 2/2017 (EPA), Law No. 444/2002 and Decree No. 8633 /2012 (EIA).

The current SEA provides a substantial amount of information that will provide a basis for the subsequent EIA studies, however, the assessment is conducted at a high level and shall be subject to detailed assessment during EIA studies as more information becomes available on the techniques to be used (i.e. type of drilling rigs, type of production platforms and the type and usage of extracted hydrocarbons). The following recommendations related to future EIA studies are proposed:

- Conducting pre-activity baseline survey, activity-level monitoring during implementation (based on environmental monitoring plan), and post-activity monitoring to assess pre and post conditions for performance reporting and national reporting, including at least:
    - Surveys of benthic species at work locations.
    - Survey of mammal species, turtles and seals which could be present in the study area during the time of the proposed activity.
    - Defining and mapping birds' migration routes and time of migration, and habitats of marine birds.
    - Survey of underwater shipwrecks and archeological sites.
    - Defining underwater infrastructure corridors and survey of underwater infrastructure.
    - Survey of water quality and bottom sea sediments quality.
    - Defining important fishing areas within the area of the proposed activity and documenting of spawning and other sensitive life stages of commercially important species.
    - Defining and mapping water ways crossing the area of the proposed activity.
    - Evaluation of time of year restrictions on operations in the EIA to address sensitive life stages of important species in each proposed project area.
    - Considerations relevant to sensitive areas, protected sites and proposed protected sites (please refer to mitigation measures in the SEA Report)

A Guidance to be followed for establishing environmental baseline prior to offshore reconnaissance and exploration drilling activities is provided in Appendix D

- Conducting social baseline studies, commensurate with the expected significance of social impacts (lower during exploration, higher during development and production) in line with the monitoring framework (Table 10-6).

- Conducting specific studies, as applicable:
    - Underwater noise modelling for seismic, drilling and production activities.
    - Conducting air dispersion modelling studies for drilling and production activities.
    - Conducting ambient noise modelling studies for onshore facilities.
    - Conducting dispersion modelling in case of discharge
    - Conducting oil spill modeling
- Mandatory GHG assessment for all production facilities and demonstration of effective integration of BAT in design and implementation of facilities.
- Preparation of needed environmental and social management plans e.g. waste management plan, chemical management plan, chemicals substitution plan, chemicals database, compensation plan, pollution prevention, environmental emergency plan, environmental monitoring…etc.
- The site selection of proposed land-based activities shall be based on an analysis of alternatives, and shall be in compliance with SDATL (National Spatial Land Use Plan).
- Specifying land-based infrastructure that will be used to support the proposed activity (such as ports and airports). The adequacy of existing infrastructure to cater for the requirement of proposed activity shall be assessed.
- Use of Offset mechanism for ecological losses and devaluation after all other opportunities for avoidance and mitigation have been exploited
- Contingency plans: OSCP, gas blow-out, chemical spill, hydrocarbon spill
- Assessment of impacts from Transportation between offshore and supply base
- Assessment of cumulative and transboundary impacts
- It is recommended that future EIA studies demonstrate compliance with the SEA recommendation.

11. RECOMMENDATIONS AND CONCLUSIONS

11.1 SEA POLICY RECOMMENDATIONS

In addition to the various mitigation measures recommended in the SEA, various policy recommendations are made to inform the sustainable development of the oil and gas sector.

11.1.1 Sector Development Policies

- ✓ **Blocks Environmental Sensitivity**: Based on the baseline review conducted under this SEA, nearshore blocks are the most environmentally sensitive blocks. This is because the continental slope is part of a considerable portion of the areas of these blocks. It is recommended that, if these blocks are to be licensed, in-depth, baseline surveys (including eco-toxicological studies) and stricter controls shall be adopted, as applicable.
- ✓ **EIA for Plan for Development and Production:** Based on the nature of stages of the field development, it is recommended that an EIA is submitted at the conceptual design and preliminary engineering stages then updated EIAs at the preliminary and detailed design and construction phases.
- ✓ **Gas export**: As a general policy, an LNG export option is to be avoided given its high impact on the carbon footprint of Lebanon jeopardizing meeting national commitments towards GHG emissions reduction and not being in line with the global need to mitigate the effects of climate change. Export through pipelines should be considered instead. If LNG option is a preferred option for technical or commercial reasons, emissions should be offset to ensure compliance with Lebanon's international commitments.
- ✓ **Processing Facilities**: The SEA preferred option for multi-phase separation (i.e. separation of water, oil and gas from the extracted hydrocarbons) is to conduct such processing offshore in deep sea. It is recommended that these processes are not brought to shore or to the continental shelf to avoid significant impacts on the marine environment, fisheries and public health particularly given the likely generation of produced water from this process.

11.1.2 Environmental Governance

Despite of its importance, the required independence of the HSE regulator(s) must not become a pursuit of altruism since the only way to remove HSE risks from economic activity is to take land/sea bed out of economic use. The regulator is an enabler of high hazard industries on behalf of the state, and the economic activity is the primary purpose of allowing high hazard industries to operate. Nevertheless, identifying and mitigating the risk is indispensable at the short and long terms.

- ✓ On the short term: The principal organizational adaptation will be the creation of functional separation between the HSE decision making and the economic decision making (resource management) at the Petroleum Administration. In such circumstances, every endeavor must be made from the Minister down to ensure at all times the independence and objectivity by preventing conflicts of interest between the HSE regulation on one hand and the considerations of economic regulation and revenue collection on the other hand.
- ✓ On the long term: The principal organizational adaptation will be the creation of structural separation that is the complete separation of the HSE regulator from the economic regulator. This is the recognized international best practice model. Such structural separation could take place through various scenarios while taking into consideration the following key issues:
    1. The existing mandated roles & responsibilities of the key HSE regulatory authorities in Lebanon
    2. The existing offshore oil & gas regulatory framework (i.e. OPRL, PAR, LPA Decree, EPA)
    3. Fulfilling all, or to the maximum extent possible, the requirements of the international best practice principles
    4. Ensuring that the occupational health & safety and Major Accident prevention (including Major Accident to the Environment) are regulated by a single entity
    5. Achieving sufficient independence between HSE regulation and economic regulation
    6. Government's constraints regarding mobilization of resources

As a first scenario, an entity responsible for Occupational Health & Safety and Major Accident Prevention (including MATTE) will be established. Such entity could operate in parallel to LPA under the tutelage of the Minister of Energy and Water or under the tutelage of another ministry or be a fully independent regulatory authority. In this scenario, the follow up of all environmental matters sits with the Ministry of Environment (MOE). This will entail a close interface between the proposed health and safety regulator and the environmental regulator (MOE) namely on common topics (MATTE, management systems, etc.). Such a scenario would require active capacity building at the Ministry of Environment on the supervision of the new emerging sector. It may also require organizational arrangements at the Ministry of Environment to better follow up on the sector e.g. the provision of a specific unit.

As a second Scenario 2, an entity is established as fully independent regulatory authority that regulates all HSE aspects including day-to-day environmental matters. If need be, such entity could communicate with other ministries e.g. Ministers of Labor and Environment.

In both scenarios, all economic regulations (resource management) remains at LPA under the tutelage of MOEW.

11.1.3 Baseline Surveys

Based on the baseline review and analysis and in light of the identified gaps given the lack of data on the Lebanese offshore, baseline surveys (environmental, social, economic) should be undertaken prior to any petroleum activity in order to develop an understanding of the environmental and socio-economic conditions, identify sensitivities, develop background levels, assess the environment's capacity for restoration and inform the impact assessment.

The scope and scale of these baseline surveys will necessarily vary depending on the associated activity (reconnaissance or drilling or production).

The approach and methodology of baseline surveys should be based on international best practices, such as, IOGP, OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities.

Data Management: All currently available data, as well as new emerging data and/or studies linked to any SEA relevant topic, should be continuously collected, verified and stored in appropriate databases, in order to achieve the following:

- Support responsible authorities in the monitoring process.
- Support operators in the development of high-quality EIAs, as well as other plans and baseline studies.
- Support transparency and accountability across the sector.

11.1.4 Waste Management Policies

Main policy recommendations related to the management of waste streams that could potentially be generated during the exploration, production and decommissioning phases include:

- ✓ Waste management hierarchy should be respected throughout the lifecycle of the upstream petroleum activities
- ✓ Priority should be given to waste prevention and minimization throughout the entire value chain, without entailing excessive costs. Implementation of the prevention

principle should be equally directed toward reduced consumption patterns and better utilization of resources. Waste Management Plans should demonstrate that opportunities for prevention and minimization were used to the highest feasible extent

- ✓ Drilling fluids and cuttings should not be discharged to the sea; ship-to-shore for treatment or shipment outside Lebanon are acceptable options. Any other potential option shall be subject to a detailed environmental assessment.
- ✓ Operators are recommended to use water-based drilling fluids unless safety of the well could be jeopardized
- ✓ Produced water generated offshore should not be brought onshore for handling/treatment of disposal. Produced water should be preferably discharged into injection wells
- ✓ Only in the case that re-injection of produced water offshore is technically not feasible, discharge in the sea is allowed following strict conditions; it is recommended to follow OSPAR's risk based approach to the Management of Produced Water discharges from offshore installations in the marine environment
- ✓ In case discharge to the sea is the only option available, treated produced water cannot be discharged in the continental shelf or continental slope, or near any other sensitive ecosystem
- ✓ If NORM wastes are generated, the Lebanese Atomic Energy Commission (LAEC) should be immediately notified and these wastes should be managed according to the requirements of the LAEC; The Lebanese government should be prepared to have a state-of-the-art radioactive waste handling facility, adequately sited, and capable to store, treat and dispose of radioactive wastes generated by the petroleum sector

11.1.5 Chemical Management Policy

Main policy recommendations related to the management of chemicals include:

- ✓ Relevant authorities to develop a chemical management framework which defines the import, handling, use, storage, transport and disposal of chemicals, particularly those relevant to the oil a nd gas sector
- ✓ Chemicals storage onshore should be centralized and limited to zones classified for such purposes (e.g. industrial zones)
- ✓ Eco-toxicity data shall be available for chemicals intended for use where preference should be given to chemicals registered in international databases such as European Chemical Agency (ECHA) or equivalent
- ✓ Chemicals Management Plans should be developed to be approved prior to the start of any activity involving the use of chemicals in line with EU regulations

- ✓ Continuous efforts should be targeted to substitute chemicals with hazardous characteristics with less hazardous alternatives
- ✓ International Maritime Dangerous Goods (IMDG) Code should be adopted for the transportation of dangerous goods or hazardous materials by vessels
- ✓ For the transport by road of chemicals considered dangerous goods, Lebanese Transport Operators are required to follow national legislations including Decree No. 5606 dated 11 Sep 2019 on the management procedure of hazardous waste and its related Decision No. 999/1 dated 24 Dec 2019 on the transport of hazardous waste, in addition to the rules of European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR and its protocol)
- ✓ Government to consider ratifying the hazardous noxious substances related Convention and Protocols

11.1.6 Transparency & Fiscal Policy

The E&P sector in Lebanon has already established strong safeguards to enable transparency and control corruption within the sector; this includes the recently adopted Transparency Law for the offshore oil and gas sector and the provision of a Sovereign Wealth Fund to manage revenues from the sector. However, it is still vital that the Government of Lebanon ensures the enforcement of both set-up mechanisms throughout all phases of the sector.

Potential investment from Sovereign Wealth Fund reserves into productive sectors, infrastructure and social welfare could significantly contribute to enhancing socio-economic conditions in Lebanon, as well as providing investments in "green industries", leading to further improvement of living conditions in Lebanon. Therefore, the design and operational management of the SWF should be carefully done, preferably in a highly participatory and transparent manner, not only to mitigate exposed social and economic risks, but also to ensure long-term and sustainable development of Lebanon.

11.1.7 Management of Expectations

Development of any important economic sector, such as the petroleum sector, brings important impacts on the Lebanese society – both positive and negative. Therefore, it is important for the Government of Lebanon to understand the key drivers of change in social conditions in order to enhance positive impacts and mitigate negative ones.

Since first signs of unrealistic expectations from the petroleum sector were already identified, substantial responsibility lies on the shoulders of responsible authorities to communicate realistic and evidence-based information to the Lebanese society. It is highly recommended that responsible authorities develop and enforce a comprehensive communication strategy, which will:

- Raise the awareness on relevant topics;
- Ensure active and constructive stakeholder engagement;
- Promote beneficial impacts effectively;
- Manage expectations from the sector;
- Promote Corporate Social Responsibility (CSR) practices in the sector.

If developed and appropriately implemented, it could also become an additional and important pillar of transparency and accountability in the sector.

11.2 IMPLEMENTATION OF THE SEA

Main recommendations for the effective and efficient implementation of this SEA include:

- ✓ Endorsement of the SEA recommendations and policies through integration into regulations and enactment by legal texts, as applicable.
- ✓ Maintain the SEA Task Force for the purpose of coordinating SEA implementation and environmental management of the sector (SEA Implementation Committee). Details of proposed requirements/modality for the SEA Implementation Committee are presented below.
- ✓ Proper enforcement of legal requirements and existing control measures. **Appendix E** of the SEA report includes a proposed template for the SEA implementation plan, this template shall be populated by the SEA Implementation Committee. **Appendix F** presents a populated **example** for the purpose of explaining the format.
- ✓ Integration of the SEA framework indicators (state indicators) within the monitoring plans of key performance indicators monitored by authorities, as relevant.
- ✓ Operationalization of the systematic monitoring of indicators through envisioning of resources (qualified human resources, equipment, finances)Operationalization of the environmental database on environmental data associated with the offshore oil and gas sector.
- ✓ Establish a Scientific Committee, particularly on marine related issues, to act as an advisor to the LPA on technical matters.
- ✓ It is recommended that this SEA be updated in 5 years from the date of MoE final approval of this SEA. The scope of the update shall be decided by MoE in coordination with MOEW/LPA.

Requirements for SEA Implementation Committee and Possible Modalities

There are several options for the future operational model of the Implementation Committee:

1. It could remain in a similar operational model as the Task Force today – a technical body for consultation and cross sectorial coordination, with limited decision-making capacities. However, this would mean that individual ministries would be responsible for the implementation of significant parts of the SEA Implementation plan, while MoE and/or LPA would have to oversee overall implementation and progress.
2. It could be officially named by the Lebanese Government – each ministry/responsible authority would have 1 "focal-point" representative, who would take over the responsibility to represent its ministry in the Implementation Committee. The Implementation Committee would remain predominantly technical and coordinating body, where representatives would oversee realization of the SEA Implementation Plan, would jointly seek out best solutions and propose them to decision makers.
3. It could be named as a working body of the SDGs committees and would operate in a similar way, as described in the second option.

In either case it is advisable that:

- Implementation Committee takes over the responsibility to oversee operational realization of the SEA Implementation Plan.
- Implementation Committee convenes on regular basis – for example every 3 or every 6 months.
- LPA and/or MoE take over the leading role in the Task force, as majority of tasks falls under their jurisdiction.
- NGOs and/or other relevant actors are invited to oversee the work of the Task force, thus further contributing to transparency and accountability across the sector.

11.3 CONCLUSION

This SEA study has systematically identified potential positive and negative environmental and socio-economic impacts that could be generated from the development of the offshore oil and gas sector in Lebanon.

Significance of both positive and negative impacts depends on the quantities and types of hydrocarbons that could be found offshore Lebanon and how they are developed. In summary:

- ✓ If no discoveries are made, both negative environmental impacts and positive socio-economic impacts would remain low, except in the case of a major accident during exploration drilling; it is therefore very important that focus be directed by regulators towards the prevention of major accidents
- ✓ If modest discoveries are made or if the government decides to develop discoveries solely for the purposes of power generation, both negative environmental impacts and positive socio-economic impacts would remain moderate; several measures are proposed in this SEA to minimize negative impacts and maximize positive ones
- ✓ If significant discoveries are made, negative environmental impacts could be significant if mitigation measures are not implemented; at the same time, positive socio-economic impacts particularly in terms of GDP contribution, reduced imports and increase exports, as well as potential investment from Sovereign Wealth Funds reserves into productive sectors, infrastructure and social welfare could significantly contribute to enhance socio-economic conditions in Lebanon.

It is therefore crucial to strictly implement recommendations from this SEA to ensure that potential negative impacts are effectively managed and positive impacts are enhanced in case discoveries are made and are developed in Lebanon.

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