ENVIRONMENTAL IMPACT ASSESSMENT PROCESS FOR THE FLOATING LIQUEFIED NATURAL GAS PROJECT

ENVIRONMENTAL IMPACT STUDY

FINAL REPORT

VOLUME II – IMPACT ASSESSMENT AND MITIGATION MEASURES

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Eni East Africa S.p.A

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March 2015

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AAHTS	Anchor Handling Tug Supply
AoI	Area of Influence
ADMS	Air Dispersion Modeling Study
AII	Area of Indirect Influence
AIS	Alien Invasive Species
AuIS	Automatic Information System
ALARP	As Low As Reasonably Practical
AMA	Association of Environment
AQS	Air Quality Standards
AWL	Above Water Level
BAOAC	Bonn Agreement Oil Appearance Code
BDV	Blow Down Valves
BOD	Biological Oxygen Demand
BOP	Blowout Preventer
BWMP	Ballast Water Management Plan
CDS	Sustainable Development Centre
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CSR	Corporate Social Responsibility
DAH	dissolved-phase aromatic hydrocarbons
DP	Dynamically Positioned
DPCA	Provincial Directorate for the Coordination of Impact Assessment
EEA	Eni East Africa, S.p.A.
EEZ	Economic Exclusive Zone
EF	Emission Factor
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EMP	Environmental Management Plan
EP	Equator Principles

Acronym	Definition
EPDA	Environmental Pre-feasibility and Scope Definition Study
EPCC	Exploration and Production Concession Contract
ERP	Emergency Response Plan
FEED	Front-End Engineering and Design
FLNG	Floating Liquefied Natural Gas
FNP	Fórum para a Natureza em Perigo
GDP	Gross Domestic Product
GEMSS	Generalized Environmental Modeling System for Surfacewaters
GHG	Greenhouse Gases
GoM	Government of Mozambique
GT	Gross Tonnage
GTC	Gas Turbine compressors
GTG	Gas Turbine generators
GWP	Global Warming Potential
HFC	Hydro Fluoro Carbons
H_2S	Hydrogen Sulphide
IDPPE	Institute for the Development of Small Scale Fisheries
IMO	International Maritime Organization
INAHINA	National Institute of Hydrography and Navigation
INAMAR	National Maritime Institute
ITDs	sexual transmitted infections
IUCN	International Union for the Conservation of Nature
I&APs	Interested and Affected Parties
KPIs	Key Performance Indicators
LC50	Lethal Concentration 50
LDAR	Leak Detection and Repair System
LNG	Liquefied Natural Gas
LTOBM	Low Toxic Oil Base Mud
MARPOL	International Convention for the Prevention of Pollution from Ships
MEET	Methodology for Estimate Air Pollutant Emissions from Transport
MITADER	Ministry of Land, Environment and Rural Development

Acronym	Definition
MODU	Mobile Offshore Drilling Unit
MT/hr	Metric Ton Per Hour
MTPA	Million Tons per Annum
NAF	Non Aqueous Fluid
NF3	Nitrogen Triflouride
NOx	Nitrogen Oxides
NOSCP	National Oil Spill Contingency Plan
N_2O	Nitrous Oxide
NTS	Nontechnical Summary
OBM	Oil Based Muds
OSCP	Oil Spill Contingency
OSRL	Oil Spill Response Limited
OSRP	Oil Spill Response Plan
PFCs	Per Fluoro Carbon
PM	Particulate Matter
PPP	Public Participation Process
PSV	Platform Supply Vessel
PSVs	Pressure Safety Valves
PTS	Permanent Threshold Shift
SBM	Synthetic Based Mud
SDU	Subsea Distribution Unit
SF6	Sulphur Hexafluoride
SOx	Sulphur Oxides
SPS	Subsea Production System
SURF	Umbilicals, Risers, Flowlines System
tCO_2e	Tons of Carbon Dioxide Equivalent
ToR	Terms of Reference
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
UNFCCC	United Nations Framework Convention on Climate Change
US-EPA	United States Environmental Protection Agency

Acronym	Definition
VLCCs	Very Large Crude Carriers
VOC	Volatile Organic Compounds
WBM	Water Base Mud
WHO	World Health Organization

7 Impact Assessment and Mitigation Measures

7.1 Introduction

7.1.1 General Considerations

This Chapter provides an assessment of the potential biophysical and socio-economic impacts, both direct and indirect, positive and negative, that will result from the installation and drilling, commissioning, operation and decommissioning of the Floating Liquefied Natural Gas (FLNG) Project.

Potential impacts of the project are assessed for each aspect of the biophysical and socio-economic environment described in Chapter 6 (Volume I). Impact identification was based on the preliminary impact scoping developed in the Environmental Pre-feasibility and Scope Definition Study (EPDA), and was updated considering the findings of the specialist studies and other more detailed analysis undertaken for the EIS.

For each identified impact, an impact description is provided and its significance is assessed according to the standardized impact assessment methodology, as described in Section 7.1.2 below. Considering the assessed significance rating, mitigation measures are then defined aimed at reducing the significance of the residual impact to acceptable levels, as described in section 7.1.2.5. For positive impacts and where relevant, enhancement measures are proposed. Monitoring requirements are also provided, where relevant.

The significance of each potential impact is also rated after the application of mitigation/enhancement measures, so as to assess the residual impact significance. The impact assessment for each impact is summarized in a table format, including the pre-mitigation assessment, the key proposed mitigation measures and the residual impact assessment.

Mitigation, enhancement and monitoring measures resulting from the impact assessment are then organized in thematic programs in the EMP, which is presented in Volume III.

7.1.2 Impact Assessment Methodology

The purpose of impact assessment is to:

- Identify and evaluate the likely significance of the potential impacts of the Project on identified receptors and natural resources according to a defined set of assessment criteria;
- Develop and describe measures that will be taken to avoid, minimize, reduce or compensate for any potential adverse environmental effects;
- Report the significance of the residual impacts that remain following mitigation.

The adequate assessment and evaluation of the potential impacts and benefits associated with the proposed Project, follows a standardized scientific methodology that will reduce the subjectivity involved in making such evaluations. This methodology is used to determine the significance of the predicted impact on, or benefit to the surrounding natural and/or social environment. For this, the proposed Project must be considered in the context of the natural and social area that will be affected during the lifetime of the Project, or biological, physical and socio-economic baseline conditions.

The impact assessment provided is based on the professional judgment and experience of various specialists and EIA practitioners. The evaluation of impact significance is thus contingent upon different expert and professional judgment and dependent upon the environmental and community context. But

ultimately, impact significance involves a standardized and as objective as possible process of determining the acceptability of a predicted impact on the receiving environment.

7.1.2.1 Impact Prediction

An impact is essentially any change to a resource or receptor brought about by the presence of Project components or by the execution of Project related activities. There are a number of ways that impacts may be described and quantified, including:

- Nature of impact: positive or negative;
- Type of impact: direct, indirect, cumulative or perceived;
- Duration of impact: temporary, short-term, medium-term , long-term or permanent;
- Scale of impact: on-site, local, regional, national, international / trans-boundary;
- Sensitivity, resilience and / or importance of the receptor/resource;
- Number of elements that could be affected by the impact.

The types of impacts and terminology used in the assessment are outlined in the **Table 7.1** below.

Table 7.1 – Defining the nature of the impact

Term	Definition
Nature	
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor
Type of impact	
Direct	Impacts that result from the direct interaction between a planned project activity and the receiving natural and human environment (e.g. atmospheric emissions which affect air quality)
Indirect	Impacts that result from other (non-project) activities but which are facilitated as a result of the project (e.g. in-migration of job-seekers, which places additional demands on natural resources) or impacts that occur as a result of subsequent interaction of direct project impacts within the environment (e.g. increased noise levels that affect marine fauna which in turn affect tourism-based activities).
Cumulative	Impacts that act together with current or future potential impacts of other activities or proposed activities in the area / region that affect the same resources and / or receptors (e.g. combined effects of waste water discharges from more than one project into the sea, which may be acceptable individually, but cumulatively result in a reduction in water quality and fishing productivity).
Perceived	Changes that may be unconnected to, but blamed on, the project. These are identified and assessed through stakeholder engagement and consultation.

The EIS considered both routine (e.g. increased vessel traffic) and non-routine events that may lead to potential impacts. “Unplanned” events generally relate to accidents (such as oil/fuel spills, emergency flaring or venting of gas, etc.) that may result in adverse impacts. In these cases, the probability of the event occurring is also considered.

7.1.2.2 Assessing Significance

Once potential impacts were identified, they are assessed in order to determine mitigation/enhancement and management measures. In assessing the significance of each impact (positive or negative), the following criteria was applied:

- Temporal scale of the impact (i.e. temporary, short-term, long-term, permanent).
- Spatial scale of the impact (i.e. local, regional, national, international, trans-boundary).
- Sensitivity, resilience and/or importance of the receptor/resource that is being impacted.
- Number of elements (including tourism and fishing operators, ships, species and habitats) that could be affected by the impact.

Each criterion was ranked with scores assigned as presented in **Table 7.2** below to determine the significance of every single impact (equal to the sum of scores). The total scores, with their impact levels and actions, are indicated in **Table 7.2**.

Table 7.2 – Criteria for significance ranking

Ranking	Evaluation Criteria				Significance
	Duration	Extent	Importance/resilience of receptor/resource	No. of elements involved*	
Low 1	Less than 1 year / Temporary	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources, able to recover or adapt to the change without interventions	Affecting small no. of tourism and fishing operators, ships, and/or small no. of species and habitats	Ranging from 4 - 16
Medium 2	Between 1 and 5 years	Regional scale: as determined by country's administrative boundaries	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting medium number of tourism and fishing operators, ships, and/or higher no. of species and habitats	
High 3	Between 5 and 10 years	National scale: Entire country	High value/sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting great no. of ships and /or medium/large tourism and fishing operators and/or species, habitats and ecosystems	
Critical 4	Over 10 years / Irreversible	International scale: trans-boundary	Extreme value/sensitivity of receptors or resources, resulting in permanent changes	Affecting huge no. of ships and /or large tourism and fishing operators and/or habitats structure and ecosystems functions	
Score	(1; 2; 3; 4)	(1; 2; 3; 4)	(1; 2; 3; 4)	(1; 2; 3; 4)	

The evaluation is carried out on a case-by case basis, where the significance of an impact heavily relies on the affected biological, physical and socio-economic baseline conditions, site-specific conditions and the specific nature of the project. Consequently, the weights for the evaluation criteria, as indicated in **Table 7.2** above, above were adjusted in some instances.

The weights specified above acted as guidelines. The rationale for setting thresholds and their values are being specified. These will then form the basis for mitigation measures as described below. Any change in weighting and the reason for this change are described in detail to allow this to be properly evaluated in future, should a further change be required.

The results of the individual and integrated impact assessment will also allow the evaluation of project alternatives. Comparison of impacts associated with each alternative should help identify the option that results to be more beneficial or provides least damage to the environmental, social and health context as a whole, at an acceptable financial and reputational cost, in the short and long term.

Table 7.3 – Impact significance rating and actions

Ranking	Impact Level		Control and Management Actions
4-6	Low	Actions in the short term	Ensure that policy and control measures are adequate to control the impact
		Actions in the long term	Verify that monitoring and reporting activities are properly established to guarantee the correct application of policy and ensure that control measures remain adequate.
7-9	Medium	Actions in the short term	Check if current policy and control measures are adequate, and revise them accordingly to set appropriate objectives for improvement.
		Actions in the long term	Develop adequate plans and activities for control measures, ensuring that are approved and implemented with timescales set and resources (budget and personnel) allocated.
10-12	High	Actions in the short term	Plans and activities are implemented to mitigate the impact as soon as possible. Interim reduction measures are established.
		Actions in the long term	Long-term plans and activities are developed. Parameters and Key Performance Indicators (KPIs) are set and properly measured, monitored, reported and verified. Targets are set for improvement and feedback used for corrective actions.
13-16	Critical	Actions in the short term	Immediate emergency measures to reduce the impact. Align the current level of control and implemented measures to best available practices to address the issue. Parameters and KPIs are measured, monitored, reported and verified. Targets are set for improvement and feedback used for continuous improvement.
		Actions in the long term	The Project demonstrates the delivery of continuously improved performance through Research and Development, technology innovation, training of personnel, strategic partnerships and input and feedback from internal and external stakeholders

Comparing different alternatives for the proposed project will include the feasibility of the mitigation measures, their capital and recurrent costs, their suitability under local conditions and their institutional and monitoring requirements. Assuming that the decision from project comparisons is for the project to go ahead, the result will be the selection of a preferred alternative with the associated recommended mitigation/enhancement measures.

7.1.2.3 Cumulative Impacts

Cumulative impacts occur when a Project activity acts together with other activities (other projects) to impact on the same environmental or social resources or receptor. Cumulative impacts have been defined as *"the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is*

conducted[1])". By definition, the impact assessments in this EIS Report consider the cumulative impacts of past, present and planned further projects in that all impacts are assessed against the present day baseline. The present day baseline includes impacts of past and present projects that have shifted the original natural conditions to the present day conditions.

7.1.2.4 Mitigation Measures

One of the key objectives of an EIS is to identify and define socially, environmentally and technically acceptable and cost effective mitigation (or enhancement) measures. These should aim at avoiding or minimizing any negative impacts identified, and to create or enhance positive impacts, thus avoiding unnecessary damage to the environment; safeguarding valued or finite resources, natural areas, habitats and ecosystems; and protecting humans and their associated social environments.

Mitigation measures are developed to avoid any negative impact first, rather than trying to reduce its negative effect later. In cases where this is not possible, the objective will then be to reduce (on or off site) the impacts to an acceptable level, such that no major/critical residual impacts are left. If residual impacts remain, after mitigation, then remediation or compensation (offset or net positive outcomes) should be considered. These mitigation criteria and the hierarchy to identify the appropriate mitigation measure are illustrated in **Table 7.4** below.

Table 7.4 – Mitigation criteria

Mitigation criteria (presented in hierarchy)	Definition
Avoid at source (minimization)	Re-design the project in order to remove the potential impact (e.g. relocating facilities).
Reduce on site (End -of-pipe)	Design control systems to minimize impacts (e.g. installation of illumination with reduced light glow).
Reduce off site	Implement off-site measures in order to reduce those impacts that cannot be eliminated with on site treatments (e.g. radar and buoy warning systems).
Remedy	Repair any residual, unavoidable damage to natural and human environment by restoration activities or appropriate interventions.
Offset	Compensate for residual, unavoidable impacts if other mitigation measures are not feasible, cost-effective, or already fully implemented.
Net positive outcomes	Make a positive contribution to Biodiversity conservation and/or improvement of Ecosystem Services and communities' development.

In this context, the term mitigation measure includes operational controls as well as management actions. These measures are often established through industry standards and may include:

- Changes to the design of the project during the design process (e.g. changing the development approach);
- Engineering controls and other physical measures applied (e.g. waste water treatment facilities);
- Operational plans and procedures (e.g. waste management plans); and
- The provision of like-for-like replacement, restoration or compensation.

For impacts that are assessed to be of *Critical* and *High* significance, a change in design shall be evaluated to avoid or reduce these. For impacts assessed to be of *Medium* significance, specific mitigation measures

[1]As defined by IFC Performance Standard 1, January 2012.

such as engineering controls are usually required to reduce these impacts to As Low As Reasonably Practical (ALARP) levels. This approach takes into account the technical and financial feasibility of mitigation measures. Impacts assessed to be of *Low* significance are usually managed through good industry practice, operational plans and procedures. The focus of mitigation is usually on avoiding or reducing negative environmental and social impacts. Additional measures can be recommended in order to ensure the enhancement of positive impacts, such as economic benefits.

7.1.2.5 Assessing Residual Impacts

Residual impacts are those impacts which remain once the mitigation measures have been designed and applied. Once the mitigation is applied, each impact is re-evaluated (assuming that the mitigation measure is effectively applied) and any remaining impact is rated once again using the process outlined above. The result is a significance rating for the residual impact.

The degree of significance attributed to residual impacts is related to the weight the EIA Team considers should be given to them in making decisions on the Project and developing conditions.

Any residual **critical** or **high impacts**, whether positive or negative, are considered to warrant substantial weight (when compared with other environmental, social or economic costs and benefits) for those making decisions on the Project. Conditions will be expected to be imposed to ensure residual negative impacts are strictly controlled and monitored and residual positive impacts are fully delivered.

Residual **medium impacts** are considered to be of lesser importance to making decisions, but still warranting careful attention to conditions regarding mitigation and monitoring, to ensure best available techniques are used to keep adverse impacts within levels deemed to be acceptable and to ensure beneficial impacts are delivered.

Low impacts are brought to the attention of decision-makers but are identified as warranting little if any weight in the decision; mitigation will be achieved using normal good practice and monitoring will be expected to be carried out to confirm that impacts do not exceed predicted levels.

7.2 Impact Assessment: Physical Environment

7.2.1 Air Quality

7.2.1.1 General Considerations

Following the air quality baseline assessment (see Volume I), this section assesses the potential air quality impacts resulting from project implementation. The main project impacts on air quality are associated with vessel circulation as well as the operation of the FLNG (both during normal operation and unplanned events). As such, impacts have been grouped in (1) drilling, installation and commissioning phases; (2) operational phase; (3) decommissioning phase and (4) unplanned events.

As stated in the baseline assessment, no sensitive receptors were identified in close proximity to the project, given that the FLNG will be located at about 50 km from the coast. Other sensitive receptors such as fishing, commercial and recreational vessels will only be exposed discontinuously and occasionally to the project emissions, and in any case will be located outside the exclusion zone of 3.7 km.

It should be noted that impacts related with atmospheric emissions of greenhouse gases (CO_2, NH_4, N_2O) during all project phases have been assessed separately and are presented in an independent section after the Air Quality assessment (see Section 7.2.2).

7.2.1.2 Potentially Impact Generating Project Activities

The main project activities likely to result in atmospheric emissions include:

- Circulation of vessels during drilling, installation, commissioning and decommissioning: likely to emit Nitrogen Oxides (NO_X), Carbon Monoxide (CO), Volatile Organic Compounds (VOC), Particulate Matter (PM) and Sulphur Oxides (SO_X);
- Operation of the FLNG facility including power generation unit, cold compressor unit and operational flaring: likely to emit NOx, CO and PM.

Given that details on the drilling program were not available at the time of this assessment, air emissions resulting from the drilling process, including power generation, well clean-up and well testing are excluded from the assessment.

7.2.1.3 Drilling, installation and commissioning phase

Impact: Increase in atmospheric concentrations resulting in potential adverse effects on air quality

Impact Assessment

The vessels involved in the offshore drilling, installation and commissioning activities will support the wells drilling, as well as the preparation of the sea bed and installation of subsea facilities, mooring chains and anchors; in particular vessel activities include towing and hook up of FLNG during the installation phase and logistic support during the commissioning phase. Thus different types of vessels will be involved in these activities (e.g. construction vessel, supply vessel, security vessel) which will release exhaust gases.

The impact on local air quality produced by Project vessel activities has been assessed by means of a quantitative estimation of vessel emissions. The calculation of ships transport emissions was based on the Methodology for Estimate Air Pollutant Emissions from Transport (MEET), developed by the UK Transport Research Laboratory.

The detailed MEET method was applied based on the Project data on vessel activity for the drilling, installation and commissioning of the FLNG. **Table 7.5** below presents the number and type of vessels involved in the Project along with their Gross Tonnage (GT) and number of working days. According to the project information currently available, the maneuvering operating mode and a medium speed diesel engines (< 200 r/min) were assumed for the four types of vessels considered. Moreover, the calculation assumed one working day as 24 continuous hours of work.

Table 7.5 – Vessels Involved in the Drilling, Installation and Commissioning of the FLNG

Type of Vessel	Number of ships per day	Working hours per day	Working days	Gross Tonnage
Flexible-lay & Construction vessels	2	24	200	6000
Anchor Handling Tug Supply (AAHTS)/ Platform Supply Vessel (PSV) Construction Support	6	24	200	2500
PSV for drilling support	3	24	400	2500
Security vessels	3	24	400	1000

Vessel emissions of the main atmospheric pollutants have been estimated based on the data presented in **Table 7.5** above, by applying the MEET methodology (please see **Appendix XIII.1**, **Volume IV**, for more details). Results are presented in **Table 7.6** below. It is assumed that all vessels used will be in compliance with the emission standard required by MARPOL Convention 73/78, IMO and use a low sulphur fuel.

Table 7.6 – Estimation of Air Pollutant Emissions from Vessels to total number of working days for the Drilling, Installation and Commissioning Phase

Pollutant	Tonnes emitted (t)
NO_x	4438.63
CO	2436.89
VOC	313.32
PM	104.44
SO_x	69.63

The FLNG installation will be completed in little more than 1 year (up to 400 days) therefore its impact duration is considered to be *medium*. Atmospheric emissions will be released at a distance of about 50 km away from the closest human receptors located at the Quirimbas Islands. In terms of air quality, the dispersion of pollutant emissions is rapid in an offshore environment, and impacts are not expected to occur on the terrestrial environment; moreover considering the wind regime of the area, predominant northerly and southerly winds are likely to transport the emitted pollutants far from the island and coastal areas. Additionally, emissions from vessels will be mobile and temporary and this will increase the dispersion of pollutants. Therefore, the extent of the impact is considered to be *local*, and the resilience of receptors and the number of elements involved are considered to be *low***.** Subsequently the significance prior to mitigation is assessed as ***low***.

Mitigation Measures

- Implement an Air Quality Management plan focused on optimizing transport and logistics, maintaining all the equipment efficient in order to reduce the fuel consumption and minimize air emissions.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Increase in atmospheric concentrations resulting in potential adverse effects on air quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Prepare and implement an Air Quality Management Plan.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Medium	2
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**5**		**Low**	**5**

7.2.1.4 Operational Phase

Impact: Increase in atmospheric concentrations resulting in potential adverse effects on air quality

Impact Assessment

The power generation unit and the cold compressor unit will operate continuously during the FLNG operation phase. The Cold Compressor Unit (Unit 370) which consist of four (4) Gas Turbine compressors (GTC); and the Power Generation Unit (Unit 470) which consist of four (4) Gas Turbine generators (GTG).

Flaring of hydrocarbons will not occur during routine normal operations. Flaring will only occur during upset and emergency conditions (lasting less than 15 minutes) and during planned non-routine operational conditions, such as start-up, partial/total shutdown, depressurization and equipment and pipe work purging, which will occur discontinuously during the operational phase and last 15 minutes or more.

Based on preliminary project data, no fugitive emissions are predicted to arise from the FLNG storage tanks or from the ship loading systems. The combined vapors from the FLNG tanks and the ship loading systems will be compressed by the boil-off gas compressors and returned to the refrigeration system, or flared.

The FLNG normal operation will release emissions of atmospheric pollutants, such as NOx, CO and PM, into the atmosphere. Therefore, the operation of the FLNG is likely to determine a change of the existing air quality conditions (in terms of NOx, CO and PM concentrations), resulting in a potential impact on local air quality.

No sulphur is expected in the fuel gas used to feed the gas turbines. This is because any traces of reduced sulphur compounds such as hydrogen sulphide (H_2S) will be removed, if required, during the pre-treatment phase of the gas liquefaction process. Since no sulphur is expected in the fuel gas feeding the gas turbines, their activity will not produce SO_2 emissions. Emissions of pollutants in the effluent are compliant with emission limits stated as applicable to the Project, in correspondence between EEA and MITADER (see **Appendix IV**, **Volume IV**).

Due to the offshore location of the FLNG and the absence of residential or permanent (e.g. fishery facilities) receptors in the area around the FLNG, it is unlikely that emissions of airborne pollutants will have a continuous adverse effect on local population during the project operational phase; moreover, atmospheric emissions disperse quickly in offshore environments. Other sea users, such as fishermen, will only be exposed discontinuously and occasionally to the project emissions.

The potential impact on local air quality has been quantitatively assessed by means of a dedicated Air Dispersion Modeling Study (ADMS) (ERM, 2014g). Results obtained from the ADMS have been subsequently compared against National and International Air Quality Standards (AQS).

The ADMS was performed with the CALMET–CALPUFF modeling system, adopted and recommended by the United States Environmental Protection Agency (US-EPA). A detailed description of the modeling set up - dispersion modeling tool, model domains, and meteorological data – emission scenarios along with model results, sourced from ERM (2014g) is presented in **Appendix XIII.2** (see **Volume IV**).

Ground concentrations of macro pollutants produced by the FLNG under operational conditions were modeled over a 40 km x 40 km domain, approximately centered on the FLNG Coral 1 location. This domain represents the area of study for this ADMS.

The ADMS results are presented in **Table 7.7** below, along with Mozambican and International AQS. Modeled pollutant concentrations were spatially localized by mean of iso-concentration maps. The latter are presented in **Appendix XIII.2** (see **Volume IV**).

Table 7.7 – Operation Phase: Maximum Modeled Concentrations of Atmospheric Pollutants

Pollutant	Averaging Period	Modeled concentrations [µg/m^3]	Mozambique AQS [1] [µg/m^3]	IFC/WHO [2] [µg/m^3]
NO_2	Calendar year	0.12	10	40
	1 h	26.46	190	200
TSP	Calendar year	<0.01	60	-
	24 h	0.02	150	-
PM10	Calendar year	<0.01	-	20
	24 h	0.02	-	50
CO	8 h	11.23	10000	-
	1 h	50.93	30000	-
	30 min[3]	203.72	60000	-
	15 min[3]	814.88	100000	-

Notes: [1] Decree 18/2004, as amended by Decree 67/2010; [2] WHO (2005); [3] The model resolution is one hour. Concentrations for averaging periods shorter than 1 hour were calculated on the base of the methodology provided by EPA in the Workbook of screening techniques for assessing impacts of toxic air pollutants.

As shown in **Table 7.7** above modeled maximum pollutant concentrations comply with National and International AQS. In particular modeled concentrations are considerably lower than their respective concentration limits and are unlikely to contribute to significant change of the existing background concentrations of pollutants. Moreover, as shown in the iso-concentration map presented in **Figure 7.1** below (see more maps in **Appendix XIII.2** – **Volume IV**), NO_x concentration maxima produced by the FLNG operation phase occurs offshore and does not affect local population.

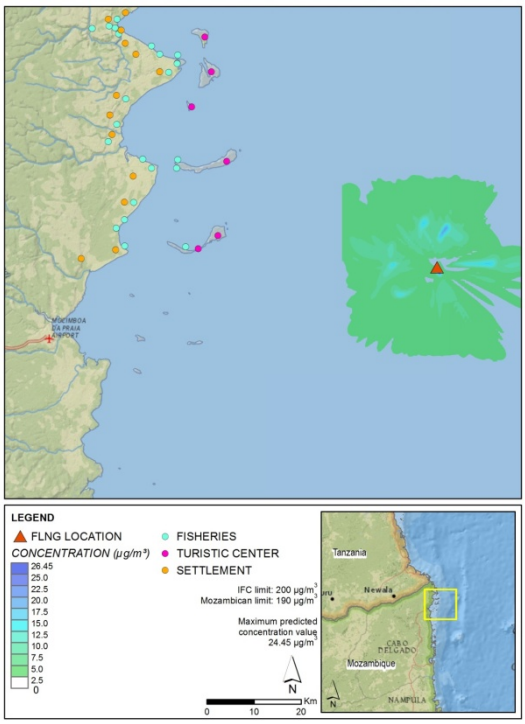


Figure 7.1 – Operational ADMS – NOx Hourly Concentration Map

Therefore the extent of the impact is considered to be *local*, and the resilience and the number of elements involved are considered to be *low*. Impact duration is considered to be *high* (long term, but reversible), since atmospheric emissions related to the Project routine operation will be released throughout the Project life. Subsequently the significance prior to mitigation is assessed as *low negative.*

Mitigation Measures

- Atmospheric concentrations of airborne pollutants induced by the FLNG routine operation comply with National and International AQS. Furthermore, induced concentration maximum occurs offshore and do not affect receptors as previously referred. Therefore air quality impacts arising during the Project routine operation will be managed through the implementation of a discontinuous Stack Emission Monitoring System for the gas turbines. Moreover the implementation of a Leak Detection and Repair System (LDAR) is recommended[2], in order to verify that the expected level of fugitive emissions released by the FLNG during its routine operation remain negligible. Uncontrolled VOC emissions might arise from pumps, valves, connectors, compressors, open ended lines and sampling connections;
- This monitoring activity will be included in the EMP and will allow verification that the compliance of the FLNG emissions with in-force atmospheric emission limits.

Impact Assessment Summary

On the base of the impact assessment methodology for this phase, the potential impact significance on air quality associated with the operational phase of the project is summarized below in the following table.

2 LDAR is a work practice designed to identify leaking equipment so that emissions can be reduced through repairs. A component that is subject to LDAR requirements must be monitored at specified, regular intervals to determine whether or not it is leaking. Any leaking component must then be repaired or replaced within a specified time frame.

Impact: Increase in atmospheric concentrations resulting in potential adverse effects on air quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement a Stack Emission Monitoring System; - Implement a Leak Detection and Repair (LDAR) System.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

7.2.1.5 Decommissioning phase

Impact: Increase in atmospheric concentrations due to vessel activity during decommissioning phase resulting in potential adverse effects on air quality

Impact Assessment

The activity of the vessels involved in the decommissioning of the FLNG along with the pumps involved in the flushing of the subsea flow lines represents the main source of atmospheric emissions during the decommissioning phase. The activity of the pumps is not expected to last more than one month.

The vessels involved in the offshore decommissioning activities will support the plugging and abandoning of the wells and perform the removal and towing of the FLNG. Thus different types of vessels will be involved in these activities, which will release exhaust gases. It has to be noted that a low sulphur fuel will be used and that vessels emissions will comply with the International Maritime Organization (IMO) requirement for Sulphur dioxide emissions.

The flow lines flushing activities are not expected to last more than one month with consequent negligible emissions released by the pumps.

With regard to the FLNG towing and removal activities, a similar number and type of vessels required for the drilling, installation and commissioning phase is expected to be used, and that the activity will be completed in less than 1 year. Therefore, the duration of the impact is considered to be *low,* the extent of the impact is considered to be *local*, and the resilience of receptors and the number of elements involved are considered to be *low*. Subsequently the significance prior to mitigation for the decommissioning phase is assessed as ***l****ow negative*.

Mitigation Measures

Impacts arising on local air quality during the Project decommissioning phase will be managed through the implementation an Air Quality management plan. The latter will be focused at optimizing the transports and logistics in order to reduce the fuel consumption and minimize air emissions.

Impact Assessment Summary

The potential impact significance on air quality associated with the decommissioning phase of the project is summarized below in the following table.

Impact: Increase in atmospheric concentrations due to vessel activity during decommissioning phase resulting in potential adverse effects on air quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Prepare and implement an Air Quality Management Plan.	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

7.2.1.6 Unplanned Events

Impact: Increase in atmospheric concentrations due to accidental releases to the atmosphere resulting in potential adverse effects on air quality

Impact Assessment

Unplanned events, generally related to accidents (such as unexpected power failure and associated major emergency flaring or venting of gas, etc.), are not expected to occur during the FLNG drilling, installation and commissioning phase nor during decommissioning, but only during the operation and maintenance phase. The FLNG in unplanned events, thus in emergency conditions, will release atmospheric emissions of airborne gaseous pollutants mainly caused by the emergency major flaring.

The emergency flaring is related to depressurization or relief lasting less than 15 minutes. It mainly results from plant upsets and relief due to failure of plant control systems or plant shut down. This mainly involves opening of Pressure Safety Valves (PSVs) or Blow Down Valves (BDVs).

The assessment of the potential impact on air quality arising in case of unplanned events during the FLNG operation phase, took into account the worst case emergency flaring based on Project design data.

The FLNG emergency flaring occurring in case of unplanned events during the operation phase will release atmospheric emissions of atmospheric pollutants, such as NOx, CO and PM, into the atmosphere. Therefore, the FLNG is likely to determine a change of the existing air quality conditions (in terms of NOx, CO and PM concentrations), resulting in a potential impact on local air quality.

Due to the offshore location of the FLNG, it is unlikely that emissions of airborne pollutants will have an adverse effect on human receptors in case of unplanned events during the operation because atmospheric emission disperses quickly in offshore environments. However due to the characteristics of the unplanned events which have the potential to generate a plume with strong buoyancy that could reach the coastline, the impact on local air quality has been quantitatively assessed by means of a dedicated modeling study (please refer to **Appendix XII**, **Volume IV** for details on the modeling approach).

Ground concentrations of macro pollutants produced by the FLNG during emergency flaring were modeled over a 110 km x 110 km domain. The domain size was chosen in order to include impacts on the coastal areas caused by the emergency flaring. The latter treats high volumes of gas, and its atmospheric emissions flow is characterized by strong buoyancy which could potentially result in impacts far away from the flare.

The ADMS results are presented in **Table 7.8** below along with Mozambican and International AQS. Modeled pollutant concentrations were spatially localized by mean of iso-concentration maps, as illustrated in **Figure 7.2** below (please see more maps in **Appendix XIII**, **Volume IV**).

Table 7.8 – Unplanned Event Operation Phase: Maximum Modeled Concentrations of Atmospheric Pollutants

Pollutant	Averaging Period	Modeled concentrations [µg/m³]	Mozambique AQS(1) [µg/m³]	IFC/WHO (2) [µg/m³]
NO_2	1-hour	3.04	190	200
TSP	24-hour	1.66	150	---
PM10	24-hour	1.66	---	50
CO	8hours	9.09	10000	---
	1-hour	16.56	30000	---
	30-min(3)	66.24	60000	---
	15-min(3)	264.96	100000	---

Notes: (1) - Decree 18/2004, as amended by Decree 67/2010; (2) WHO (2005); (3) The model resolution is one hour. Concentrations for averaging periods shorter than 1 hour were calculated on the base of the methodology provided by EPA in the Workbook of screening techniques for assessing impacts of toxic air pollutants.

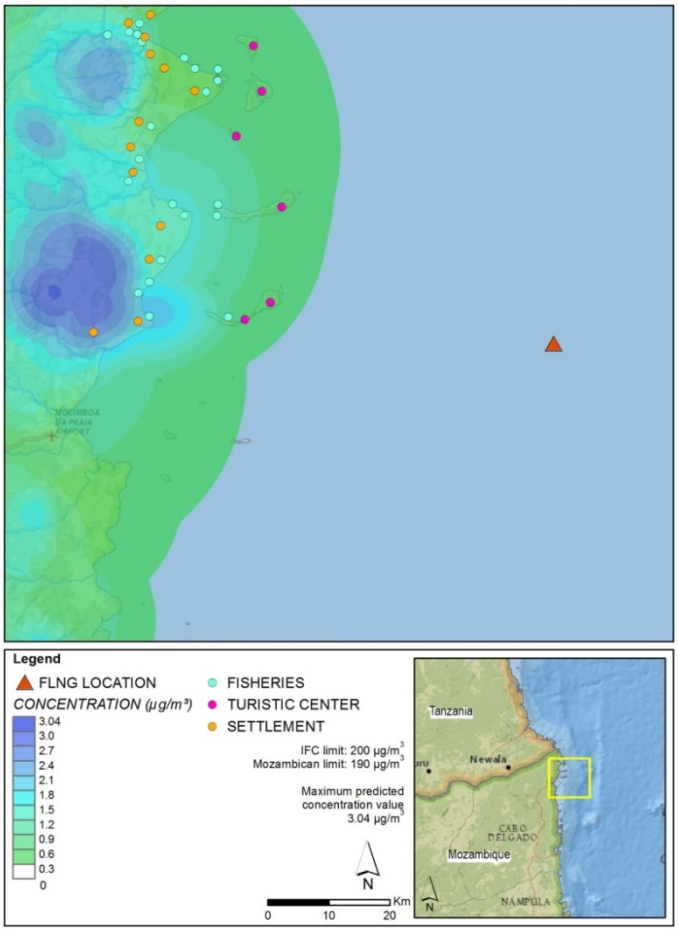


Figure 7.2 – Emergency ADMS – NOx Hourly Concentration Map

From **Figure 7.8** above it can be concluded that modeled pollutant concentrations comply with National and International AQS. NOx maximum concentration affects the Mozambican coast (**Figure 7.8**). This is due to the fact that the emergency flaring treats high volumes of gas, and its atmospheric emissions flow is characterized by strong buoyancy which results in impacts far away from the flare. However, modeled concentrations are considerably lower than their respective concentration limits and are unlikely to determine any considerable change of the existing background concentrations of pollutants.

Considering the discussed above, the extent of the impact is considered to be *local*, and the resilience and the number of elements involved are considered to be *low*. Impact duration was considered to be *low*, since atmospheric emissions related to the Project operation at unplanned evens will be of short term nature. Subsequently the significance prior to mitigation is assessed as *low negative*.

Mitigation Measures

Atmospheric concentrations of airborne pollutants induced by the FLNG, in case of unplanned events, comply with National and International air quality standards. Therefore impacts on local air quality will be managed through good industry practice, operational plans and procedures aimed at reducing the probability of occurrence of unplanned events.

Impact Assessment Summary

The potential impact significance on air quality associated with the operation in case of unplanned events is summarized below.

Impact: Increase in atmospheric concentrations due to accidental releases to the atmosphere resulting in potential adverse effects on air quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement good industry practice, operational plans and procedures aimed at reducing the probability of occurrence of unplanned events.	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

7.2.2 Greenhouse Gases (GHG) Assessment

7.2.2.1 Methodology

This section covers the Greenhouse Gases (GHG) emissions associated with the FLNG, during drilling, installation and commissioning, operation and decommissioning phases. The following topics are analyzed:

- The applicable methodologies for GHG emissions estimation;
- The assessment of GHG emissions associated with the drilling, installation, operation and decommissioning, including the definition of the emission sources; and
- The potential mitigation measures aiming to minimize the GHG footprint of the FLNG facility.

The assessment has been developed considering the entire lifetime of the project in order to estimate the annual average emission of GHGs.

The estimate of the Project GHG footprint was done based on the Greenhouse Gas Protocol Corporate Accounting Standard Methodology for operation phase and on MEET methodology for installation and commissioning project phases (see **Appendix XIII**, **Volume IV** for a description of the MEET methodology). Greenhouse gases included in the GHG assessment methodology are the gases under the United Nations Framework Convention on Climate Change / Kyoto Protocol: CO_2, CH_4, N_2O, Hydrofluorocarbons (HFCs), Perfluorocarbon (PFCs), Sulphur Hexafluoride (SF_6), and nitrogen triflouride (NF_3). GHG emissions are expressed in tons of carbon dioxide equivalent (tCO_2e). Of these, the greenhouse gases analyzed in the present study are CO_2, CH_4 and N_2O, considered the main GHG pollutants. Other GHG emissions may be associated with the LNG facility, such as SF_6, which is used for electrical switchgear, and HFCs, which are commonly used for air conditioning. These gases are not required in large quantities, and their emissions are very small as the gases are stored in sealed vessels. Therefore these gases will not contribute significantly to the project GHG emissions inventory.

Emissions are estimated by multiplying activity data with the corresponding emission factor (EF). All emissions are then converted into CO_2 equivalent through the global warming potential factor (GWP).

This study was completed based on project design and expected activity data available at the time of its preparation, and not on actual activity data.

7.2.2.2 Greenhouse Gases Overall Emissions

This section presents the GHG overall emissions associated with each phase of the FLNG project, namely during drilling, installation and commissioning, operation and decommissioning phases. As previously stated, emissions were accounted based on MEET methodology for installation and commissioning project phases (see **Appendix XIII**, **Volume IV**) and by the Greenhouse Gas Protocol Corporate Accounting Standard Methodology for the operational phase.

Drilling, installation and commissioning phase

During drilling, installation and commissioning, GHG emissions will be mainly produced by the activities, and associated exhaust gases, of vessels for personnel and material transport. The vessels involved in the offshore drilling, installation and commissioning activities will support the drilling, as well as the preparation of the seabed and installation of subsea facilities, mooring chains and anchors; in particular vessel activities include towing and hook up of FLNG during the installation phase and logistic support during the commissioning phase. Thus different types of vessels will be involved in these activities (e.g. construction vessel, supply vessel, security vessel) which will release greenhouse gas.

Other potential emission sources, such use of portable diesel generators and engines, are excluded from the assessment as no information is available at this stage to assess their contribution to the overall GHG emissions associated with the proposed FLNG Project. Nevertheless, this contribution is considered not to be material, as portable diesel generators and engines are usually driven by fuel diesel stored directly in the vessel store, already accounted for in the overall GHG emissions associated with vessels operations.

Transport of personnel and workers to/from the project location (scope 3 emissions) are also excluded from the assessment as not directly under EEA operational control.

GHG Emissions from Shipping and Vessels Operations

The calculation of GHG emissions from ship transport was based on the MEET methodology. The detailed MEET method for the calculation of ship transport emissions has been applied based on the Project data on vessels activity for the drilling, installation and commissioning of the FLNG (see **Appendix XIII**, **Volume IV**).

Table 7.9 below illustrates the number and type of vessels involved in the Project along with their Gross Tonnage (GT) and number of working days – including stationary operations at the project site. According to the project information currently available, the maneuvering operating mode and a medium speed diesel engines (< 200 r/min) were assumed for the 4 types of vessels considered. Moreover, the calculation assumed one working day as 24 continuous hours of work.

Table 7.9 – CO_2 emissions from vessels Involved in drilling, installation and commissioning phases

Type of Vessel	Number of ships per day	Working hours per day	Working days	Gross Tonnage	Tons of CO_2 emitted
Flexible-lay & Construction vessels	2	24	200	6 000	19 421
AHTS/PSV Construction Support	6	24	200	2 500	122 308
PSV for drilling support	3	24	400	2 500	64 259
Security vessels	3	24	400	1 000	72 515
Total CO_2 emitted					**278 502**

The major contribution to the GHG emissions will be represented by the construction and support vessels (AHTS/PSV), due to the number of ships in activity and their gross tonnage. This contribution, however, will be limited to the duration of the associated activities, about 200 days. No information was provided regarding power generation on vessel for the drilling rig, neither well clean up and testing.

Operational phase

The main GHG sources identified during the operation phase can be grouped into 3 different classes:

- GHG emissions from fuel combustion for compressors, gas turbines and turbine generators;
- GHG emissions from flaring limited to the process upsets;
- Fugitive emissions.

GHG emissions released from the vessels used for workers and material transport during operation can be considered negligible compared to the emissions generated during the three activities reported in the list above. The following paragraphs detail the GHG emissions generated by the different operation activities.

GHG emissions have been estimated by means of the GHG Protocol Guidance (Calculation tools). Calculation based on the GHG Protocol typically entails the collection of activity data, in the form of the quantity of fuel consumed for combustion purposes or other activity data (such as electricity consumption, fugitives volumes, etc.), and emission factor data, in the form of information on the characteristics of the fuel combusted and the efficiency of the oxidation process.

GHG emissions from Combustion for Power Generation

Normal operations refer to the day-to-day running of the FLNG plant to produce LNG. These production processes will operate on a continual basis and include stationary emission sources that combust natural gas. Approximately a total power capacity of 63 MW (generated by gas turbines) is required for operation of

the LNG trains. The total power capacity has been calculated considering a maximum required power of 24 MW, and a machine efficiency of 38%[3] (data typical for turbines associated to power generator units or combined with compressors or power generator units). The turbines and compressors have been assumed in operation for 8000 hours per year (about 330 days). Based on these data the total theoretical energy consumption on an annual basis is of 504,000 MWh.

The GHG emissive factors adopted and the annual estimate of GHG emissions are reported in the following **Table 7.10** and **Table 7.11** respectively.

Table 7.10 – GHG Emission Factors and GWP Values

GHG' s	Emissive Factors (*) [t/MWh]	GWPk (**) [tCO2_eq/t]
CO_2	0.202	1
CH_4	3.6 10-6	25
N_2O	3.6 10-7	298

Source: (*) Emission-Factors-from-Cross-Sector-Tools-(August-2012).xlsx (GHG Protocol); (**) Coefficient eGWPk Source: IPCC Fourth Assessment Report: Climate Change 2007 (AR4)

Table 7.11 – Estimated GHG Emissions (per Year)

Fuel	GHG emissions (tons /year)			
	CO_2 [t/y]	CH_4[a] [t/y]	N_2O[a] [t/y]	all GHGs [b] [t_CO2_eq/y]
Natural Gas	101 780	1.814	0.181	101879

Notes: [a] Coefficient GWPk Source: IPCC Fifth Assessment Report: Climate Change 2013 (AR5). [b] CO2-eq calculated by multiplying the mass and the GWP of the gas.

It is estimated that during operation the FLNG facility will produce approximately 101,879 tons of CO2_eq per annum from combustion for power generation.

GHG emissions from Flaring

During the normal operation activity, some flaring may be required to deal with process upsets (e.g., facilities start-up, pre-cooler shutdown, etc.). These upsets, labeled as continuous flaring, may produce GHG emissions but, at this stage, FLNG data about the mass balance are not available to properly quantify the GHG emissions from continuous flaring on annual basis. It is known, however, that the FLNG will implement a Zero-Permanent Flaring policy. This will allow the minimization of the GHG emissions from flaring, that will be limited to the process upsets and usually relatively short in duration, thus it is not expected the production of significant CO_2 emissions.

Pilot flame consumption was considered negligible compared with annual average, based on experience in similar facilities and taking into consideration consumption sources.

GHG - Fugitive Emissions

Fugitive emission of natural gas, which mainly consists of CH_4 emissions, may arise from pipes, junctions, equipment, valves, flanges, seals and connectors associated with LNG processing, as well as the storage tanks and from the ship loading systems. These could give a sensible contribution to the FLNG the Green

[3] The Best Available Techniques Reference Document (BREF) for Large Combustion Plant sets a target for thermal efficiency ranging from 36% and 40% for gas turbines (new plants).

House Gas footprint, since the GWP of CH_4 is about 25 times the CO_2 m (100 time horizon, IPCC Fourth Assessment Report: Climate Change 2007).

It should be noted that no significant fugitive GHG emissions are predicted to arise from the FLNG storage tanks or from the ship loading systems. The combined vapors from the FLNG tanks and the ship loading systems are compressed by the boil-off gas compressors and returned to the refrigeration system, or flared. Only minor vents, including from blow down operations, could potentially take place at the facility.

Decommissioning phase

FLNG and the associated facilities will be decommissioned safely and with due regard to the environment, with the aim of creating the conditions to allow, within a reasonable time, the restoration of conditions prior to the installation work. The activity of the vessels involved in the decommissioning of the FLNG along with the pumps involved in the flushing of the subsea flow-lines represents the main source of atmospheric emissions during the decommissioning, which will be completed in less than 1 year.

As a conservative estimation GHG emissions are Scope 1[4] GHG emissions and they are assumed to be the same as the drilling, installation phase GHG emissions since similar equipment and activities will be required.

7.2.2.3 GHG Impact Assessment

Impact: Increase in GHG emissions to the atmosphere

The impact of the estimated GHG emissions related to the lifetime of Project against Mozambique's national GHG inventory has been assessed by comparison with an emissions trajectory from 1994 to 2028. Given the nature and scale of the Project, all the phases of the projects have been assessed cumulatively. Based on the preliminary project data available and considering the degree of confidence in the assessment, the FLNG is estimated to emit approximately less than 150 000 tonnes of CO2e per year during entire lifetime.

If compared with the total amount of national emissions (estimated value) the GHG emission of FLNG can be assessed as negligible since it accounts for around 0.2% and 0.07% of the Projected National Emissions.

The extent of the impact is *national*, as it is Mozambique's GHG emissions that are directly increased due to the impact of the Project. The duration of the impact is regarded as *high* (long term but reversible), since the impact will occur throughout the life cycle of the project. The intensity, however, is *low*, as the FLNG emissions correspond to a negligible fraction of Mozambique's national emissions. Subsequently the significance prior to mitigation is assessed as *medium negative*.

[4] The GHG Protocol defines three emission 'scopes' for GHG accounting and reporting purposes, namely:
- Scope 1 – Direct GHG emissions - Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.; emissions from chemical production in owned or controlled process equipment. Direct CO_2 emissions from the combustion of biomass shall not be included in Scope 1 but reported separately. GHG emissions not covered by the Kyoto Protocol, e.g. CFCs, NOx, etc. shall not be included in Scope 1 but may be reported separately.
- Scope 2 – Energy indirect GHG emissions - Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.
- Scope 3 – Other indirect GHG emissions - Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Mitigation Measures

The reduction of the GHG emissions may be achieved through the implementation of best available technologies and processes able to improve the facilities' efficiency. The key mitigation measures that shall be included in the design and operational features of the Project are:

- The implementation of the best available technique for energy efficiency, as the use of efficient refrigeration turbines and power generation turbines that produce lower GHG emissions;
- The installation of waste heat recovery units on the gas turbine exhaust stacks, to improve the waste heat utilization;
- The development and implementation of plans for preventative maintenance and operational efficiencies to reduce flaring;
- The development and implementation of a GHG management plan to monitor and assess GHG emissions from the FLNG operation;
- In order to reduce GHG emissions, the facility should be designed to minimize fugitive emissions. Moreover a LDAR to reduce potential fugitive emissions from valves, flanges, seals and connectors associated with LNG processing and storage of fugitive emissions is recommended.

Impact Assessment Summary

The potential impact significance of the project's GHG emissions is summarized below. While key mitigation measures can be employed to reduce GHG emissions, the overall significance of the impacts is not expected to change substantially, as the pre-mitigation impact was already assessed of low importance, and the duration and extent remain the same.

Impact: Increase in GHG emissions to the atmosphere					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implementation of the best available technique for energy efficiency; - Installation of waste heat recovery units on the gas turbine exhaust stacks; - Preventative maintenance and operational efficiencies to reduce flaring; - Development and implementation of a GHG management plan to monitor and assess GHG emissions from the FLNG operation; - Project design to minimize fugitive emissions. Implement a LDAR.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	National	3		National	3
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**8**		**Medium**	**8**

7.2.3 Illumination

7.2.3.1 General Considerations

Following the establishment of the illumination baseline of the study area (see Volume I), this section presents the assessment of the potential illumination impacts resulting from the Project. The FLNG will be implemented in four phases, namely drilling and installation, commissioning, operation and decommissioning. In order to meet marine health and safety obligations, the FLNG project and associated facilities will require illumination during all of these stages. Because of this, the impact assessment presented below is done jointly for all phases of the project.

As described in the baseline, there are two main groups of important/sensitive receptors that may be affected by illumination emissions within the AoI, namely: marine fauna and non-project people (mainly tourists and fishermen). This section addresses the impact assessment for human sensitive receptors (non-project people). The potential illumination impacts on marine fauna and avifauna are addressed in the biological environment impact assessment (see section 7.3).

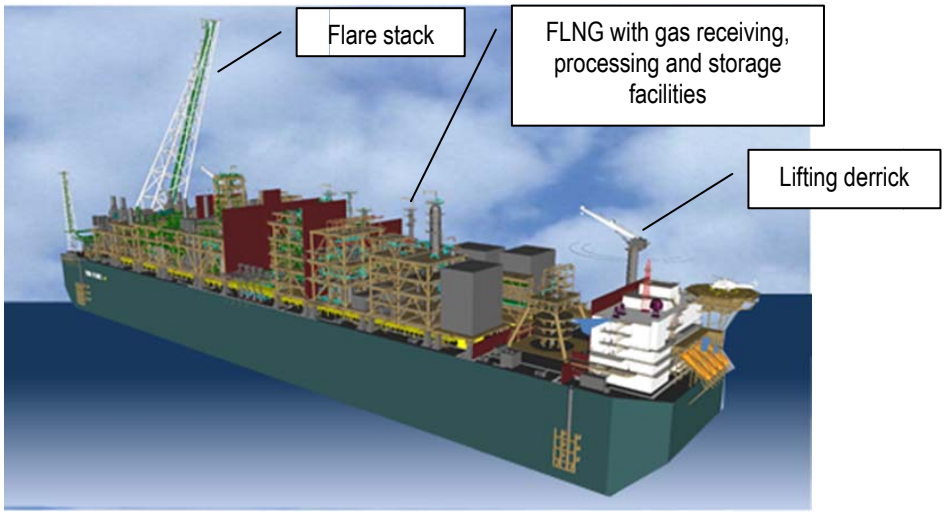
7.2.3.2 Potentially Impact Generating Project Activities

The FLNG project and associated facilities will require illumination in all phases of its development, namely drilling, installation, commissioning, operation and decommissioning, in order to meet marine health and safety obligations. In addition to illumination, flaring will also occur in case of emergency or planned non-routine events. The project facilities relevant to the assessment of illumination impacts will be (see **Figure 7.3**, following page):

- A turret moored double-hulled FLNG unit on which natural gas receiving, processing, storage and off-loading facilities will be installed. The process area, external decks and facilities will be continuously illuminated at night owing to safety regulations; and
- A flare stack approximately 177 metres above the deck level and approximately 200 metres above water line (AWL) and inclined 20 degrees from the vertical axis. Controlled flaring with approximately 20 m in length maximum will emanate from the stack during commissioning and emergency situations during operation to dispose of vapors and liquids containing hydrocarbons that are produced or released during an emergency situation.

The FLNG Facilities will require 24 hour external illumination to meet maritime and operational safety standards as described below:

- During Drilling and Installation: illumination on drilling vessels, including drilling rig, navigation lights on drilling and installation support and security vessels;
- During Commissioning: navigation lights on commissioning support and security vessels; navigation lights on helicopter flights, navigation lights on flow line risers, illumination on FLNG vessel, flaring during the testing phase;
- During Operation (including maintenance): navigation lights on supply vessels, navigation lights on helicopter flights, illumination on FLNG facilities, illumination during maintenance activities, flaring during operations (emergency or planned non-routine events); and
- During Decommissioning: navigation lights on supply vessels removing subsea facilities and FLNG vessels, navigation lights on helicopter flights, illumination for capping of wells.



Source: ERM (2014a).

Figure 7.3 – FLNG facilities relevant to the assessment of illumination impacts

Functional illumination will be required to provide a safe working environment on vessels. Typically this would be bright white artificial lighting approximately 500 lux[5] in luminosity. Navigational lighting will be required on supply and security vessels, drilling rig, helicopters and the FLNG vessel to prevent collisions with sea and air traffic. In particular, the flare stack will require navigational lighting to prevent potential collisions with helicopters.

With the exception of the pilot flame, flaring will not occur during normal operations. Controlled flaring will occur during commissioning and may happen during operation to reliably collect and dispose vapor streams of hydrocarbons released during planned non-routine operations such as start-up, shutdown, depressurization of equipment and pipe work purging or in case of emergency.

Figure 7.4 below illustrates the typical appearance of the FLNG vessel at night.

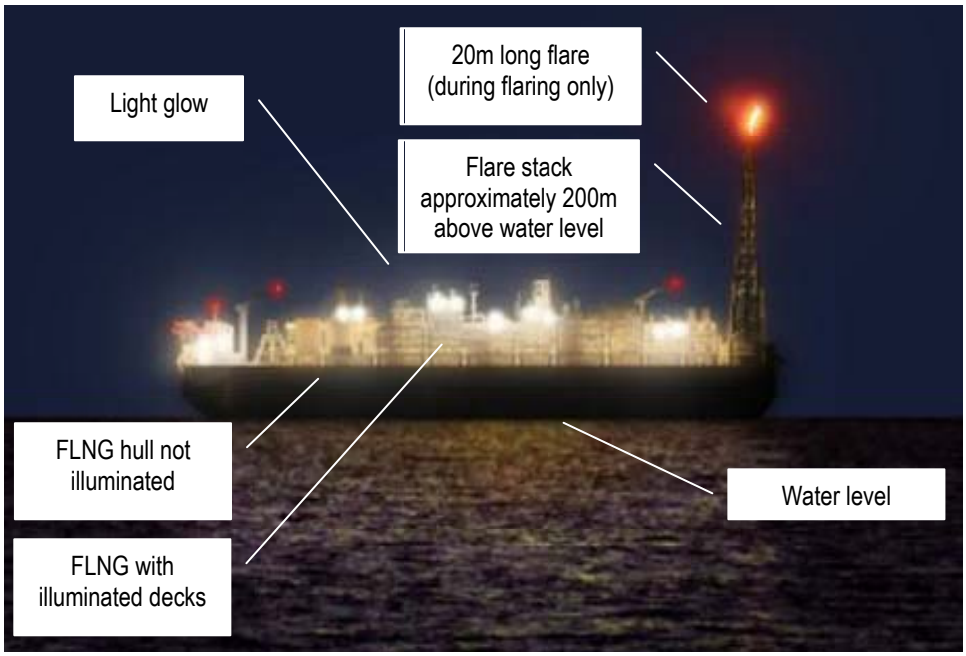


Figure 7.4 – Typical Night-Time appearance of FLNG Vessel

[5] Maritime Occupational Health and Safety Regulations published by the Canadian Ministry of Justice 2012.

The following sections assess the potential project related illumination impacts on the human sensitive receptors within the AoI, as identified in the baseline description. Potential illumination related impacts on biodiversity are assessed in section 7.3.

7.2.3.3 Drilling, Installation, Commissioning and Decommissioning Phases

Impact: Disruption of natural seascape during the drilling, installation, commissioning and decommissioning phases

Impact Assessment

As noted in the baseline description, human sensitive receptors within the Project AoI include mainly tourists and game-fishermen staying at resorts located on coastal islands and fishermen operating deepwater commercial and coastal artisanal fishing vessels. Of these, tourists lodged in resorts are the more sensitive receptor, as they are more likely to interpret any illumination impact as detracting from their experience, and as such the impact assessment is focused on the potential effects on these receptors. Passengers on cruise ships navigating within the AoI could also experience illumination impacts at night. However, these potential impacts will be very short in duration as opposed to the experience of the tourists in island resorts, who would be affected over many days. For this reason, impact on passengers is not considered further in this report.

Within the Project's AoI there is currently only one five-star tourist resort in operation, in Vamizi Island. Two more resorts are being constructed / planned on Quifuqui Island, but are still not in operation. These resorts are marketed to international tourists seeking pristine marine environments and beaches and for diving and game fishing holidays and have been sited to exploit the uninterrupted views over the Mozambique Channel. Tourists staying at these hotels are thus likely to perceive any illumination impact as negative.

During the drilling, installation, commissioning and decommissioning phases, these tourists would be sensitive to the presence of night-time glare and movement of vessels and aircraft, as they are seeking a pristine environment largely untouched by human activities. Activities such as illumination associated with vessel and helicopter movements and navigation will thus be perceived by these tourists as disruptive of this environment, despite the temporary and local scale of the impact.

The potential illumination impact of drilling, installation, commissioning and decommissioning phases is thus assessed as *direct* and *negative*, although of a *temporary* duration and *local* scale (illumination emissions by vessels and helicopters in movement), affecting a *small* number of receptors and with a *low* importance, resulting in a *low* significance.

Mitigation Measures

No specific mitigation is required. It is recommended that the FLNG facilities are designed in such a way as to reduce light emissions, namely by designing illumination on permanent facilities with the objective to reduce light glow, while meeting workplace health and safety, and navigational requirements.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Disruption of natural seascape during the drilling, installation, commissioning and decommissioning phases					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Illumination will be designed on permanent facilities with the objective to reduce light glow, while meeting workplace health and safety, and navigational requirements.	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

7.2.3.4 Operational Phase

Impact: Disruption of natural seascape during the operational phase

Impact Assessment

In the operational phase, the illumination impacts of the Project on the sensitive receptors previously described is expected to be of greater intensity, given the presence of the stationary FLNG vessel, which will required 24 h illumination, in compliance with navigational and safety requirements.

The existing lux levels within the AoI are low, ranging from 0.0001 lux on an overcast moonless night to 1.0 lux on a clear night with a full moon. The FLNG vessel will be lit at night and the expected illumination lux levels will be 500 lux which is approximately 500 times brighter than light conditions on a clear night with a full moon.

This effect will be emitted radially from the vessel and, as with sound, will attenuate with distance. The distance between the FLNG vessel and the tourist resorts would be between 45 and 56 kilometers. The visibility of the illumination and flare light glow over a number of distances was modeled in order to assess impact. The modeling is illustrated in **Figure 7.5** to **Figure 7.7**, presented in the following pages.

Figure 7.5 illustrates the baseline of a night-time sky assuming approximately 1 lux. **Figure 7.6** illustrates the appearance of illuminated FLNG vessel assuming a 500 lux level from a distance of 3 km within which the radial light glow from illumination and flaring is assumed to be the highest. **Figure 7.7** illustrates the appearance of the FLNG vessel from a distance of 60km which is the extent of the AoI. This visualization also modeled the curvature of the earth.

Source: ERM (2014a).

Figure 7.5 – Baseline of night-time sky

Source: ERM (2014a).

Figure 7.6 – FLNG Facilities viewed from 3km

Source: ERM (2014a).

Figure 7.7 – FLNG Facilities viewed from 60 km

The visualizations illustrate that light glow from the FLNG vessel will significantly change the baseline condition within 3 km but significantly attenuate with distance and from the effects of earth curvature.

As illustrated in **Figure 7.7** above, from the distance at which the tourism resorts are located, it is expected that the light glow from the FLNG vessel would be seen as a noticeable but not conspicuous glow on the far horizon. However, this will only occur when visibility conditions are conducive, generally between June and October, and occupying a narrow angle of the 360 degree panoramic view. In the rest of the year, the FLNG vessel will barely be noticeable.

Artisanal fishing boats generally do not travel further from the coastline than 15 km. Crews working on these vessels would see the illuminated FLNG vessel when viewing conditions are clear, mainly in the months between June and October from a distance of approximately 40 to 45 kilometers. The vessel would be seen on the far horizon as a faint illuminated object. It would attract the attention of working crews on fishing boats but at this distance no impacts are predicted.

Considering the discussed, the potential illumination during the operational phase is assessed as a *negative* and *direct* impact, of *high* duration (long term but reversible), but of *local* extent, *low* importance (considering that the change in the baseline condition at the outer extents of the AoI where the tourist resorts are located will be low to negligible) and affecting a *small* number of receptors, resulting in a *low* significance.

Mitigation Measures

Given the impact's low significance, no specific mitigation measure is required. However, it is recommended that the FLNG facilities are designed in such a way as to reduce light emissions, namely:

- Illumination will be designed on permanent facilities with the objective to reduce light glow, while meeting workplace health and safety, and navigational requirements;
- The use of non-reflective surface treatments should be preferred, to minimize reflective emissions.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Disruption of natural seascape during the operational phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Illumination will be designed on permanent facilities with the objective to reduce light glow, while meeting workplace health and safety, and navigational requirements; - The use of non-reflective surface treatments should be preferred, to minimize reflective emissions.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

7.2.4 Oceanography

7.2.4.1 General Considerations

Following the establishment of the oceanographic baseline of the study area (see Volume I), this section presents the assessment of the potential impacts on the marine water masses resulting from the Project, which are mostly related to potential changes in the physical and chemical properties (water quality) of seawater.

During the drilling and installation phases, the project can induce changes to water quality due to the drilling activities and discharge of cuttings. In the operational phase, changes to water quality may be caused by the water and effluent discharges of the FLNG vessel. Finally, water quality impacts may also originate in unplanned events, such as accidental oil spills. No relevant project activities which could result in significant changes to the physical and chemical properties of seawater were identified for the commissioning and decommissioning phases, and as such no impacts are assessed for those two phases. Due to the different nature of the impacts in these phases, the impact assessment below is divided into drilling and installation, operation and unplanned events (which may occur in any project phase).

It should be noted that this section only addresses the potential impacts on water quality (physical and chemical properties of the marine water mass where the FLNG vessel will be sited). The associated potential impacts on marine ecology and fisheries are addressed in section 7.3 and 7.4.1 respectively.

7.2.4.2 Drilling /Installation Phase

Potentially Impact Generating Project Activities

In the drilling and installation phases, the main project activity that may induce changes to marine water quality is the discharge of drill cuttings, associated with drilling of the production wells. The potential impact of this activity in marine water quality is addressed below.

Impact: Potential seawater quality degradation due to the discharge of drill cuttings

Impact Assessment

As stated in the Project Description (see section 4.7.1.1, Volume I), drill cuttings resulting from the lower section of drilled wells may be managed in two ways:

- Collected and transported onshore by supply vessels for treatment and disposal at a recognized landfill; or
- Treated offshore, aboard the drilling vessels, and discharged to sea.

The first option, i.e. transport for onshore disposal, is the preferred one. In this option, the three supply vessels will be used through ships or iso tanks for the transportation of the cuttings. Considering the estimated amounts, 9 - 10 trips per month will be required. Onshore authorized landfills in the area will be used, with the assumption that these landfills will be available according to the current Government plans (FUNAB) to improve the existing waste management facilities and to build new specialized ones to support the future industrial activities in Cabo Delgado area. Private investments in the waste management sector are also expected.

In this alternative, no relevant impacts would be expected on water quality. The transportation of the cuttings onshore will not generate enough additional shipping traffic to warrant a separate analysis from the already assessed impacts on shipping traffic during the drilling and installation phase, and the disposal of the cuttings in a licensed landfill is an accepted and sustainable waste management procedure, with no relevant environmental impacts.

In the second option, the cuttings will be treated on board, as described further below, and then discharged to the sea. This section assesses the potential impacts on seawater quality resulting from this option. Drill cuttings may contain a suite of potential residual contaminants (hydrocarbons, heavy metals). The discharge of these cuttings could lead to an increase in the concentration of contaminants in the marine environment (degradation of water quality). Marine fauna, especially benthic invertebrates, may also be adversely affected by exposure to these contaminants if present in sufficient quantity and exposed over a long duration, or by physical stress caused by excessive quantities of the materials impacting the benthic habitat. This section, however, only addresses potential impacts on seawater quality, presenting estimates of pollutant concentrations and their screening against applicable standards, thresholds, and general guidance values. The impact on marine fauna is discussed in section 7.3.2.

During the drilling of a production well, two different moments can result in the discharge of drill cuttings:

- In the first phase of drilling, during drilling of the riserless open hole section, there will be a direct discharge of cuttings at sea bottom level, due to the absence of a riser. During this phase, Water Based Mud (WBM) will be used;
- Once the initial portions of a well have been drilled, a riser will be installed, and muds and cuttings will be returned to the surface, where they will be treated (removal of Low Toxic Oil Base Mud - LTOBM) and discharged at mean sea level. The discharged cuttings will have a maximum of 1% of oil by weight from the LTOBM left adhered to the cuttings, in compliance with eni standards. Drill cuttings are generally inert but may contain with small amounts of trace metals and/or hydrocarbons to receiving waters, through residual LTOBM adhered to the cuttings after treatment on the drilling rig.

The potential impacts on seawater quality from the discharge of drill cuttings were assessed through modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014b). Four production wells in the FLNG site were selected for modeling, representing the range of locations that may be drilled to produce natural gas. Modeling was performed to determine two key results:

- The amount of suspended sediment (Total Suspended Solids – TSS) concentration added to the water column background concentrations; and
- The seabed accumulation (thickness) of the drill cuttings over an area of the seafloor (the footprint). These modeling results will support the assessment of impacts on benthic organisms and are discussed in section 7.3.2.

The modeling software GEMSS (Generalized Environmental Modeling System for Surfacewaters), and its modules, was used to simulate the dispersion of the cuttings with adhered residual base oil from the LTOBM, estimate the locations and thickness of deposited materials and calculate the concentration increase of TSS above the ambient values. Detailed modeling methodology and results, sourced from ERM (2014b) are provided in **Appendix X** (see Volume IV). A brief summary of the main modeling approach and results is provided here, to support the impact assessment discussion.

Volumes of discharged drill cuttings were estimated based on four wells previously drilled by EEA. On average, the following volumes are expected to be discharged per well (see **Appendix X** for detailed data):

- In the first phase of drilling, 279.4 m^3 of cuttings and 1649.6 m^3 of water based muds (seawater and prehydrated bentonite gel mud) are expected to be discharged at sea bottom level;
- In the second phase of drilling, after the riser has been installed, 368.6 m^3 of cuttings and 44.9 m^3 of LTOBM (adhered to the cuttings) are expected to be discharged at mean sea level.

The GEMSS model was then used to estimate the thickness of deposited materials at seabed level and calculate the concentration increase of TSS resulting from the discharge of these volumes, for the four wells modeled near the FLNG site. Only the TSS results are discussed in this section. Please refer to section 7.3.2 for a discussion on the thickness of deposited materials and their potential impact on benthic fauna.

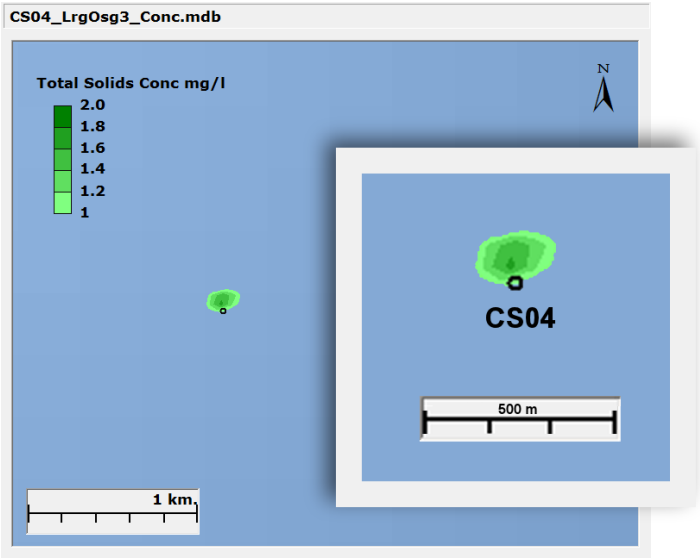
Increases in concentration of TSS will occur due to discharges of drill cuttings. The highest concentration increases will naturally exist at the point of discharge or at the seafloor during upper well section drilling, and decrease over time and distance as the suspended solids plume dissipates. Larger particles will settle out more quickly than fine particles, such that the TSS plume of tiny particles may linger and travel further than plumes of larger grain-sizes. As such, elevated TSS may form in regions where tiny suspended particles linger in a cloud and mix with subsequent discharges.

A summary of the results for the drill cuttings modeling are found in **Table 7.12** below.

Table 7.12 – Maximum incremental ambient TSS concentrations resulting from drill cuttings discharge at the four modeled wells

Well	Max TSS (mg/L)
C_N18	6.3
C_S01_1	8.4
C_S04	7.6
C_S05_1	7.0

As shown in the table, the estimated maximum concentrations of TSS are fairly low, ranging from 6.3 mg/l to 8.4 mg/l, across all four modeled wells. **Figure 7.8** below shows the contour plot of the Maximum TSS concentration for well C_S04 (for which the modeling returned the highest TSS concentrations). Maximum TSS concentrations were located within 200 meters of the release location and took place during the initial well jetting. This concentration quickly drops with distance, and at 500 m from the drilled well they are in the order of 1 mg/l.



Source: ERM (2014b).

Figure 7.8 – Contour plot for Total Suspended Solids concentrations modeled for well C_S04

The ambient seawater quality standards in Mozambique are established through Annex V of Decree 18/2004 (as amended by Decree 67/2010). This regulation, however, does not set a quality standard for marine waters in terms of TSS. In the absence of a national standard, best practice international standards were adopted, namely IFC's guidelines for effluent discharges of hydrotest water at LNG Facilities (IFC, 2007b), which lists a guidance limit of 35 mg/l. This guidance limit was adopted in this assessment as an ambient water quality threshold value.

As can be seen from **Table 7.12** (previous page), none of the modeled wells had total suspended solids that exceeded the reference threshold value of 35 mg/l, and in fact all presented TSS concentrations well below this threshold. These increases of suspended solids are therefore very unlikely to cause relevant impacts on seawater quality, and they affect a very localized area. It should be noted that TSS act as an indicator of the potential increase of other pollutant concentrations (which will be adhered to the particulate material) and their dispersion.

The impact is thus assessed as *negative* and *direct*, of *low* duration (restricted to the drilling activities), of *local* scale (only a small area around the drilling location will be affected) and *low* importance (low concentrations of TSS, and therefore of other pollutants, are expected, below the recommended threshold), resulting in a *low significance*.

Mitigation Measures

No relevant impact was identified, and as such no specific mitigation is required. To ensure the impact remains of low significance, good management of the drilling activities is recommended, including:

- During all drilling operations, all safety protocols must be strictly followed and all personnel must be experienced and well trained to prevent releases of adhered residual LTOBM beyond the planned allowable quantities;
- Pre-start readiness checks and frequent periodic inspections of equipment shall be in place for operations with LTOBM;
- Selection of drilling fluids and additives in accordance with their toxicity rating, using a globally accepted hazard assessment tool;
- Include strict requirements for personnel in terms of their CV and competences in the technical specifications for the mud services;
- With the waste management applied offshore, during use of the Low Toxicity Oil Based Mud, during use of the LTOBM, monitoring must be performed onboard the rig to ensure that the that drill cuttings discharge will be operated in compliance with the limit of oil concentration lower than 1% by weight on dry cuttings; and
- Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards, as defined in Annex V of Decree 18/2004 (as amended by Decree 67/2010).

The measures above are applicable for the onboard treatment option. If the onshore disposal option is adopted, as discussed above, only offshore recognized ships or tanks must be used for the transportation of cuttings.

Impact Assessment Summary

No significant impact was identified. The proposed management actions will ensure that the residual impact remains of low significance.

Impact: Potential seawater quality degradation due to the discharge of drill cuttings during the drilling phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- All safety protocols must be strictly followed during drilling activities; - Select drilling fluids and additives in accordance with their toxicity rating, using a globally accepted hazard assessment tool; - During use of LTOBM, monitoring must be performed onboard the rig to ensure that less than 1% oil remains adhered to the cuttings prior to disposal; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

7.2.4.3 Operational Phase

Potentially Impact Generating Project Activities

In the operational phase, the main project activities that may induce changes to marine water quality include:

- Discharge of cooling water – during operation, seawater will be used as the main cooling medium for the LNG plant. The discharge of this water, at higher temperature than drawn, may induce changes in the temperature profile of the receiving marine water mass;
- Discharge of produced water – gas reservoirs frequently include a percentage of water, which will be abstracted together with the natural gas. During the LNG process, this water is separated from the

gas, treated and discharged into the sea. This is referred to as produced water. Produced water may contain traces of inorganic and organic compounds. Even though produced water will be treated before release, the discharge may impact on the receiving seawater quality;

The following sections assess the potential impacts of these activities in marine water quality.

Impact: Potential increase of marine water temperature due to the discharge of the FLNG's cooling water

Impact Assessment

The LNG production process will require a refrigeration system. Sea water has been selected as the main cooling medium: due to the thermal duties to be released from the topside process facilities, air cooling would be impractical for footprint and weight. An intermediate fresh water cooling system has been also foreseen in order to limit the number of items in contact with sea water. The envisaged system is then to have process fluid cooled in a closed loop of sea water. The heat is then exchanged with sea water and finally released to the sea.

Sea water is pumped by vertical sea water pumps at about 150 meters depth. Deep sea water intake hose system is equipped with a sea water filtration screen to avoid any debris carry-over. As result of this process, the seawater used to cool down the system will be heated and discharged in the ocean. It should be noted that the discharge cooling water has no relevant contaminants, the thermal component being the only concern.

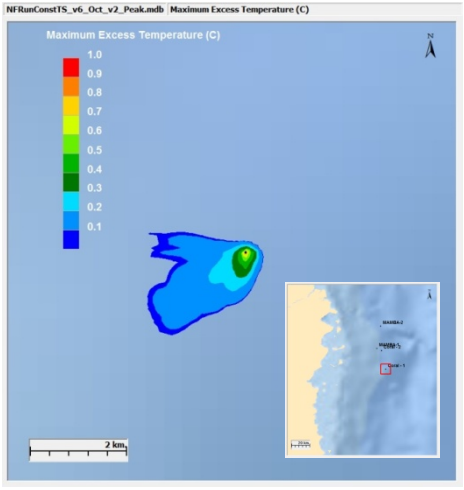
The potential temperature impacts from cooling water discharge on the receiving marine water were assessed through modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014c). This included establishing a hydrodynamic model of the FLNG area of influence, using the model software GEMSS. The hydrodynamic modeling methodology and results are provided in **Appendix VII** (see **Volume IV**).

Based on this hydrodynamic model, two modeling approaches were then used to simulate the dispersion plume of the FLNG's thermal discharge: one model (CORMIX) predicted the temperature rise from the point of discharge to the end of the mixing zone (assumed to be 100 m as per IFC guidelines); while GEMSS was also used to predict the temperature rise on a larger scale extending far beyond the initial mixing zone. The thermal modeling methodology and results are provided in **Appendix VIII** (see **Volume IV**). A brief summary of the main modeling approach and results is provided below, to support the impact assessment rationale.

The total flow rate of the thermal discharges, at average and peak operation, is estimated to be 24,964 MT/hr (Metric ton per hour) and 27,445 MT/hr, at a combined temperature of 30.6°C. The discharge is made at superficial level (0.5 to 7.5 m below sea level). For the modeling, it was estimated that discharge was to the model segment that represents the top 3 m below sea level.

The ambient temperatures used to derive the initial temperature differences were calculated by subtracting the monthly average sea surface temperature documented in the metocean report (Eni E&P, 2014). These temperatures are 27.79, 26.72, and 29.86°C for May, October and March respectively. The associated discharge excess temperatures are 2.81, 3.88, 0.74 °C, respectively. For the simulation, the discharge was assumed to be continuous with a discharge depth of 0-3 m below sea level. The discharge velocity for the cooling water was assumed to be at 5 m/s.

The modeling was conducted for three oceanographic seasons: maximum, minimum and typical current speeds. For each of these scenarios, modeling was done for normal operation conditions and for peak operation conditions (assuming the FLNG plant is operating at full capacity). The worst-case modeling scenario, in terms of potential increases to marine water temperature caused by the thermal discharge, is the scenario of minimum current speeds and peak discharge. This is the scenario where greater volumes of heated water will be discharged to sea and where the natural cooling effect of marine currents (due to mixing) is lower. **Figure 7.9** below shows the modeling results for this scenario (please see **Appendix VIII** for more modeling results).



Source: ERM (2014c).

Figure 7.9 – Maximum temperature rise in marine water during cooling water peak discharges and low current speeds

As can be seen in **Figure 7.9** above, even in the worst case scenario, temperature increases in the receiving marine waters are expected to be fairly low. The maximum expected temperature increase, at the discharge point, is of only 0.84 ºC and at the edge of the mixing zone (100 m from the point of discharge) the maximum simulated temperature increase is only 0.2 ºC.

The marine water quality standards in Mozambique are established through Annex V of Decree 18/2004 (as amended by 67/2010). This regulation, however, does not set a quality standard for marine waters in terms of temperature increases. In the absence of a national standard, best practice international standards were adopted, namely IFC's guidelines for thermal discharges, that defines that any thermal discharge should not result in a temperature increase greater than 3 ºC at the edge of the mixing zone (which, if not specifically determined, should be considered to be 100 m from the discharge point). The application of this standard to the FLNG EIS was proposed to MITADER and accepted by the environmental authority (see **Appendix IV** – Volume IV).

The modeling results indicate that at 100 m from the discharge point the maximum temperature increase will be of only 0.2 C, as indicated above, which is fully compliant with the adopted standard. As such, the temperature increase impact from the FLNG thermal discharge is not expected to be relevant.

The impact is thus assessed as *negative* and *direct*, of *high* duration (long term but reversible), but of *local* scale and *low* importance, resulting in a *low significance*.

Mitigation Measures

No relevant impact was identified, and as such no specific mitigation is required. To ensure the impact remains of low significance, good management of the cooling system is recommended, including:

- Maintain the proper operation of the cooling system, to maintain designed discharge temperatures;
- Operation of the cooling system as per best practices and international standards includes maintaining trained operating staff as well as enforcement of all operating policies and procedures;
- Shut down of cooling system when cooling is not required; and
- Online (continuous) monitoring of cooling water discharge temperature and periodic monitoring of the receiving seawater temperature, to ensure compliance with the end of mixing zone standard.

Impact Assessment Summary

No significant impact was identified. The proposed management actions will ensure that the residual impact remains of low significance.

Impact: Potential increase of marine water temperature due to the discharge of the FLNG's cooling water					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Maintain proper operation of the cooling system, to maintain designed discharge temperatures; - Ensure that the pumping of cooling water through the system is turned off when cooling is not required; - Continuous monitoring of the discharge temperature; - Periodic monitoring of the receiving seawater temperature, to ensure compliance with the end of mixing zone standard.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

Impact: Potential seawater quality degradation due to the discharge of produced water in the operational phase

Impact Assessment

Gas reservoirs frequently include a percentage of water, which will be abstracted together with the natural gas. During the LNG process, this water is separated from the gas, treated and discharged into the sea. This is referred to as produced water.

Produced water can contain a suite of potential contaminants (hydrocarbons, heavy metals). Most of these contaminants will be removed during the treatment process, prior to discharge. However, the discharge produced water will still present hydrocarbons (oil and greases), suspended solids and Biological Oxygen Demand (BOD), and the potential impact of the discharge of these pollutants on seawater quality needs to be considered.

Table 7.13 below presents the pollutant concentrations of the discharged produced waters, as well as the applicable emission limits for industrial effluents. It should be noted that the emission limits for industrial effluents in Mozambique are established through Decree 18/2004 (as amended by Decree 67/2010), for each type of industry. However, the national regulation does include limits for the discharge of industrial effluents for the LNG sector. As such, the emission limits presented in **Table 7.13** were sourced from the IFC's guidelines for the LNG sector, and their applicability for the FLNG project was approved by MITADER.

Table 7.13 – Produced water discharge pollutant concentrations and effluent concentration standards

Constituent	Discharge Concentration	Approved Mozambique Maximum Level Applicable to the FLNG
Oil and Grease (mg/l)	10	10
BOD_5 (mg/l)	25	25
TSS (mg/l)	35	35
Temperature (°C)	38	-

Table 7.13 above shows that the predicted emissions are compliant with the applicable emission limits. The potential impacts of these discharges on the receiving seawater ambient quality were assessed through modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014d). The modeling methodology and detailed results, sourced from ERM (2014d), are provided in **Appendix IX** (see **Volume IV**). A brief summary of the main modeling approach and results is provided below, to support the impact assessment rationale.

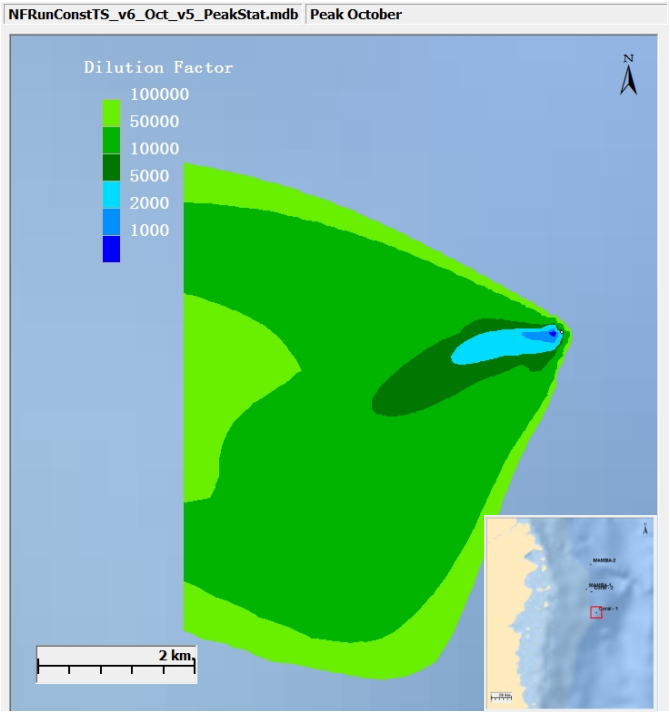
The total flow rate of the produced water discharges, at average and peak operation, is estimated to be 32 m^3/h and 62 m^3/h respectively. The discharge is made at superficial level (0.5 to 7.5 m below sea level), at the same elevation as the seawater cooling discharge. For the modeling, it was estimated that discharge was to the model segment that represents the top 3 m below sea level. It was further assumed that the discharge was continuous and that the contaminants were conservative (i.e., no decay was considered).

The modeling was conducted for three oceanographic seasons: maximum, minimum and typical current speeds. For each of these scenarios, modeling was done for normal operation conditions and for peak operation discharge (assuming the FLNG plant is operating at full capacity). The worst-case modeling scenario, in terms of potential degradation of seawater quality due to the produced water discharges, is the scenario of minimum current speeds and peak discharge. This is the scenario where greater volumes of produced water will be discharged to sea and where the natural diluting effect of marine currents (due to mixing) is lower.

Figure 7.10 (following page) shows the modeling results for this scenario (please see **Appendix IX** for more modeling results). Due to the lack of baseline concentrations, only incremental concentrations attributable to the produced water discharge were considered. The maximum incremental concentrations of pollutants in seawater will occur at the discharge point and its proximity. The figure shows that, in the worst-case scenario, the produced water discharge suffers dilution by a minimum factor of 490 at the discharge point (within 70 m of the discharge point). This dilution factor increases with distance, resulting in lower pollutant seawater concentrations as distance to the discharge increases. The estimated maximum incremental concentrations for all discharge pollutants are provided in **Table 7.14** below.

Table 7.14 – Maximum predicted incremental ambient pollutant concentrations resulting from produced water peak discharge with minimum current speeds

Discharge Concentration (mg/l)			Maximum concentration (mg/l)			Minimum Dilution Factor
Oil and Grease	BOD5	TSS	Oil and Grease	BOD5	TSS	
10	25	35	0.02	0.05	0.07	490



Source: ERM (2014d).

Figure 7.10 – Minimum dilution factor in marine water during produced water peak discharges and minimum current speeds

As shown in **Table 7.14** (previous page) the resulting increases in the ambient concentration of oil and greases, BOD5 and TSS are all very low. The ambient seawater quality standards in Mozambique are established through Annex V of Decree 18/2004 (as amended by Decree 67/2010), and the following **Table 7.15** shows the applicable limits for the pollutants of interest.

Table 7.15 – Ambient Seawater Quality Standards as per Decree 18/2004

Pollutant	Unit	Ambient Quality Standard
BOD5	mg/l	5
Oils and greases	-	Virtually absent
TSS	mg/l	-

As seen from **Table 7.14** above, the ambient quality standard for BOD_5 is 5 mg/l maximum. The model results show that the predicted additional BOD_5 concentration is significantly lower than the standard, with highest average increase of 0.05 mg/l, within the first 70 m of discharge. The maximum predicted additional oil and grease concentration is 0.02 mg/l, which can be considered to be virtually absent (not detectable by visual observation).

The levels of constituents (BOD_5, oil and grease, TSS) associated with the treated produced water were predicted to be below all the applicable standards and regulations. As such, no relevant degradation of seawater quality resulting from the FLNG's produced water discharges is expected.

The impact is thus assessed as *negative* and *direct*, of *high* duration (long term but reversible), but of *local* scale and *low* importance, resulting in a *low significance*.

Mitigation Measures

No relevant impact was identified, and as such no specific mitigation is required. To ensure the impact remains of low significance, good management of the produced water treatment system is recommended, including:

- Maintaining the proper operation of the treatment system, to maintain designed discharge concentrations;
- Operation of the treatment system following best practices and international standards includes maintaining trained operating staff as well as enforcement of all operating policies and procedures;
- Periodic monitoring of the produced water effluent, to verify compliance with the emission limits as defined in **Table 7.13** (see page 35);
- Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards, as defined in Annex V of Decree 18/2004 (as amended by 67/2010).

Impact Assessment Summary

No significant impact was identified. The proposed management actions will ensure that the residual impact remains of low significance.

Impact: Potential increase of marine water temperature due to the discharge of the FLNG's cooling water in the operational phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Maintain proper operation of the treatment system, to maintain designed discharge concentrations; - Periodic monitoring of the produced water effluent, to verify compliance with the emission limits; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

7.2.4.4 Unplanned Events

Potentially Impact Generating Project Activities

Unplanned events are project related events that are unplanned project activities but that may nevertheless cause environmental impacts. In terms of the FLNG Project, the main unplanned events that may result in impacts on seawater quality are associated with accidental oil spills. Considering the planned activities, the potential unplanned events that may result in oil spills are the following two scenarios:

- Scenario 1 – diesel spill associated with vessel collision happening either during drilling of wells or operation phase; and
- Scenario 2 – release of LTOBM due to the accidental disconnection of the riser occurring during the drilling phase.

The following sections assess the potential impacts of these unplanned events on marine seawater quality.

Impact Assessment

The FLNG Project will generate an increase in maritime traffic throughout its life cycle: during the drilling, installation and commissioning phases, this increase will come from the drilling and support vessels involved in such activities; during the operational phase, the increase will come from support vessels and from LNG carriers, used in the export process.

This increased traffic will generate an increased risk of vessel collisions. If such an accidental collision happens, it could result in the release of significant quantities of hydrocarbons to the marine environment, namely the release of diesel oil used as fuel by these vessels. This section assesses the effects such an accidental release may have on seawater quality, along the Cabo Delgado offshore and coastal waters.

Oils consist of a suite of hydrocarbons with varying degrees of toxicity. Any release of hydrocarbons, independently of its composition, will however result in degradation of seawater quality and on direct impacts on marine fauna. This section addresses the potential impacts on seawater quality, while the impacts on marine fauna are discussed in section 7.3.4.

The potential impacts of accidental oil spills due to vessel collision were assessed through oil spill modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014e). The modeling methodology and detailed results, sourced from ERM (2014e), are provided in **Appendix XI** (see **Volume IV**). A brief summary of the main modeling approach and results is provided below, to support the impact assessment rationale.

The consequences of a potential diesel spill, due to vessel collision, was evaluated for releases throughout three different months from 2009 to 2013 – January, July, and November[6] with releases at four different locations within Area 4, for a total of 12 model simulations. Each of the 12 simulations were run for 75 iterations to cover a range of hydrodynamic and meteorological conditions across by selecting spill start dates across the five years, with 15 iterations per year for each of the three selected months.

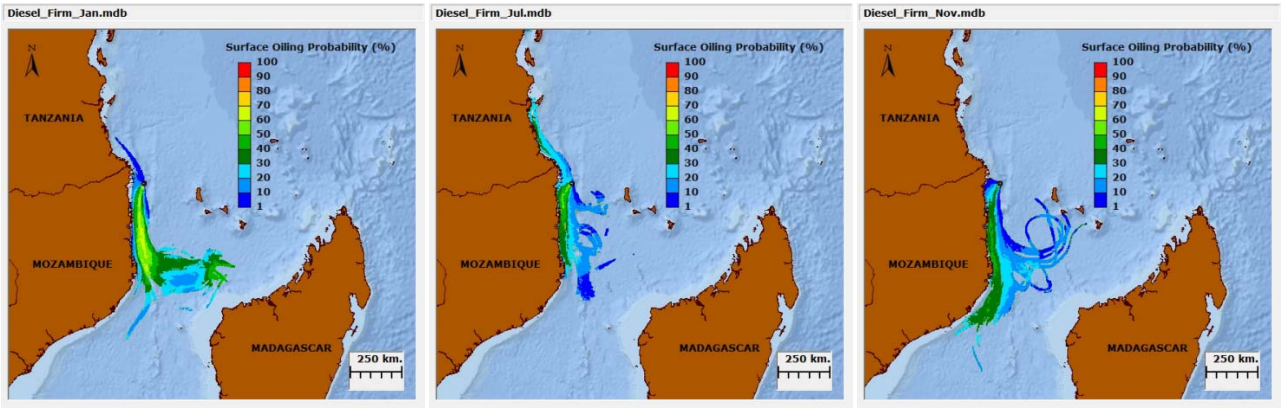
The rate of release simulated was of 800 m^3, assumed to last for 1 hour. The model was then run to simulate the dispersion of the released oil during 14 days following the spill event.

The ambient seawater quality standards in Mozambique are established through Annex V of Decree 18/2004 (as amended by 67/2010). In terms of oil and greases, the quality standard is “virtually absent”, which means that upon a visual inspection no oil should be detected on seawater. The first clearly visible oil appears as a silvery sheen at thicknesses between 0.04 µm to 0.3 µm based on values catalogued in the 2006 Bonn Agreement Oil Appearance Code (BAOAC) (Lewis, 2007). A minimum threshold thickness value has been defined as 0.1 µm. Oil at this thickness may be visible and potentially wash upon the shore as a silver sheen, but is not expected to cause physical injury (e.g., oiling, smothering) to wildlife contacting it.

Figure 7.11 below shows the modeling results for the extent of visible surface oil for a vessel collision diesel spill in January, July, and November, at Coral-1 (please see **Appendix XI** for more modeling results). The visible slick of oil is likely to travel within 750 km from the release point in January, July, and November before weathering away into a thin invisible sheen. In January, the trajectory is more likely to transport oil

[6] These were the months for which the modeling study identified the greatest risk of an occurring oil spill reaching mainland, considering the climatic and oceanographic conditions along the year. They are thus the worst-case scenario.

towards the south southeast. In July, transport is typically towards the southeast. In November, transport is typically towards the north and south southeast.



Source: ERM (2014e).

Figure 7.11 – Probability of visible surface oiling (>0.1 µm) resulting from a Vessel Collision Diesel Spill at Coral-1 (left: January; middle: July; right: November)

It should be noted that **Figure 7.11** shows the probability of visible oil reaching the illustrated locations, for all spill events modeled, and that the blue areas showed in the figure represent low probabilities. An actual slick will only cover a fraction of the areas at any moment in time.

A diesel spill may travel along the coastline from Tanzania, to central Mozambique, and towards Madagascar. While contact with the Mozambique coastline, along the Cabo Delgado and Nampula Provinces, is predicted to occur in every simulation performed (assuming no protection from response efforts), the probability of a spill reaching Tanzania is less than 10%. Areas on the water surface that may potentially have visible oil floating upon it range between 60,000 km² to over 93,000 km², depending on the winds and currents.

Considering the modeling results and seawater ambient quality standards, the risk of non-compliance with the "virtually absent" standard resulting from a vessel collision diesel spill is assessed as a *negative* and *direct* impact, of *medium term* duration (cleanup activities may take more than one year), but of *international* scale (the oil spill may reach Tanzania, although with low probability) and *high* importance (given the non-compliance with the ambient water quality standard), resulting in a *high significance*.

Mitigation Measures

Mitigation is primarily in the form of operational controls to prevent unplanned events such as a vessel collision from occurring, and to be prepared to respond in the event an accident does occur. These mitigation controls include:

- Oil Spill Response Plan: EEA will develop and implement a comprehensive oil spill response plan (OSRP);
- Incident Management and Crisis Management Support Teams: EEA will develop these teams of highly trained leaders to respond quickly to emergencies;
- Training of Personnel: EEA will train personnel to effectively respond in the event of a hydrocarbon spill;

- Equipment: Tier 1 oil spill response equipment[7] will be staged on support vessels and/or at shore;
- Agreements: EEA will also promote the use of Tier 2 equipment from peers, if necessary. EEA is also a member of Oil Spill Response Limited (OSRL), a global spill response cooperative, providing Tier 3 response equipment and personnel;
- Stakeholder Agreements: EEA will communicate with stakeholders prior to spill response operations informing potentially affected communities of the OSRP procedures.

Impact Assessment Summary

Post mitigation, operational controls may help minimize the risk of occurrence of a vessel collision and response efforts will help minimize extension of the oil slick, if such a collision does occur. For the post mitigation assessment, it was assumed all spill response protocols were applied, all trained staff reacted appropriately, and all containment methods were deployed to minimize the spread of the spill. As a result, the spill would be prevented from reaching the shorelines and surface oiling maintained within a much closer vicinity to the ruptured vessel, and not travelling into Tanzania's waters. This will reduce the extent from international to regional, the duration from lasting over a year to less than a year; and the importance from high to moderate. The overall significance score is reduced to *low* after successful application of mitigation measures. The impact assessment summary is provided in the following table.

Impact: Risk of seawater quality degradation resulting from accidental diesel spills due to vessel collisions (unplanned event)

Criteria	Pre-mitigation assessment		Key Mitigation	Post-mitigation assessment	
Nature	Negative		- EEA will develop and implement a comprehensive oil spill response plan (OSRP); - EEA will train personnel to effectively respond in the event of a hydrocarbon spill, including undertaking safety drills; - Enforcement of all policies and procedures. Tier 1 oil spill response equipment will be staged on support vessels and/or at shore; - Readiness of EEA response crew and third-party responders in the event of an unplanned oil spill.	Negative	
Type	Direct			Direct	
Duration	Medium term	2		Short term	1
Extent	International	4		Regional	2
Importance	High	3		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**High**	**11**		**Low**	**6**

Impact: Risk of seawater quality degradation resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase

Impact Assessment

During the drilling of a production well, two different drilling phases can be identified:

- In the first phase, during drilling of the riserless open hole section, there will be a direct discharge of cuttings at sea bottom level, due to the absence of a riser. During this phase water based mud (WBM) will be used;

[7] Oil spill preparedness and response is typically described in terms of tiers, namely (IPIECA, 2007):
- Tier 1 events are likely to be relatively small and/or affect a localized area. They may be dealt with best using local resources, often prepositioned close by, and managed by the operator. Tier 1 preparedness includes the provisions of local resources of trained people and specialized locally-sited equipment maintained in readiness for the containment and clean-up of small oil spills;
- Tier 2 events are more diverse in their scale and by their nature involve potentially a broad range of impacts and stakeholders. Correspondingly, Tier 2 response resources are also varied in their provision and application. Management responsibilities are usually shared in a collaborative approach and a critical feature is the integration of all resources and stakeholders in the response efforts;
- Tier 3 events are rare but have the potential to cause widespread damage, affecting many people and overwhelming the capabilities of local, regional and even national resources. Tier 3 response resources are concentrated in a relatively few locations, held in readiness to be brought to the country when needed. Such significant events usually call for the mobilization of very substantial resources and a critical feature is their rapid movement across international borders and the integration of all resources into a well organized and coordinated response.

- Once the initial portions of a well have been drilled, a riser will be installed, and muds (LTOBM) and cuttings will be returned to the surface, where they will be treated and discharged at mean sea level with a maximum of 1% oil by weight on dry cuttings.

The potential impacts of the planned discharges of drill cuttings with adhered muds on seawater quality have been assessed above. This section addresses the potential impacts of an unplanned event, resulting from an accidental disconnection of the riser during the drilling of the lower sections of a production well (a malfunction above the wellhead causing the accidental release of the drilling fluid within the volume of the riser pipe). In such an event, there will be a direct discharge of the drilling fluid (LTOBM) at sea bottom level, which can then rise to the surface and form a slick. This section assesses the effects such an accidental release may have on the seawater quality, along the Cabo Delgado offshore and coastal waters.

The potential impacts of accidental release of LTOBM due to a disconnection of the riser were assessed through oil spill modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014e). The modeling methodology and detailed results, sourced from ERM (2014e), are provided in **Appendix XI** (see **Volume IV**). A brief summary of the main modeling approach and results is provided below, to support the impact assessment rationale.

The consequences of a potential accidental LTOBM release, due to disconnection of the riser, was evaluated for releases throughout three different months from 2009 to 2013 – January, July, and November[8] with releases at four different locations within Area 4 (location of likely production wells), for a total of 12 model simulations. Each of the 12 simulations were run for 75 iterations to cover a range of hydrodynamic and meteorological conditions across by selecting spill start dates across the five years, with 15 iterations per year for each of the three selected months.

LTOBM is a mixture of lox toxicity base oil (60% of volume) with solid particles (40% of volume - typically mainly barium sulphate with other minerals and crystals such as calcium chloride, calcium hydroxide, silica, etc.). The base oil used in the LTOBM release simulation was assumed to be Baroid Alkane™ (Halliburton, 2010), a low-toxicity base oil comprised primarily of alkanes. Using properties of an example low toxicity base oil, AMC SARAPAR 147 (AMC Oil & Gas, 2012), aromatics comprise less than 0.01% of the oil by mass, while the saturated paraffinic oil mainly had carbon chain lengths in the C14 to C18 range (see **Appendix XI**, Volume IV for a more detailed LTOBM composition). Any release of hydrocarbons, independently of its composition, will however result in degradation of seawater quality result and on direct impacts on marine fauna. This section addresses the potential impacts on seawater quality, while the impacts on marine fauna are discussed in section 7.3.4.

The volume of released LTOBM simulated was of 229 m^3 (volume of LTOBM within an average riser pipe). The release was assumed to occur 3 m above the seafloor, and last for 1 hour. The model was then run to simulate the dispersion of the released base oil during 7 days following the release event.

As previously noted previously, the ambient seawater quality standards in Mozambique are established through Annex V of Decree 18/2004 (as amended by 67/2010). In what regards oil and greases, the quality standard is “virtually absent”, to which a minimum threshold thickness value of 0.1 µm was associated (oil at this thickness may be visible and potentially wash upon the shore as a silver sheen, but is not expected to cause physical injury (e.g., oiling, smothering) to wildlife contacting it).

[8] These were the months for which the modeling study identified the greatest risk of an occurring oil spill reaching mainland, considering the climatic and oceanographic conditions along the year. They are thus the worst-case scenario.

Figure 7.12 below shows the modeling results for the extent of visible surface oil for a riser disconnect release of LTOBM at C_S04 well in January, July, and November (please see **Appendix XI** for more modeling results). In January, the trajectory is more likely to transport oil towards the south southeast. In July, transport is typically towards the north and south southeast. In November, transport is typically towards the south southeast. The total of all potential areas on the surface with oil thickness above the low impact threshold ranges from 3,300 km² to almost 12,900 km².

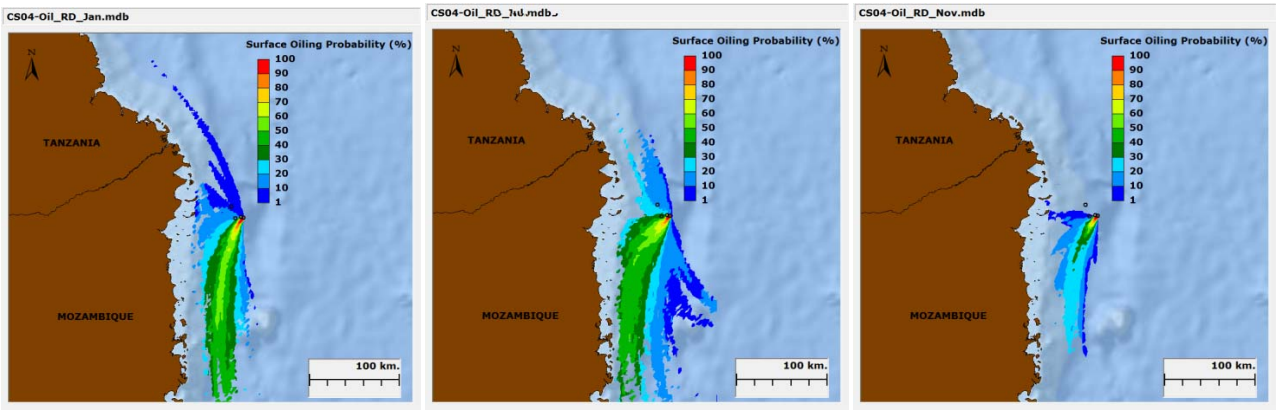


Figure 7.12 – Probability of visible surface oiling (>0.1 µm) resulting from a Riser Disconnect LTOBM Release at C_S04 (left: January; middle: July; right: November)

It should be noted that **Figure 7.12** shows the probability of visible oil reaching the illustrated locations, for all release events modeled, and that the blue areas showed in the figure represent low probabilities. An actual slick will only cover a fraction of the areas at any moment in time.

Water surface areas at risk range between 3,300 km² to almost 12,900 km², depending on winds and currents, typically travelling parallel to the coast approximately 40 km to 50 km away. The shoreline is not expected to be significantly affected. There is a low chance (less than 10 % probability) of visible oil contacting the shoreline near Vamizi Island. The probability of the oil slicks reaching Tanzania is also below 10%.

Considering the modeling results, and in what regards the seawater ambient quality standards, the risk of non-compliance with the "virtually absent" standard resulting from a accidental riser disconnection during the drilling phase is assessed as a *negative* and *direct* impact, of *low* duration, of *regional* scale (the oil spill may affect the coastlines of Cabo Delgado and Nampula) and *high* importance (given the non-compliance with the ambient water quality standard), resulting in a *medium significance*.

Mitigation Measures

Mitigation controls are mostly in terms of preventive measures to eliminate a riser disconnection and any associated impacts from occurring. They also include response activities to minimize the impacts if a riser disconnect occurred.

To avoid an unplanned release from a riser disconnect, all drilling staff, drilling supervisors and all third party contactors must be ensured to be competent and fully trained to undertake drilling operations with all the necessary certifications.

If an unplanned event occurs, all response activities must be conducted according to EEA's policies and procedures. Prior to commencement of operations, EEA's well control manual and procedures must be bridged to ensure alignment and consistency to the highest standard. Additionally, once drilling operations

are initiated periodic safety drills should be conducted by EEA drilling supervisors to ensure readiness of drilling crews and third party service providers. Additional mitigation controls include:

- Well Plans: EEA should conduct reviews of the well drilling plans by subject matter experts to assure operational readiness;
- Oil Spill Response Plan: EEA will develop and implement a comprehensive oil spill response plan (OSRP);
- Incident Management and Crisis Management Support Teams: EEA will develop these teams of highly trained leaders to respond quickly to emergencies;
- Equipment: Tier 1 oil spill response equipment will be staged on support vessels and/or at shore.
- Stakeholder Agreements: EEA will communicate with stakeholders prior to spill response operations informing potentially affected communities of the OSRP procedures.

Impact Assessment Summary

Post mitigation, operational controls may help minimize the risk of an accidental riser release and response efforts will help minimize extension of the oil slick, if such a release does occur. For the post mitigation assessment, it was assumed all spill response protocols were applied, all trained staff reacted appropriately, and all containment methods were deployed to minimize the spread of the spill. As a result, the spill would be prevented from spreading further than just around the vicinity of the rig, lowering the extent score to low, and the importance from high to moderate. The overall significance score is reduced to low after successful application of mitigation measures. The impact assessment summary is provided in the following table.

Impact: Risk of seawater quality degradation resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase (unplanned event)

Criteria	Pre-mitigation assessment		Key Mitigation	Post-mitigation assessment	
Nature	Negative		- EEA will develop and implement a comprehensive oil spill response plan (OSRP); - EEA will train personnel to effectively respond in the event of a hydrocarbon release, including undertaking safety drills; - Enforcement of all policies and procedures. Tier 1 oil spill response equipment will be staged on support vessels and/or at shore; - Readiness of EEA response crew and third-party responders in the event of an unplanned oil spill.	Negative	
Type	Direct			Direct	
Duration	Short term	1		Short term	1
Extent	Regional	2		Local	1
Importance	High	3		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**8**		**Low**	**5**

7.3 Impact Assessment: Biological Environment

7.3.1 General Considerations

Impacts on marine ecology resulting from the project in the area will arise from several project activities in the different phases of the Project. These can, however, be divided into effects of a more temporary nature, associated with the drilling, installation, commissioning and decommissioning phases, and effects of a more continued nature, associated with the operational phase. The impacts of the former phases are mostly related to the activities of vessels in the project site and with the installation and removal of the subsea infrastructure, while the impacts of the latter are associated with the operation of the FLNG vessel itself (production of LNG and its export).

Several impacts of the drilling, installation, commissioning and decommissioning phases will be very similar (such as emission of noise, light, waste, etc.), as the sources of these impacts are also similar (the movement and activities of a set of vessels). The impacts of the operational phase, however, are more specific. As such, and for clarity purposes, the impact assessment has been divided into the following sections:

- Impacts of the drilling, installation, commissioning and decommissioning phases;
- Impacts of the operational phase;
- Impacts associated with unplanned events.

These are presented and discussed in the following sections.

7.3.2 Drilling, Installation, Commissioning and Decommissioning Phases

7.3.2.1 Potentially Impact-Generating Project Activities

During the drilling and installation phase, there will be drilling and completion of production wells as well as the preparation of the seabed to install subsea facilities. Up to six wells clustered by couples will be drilled by means of offshore drilling units, with supply vessels (three) and security vessels (three) to support these activities. The installation of subsea facilities will require crane vessels and subsea construction vessels.

During the commissioning phase of the Project, a number of vessels and helicopters will be active in Concession Area 4, and the FLNG vessel will be towed to the site and moored. The FLNG vessel will be installed, with dimensions of about 400 m in length and 70 m breadth, plus additional restriction areas around it, for security reasons. All logistic support will be made via support vessels and helicopter flights. Hydrotests to establish the integrity of the flowline followed by the dewatering of the flowline will be carried on, followed by gas filling.

At the decommissioning phase, the flushing of subsea flowlines, capping of wells and the removal and towing of the FLNG will be carried out.

All of these activities can be a source of impacts, namely through the following:

- Wastewater discharges – discharge of liquid effluents normally associated with any marine vessel, including domestic effluents, bilge water, etc.. These discharges may impact on water quality, and indirectly on marine biota;
- Waste generation and management – the management and disposal of solid waste generated aboard the vessels during these phases could lead to impacts on water quality, and indirectly on marine biota;
- Discharge of drill cuttings and drilling fluids, during the drilling and installation of subsea facilities – these could lead to impacts on benthic communities, due to smothering and burial of organisms, and to the degradation of water quality, which would then lead to indirect impacts on marine biota.
- Increase vessel movements and drilling operations – these will result in noise and light emissions, which may result in the disturbance of marine fauna and avifauna, and will also increase the risk of collisions or entanglement with marine fauna;

- Potential discharge of ballast waters – the drilling and installation phases will require sourcing international vessels. Any discharge of ballast waters taken in outside of Mozambican waters would result in the risk of introduction of marine alien species, and potential impacts on local biodiversity.

Potential impacts on marine habitats and fauna generated by these activities are discussed below.

7.3.2.2 Impact Assessment

Impact: Effects of vessel liquid effluents on marine ecology due to changes in water quality

Impact Assessment

Vessels used during drilling, installation, commissioning and decommissioning will generate liquid effluents such as deck and machinery space drainage, bilge water and sewage discharge, similar to those generated by any maritime vessel, including the regional and international maritime traffic that currently operates in the study area.

Liquid effluents may have the potential of damaging the marine environment, mainly through toxicity and oxygen depletion. Untreated sewage imposes an organic and bacterial load on the natural biodegradation processes of the sea which could increase BOD and cause anaerobic conditions in the receiving seawater.

The vessels used in these project activities are expected to be equipped with sewage treatment plants, oily water and sludge holding tanks, as per Annex I of MARPOL 73/78. Sewage effluent discharged during the project's activities will thus be treated onboard and disposed of in accordance with the requirements of MARPOL Annex IV (Sewage). Treated sewage and organic waste would not increase the bacterial load, but could increase BOD.

Contaminants such as fuel, oil, lubricants and detergents in drainage and bilge water discharge into the sea could have a range of toxicity effects on marine biota. However, deck drainage will contain very small volumes of potentially toxic pollutants, while machinery space drainage and bilge water will pass through onboard oil/water separators to ensure compliance with MARPOL Annex I prior to discharge.

Volumes of all discharges to sea will also be relatively small, considering the number of vessels expected to be used in these phases, and will be similar to the discharges of normal maritime traffic in the region. It is expected that only very small quantities of contaminants will be mobilized in the discharge.

As long as the vessels comply with standard maritime regulation, no relevant impacts on water quality are expected and consequently no significant impacts on marine fauna are also expected.

The impact is considered *negative* and *indirect*. The duration of the impact is *low* (restricted to the drilling, installation, commissioning and decommissioning phases), the extent is *local* (as no relevant impacts on water quality are expected outside of the mixture zone) and the importance is *low*. The impact is thus of *low* significance.

Mitigation Measures

All discharge of liquid effluents from project vessels will need to comply with relevant international maritime standards and regulations, namely those set out in MARPOL (73/78) regulations. The main environmental standards to be complied to are:

- Establish separate drainage systems for hydrocarbon-contaminated water (closed drains) and water from non-process areas (open drains). Bund all process areas to prevent contamination by storm waters, contain spills and leaks, and channel drainage water into the closed drains;
- Use drip trays to collect run-off and spills from equipment not contained within a bunded area and channel runoff to the closed drainage system;
- Disposal of liquid waste in accordance with MARPOL 73/78:
    - Liquid effluents must be treated before discharged to the sea;
    - Sewage must be treated and disinfected (on-board treatment plant) prior to discharge;
    - Treated effluents shall achieve a BOD < 40 ppm, suspended solids < 50 ppm and a coliform count < 200 cells per 100 ml of effluent;
    - The discharge depth is variable, but it should not be less than 5m below the surface;
    - Route water from machinery spaces to the closed drainage system, or contain and treat the bilge water before discharge;
    - The concentration of oil in the water after treatment in an IMO approved oil/water separator shall not exceed 15 ppm;
    - Contain oil and chemical use areas and equipment (deck, mud tanks and pumps);
    - Use efficient oil and water separators.
- Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills as soon as they occur.

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects of vessel liquid effluents on marine ecology due to changes in water quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Discharge of deck drainage, bilge water and sewage shall comply with MARPOL 73/78 requirements; - Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills as soon as they occur.	Negative	
Type	Indirect			Indirect	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

Impact: Effects of solid waste disposal on marine ecology due to changes in water quality

Impact Assessment

Daily routines in the vessels will generate several types of solid wastes, including domestic waste (plastics, paper, etc.), sanitary waste (biomedical waste), and potentially some hazardous wastes (packages of hazardous substances or materials, light bulbs, batteries, etc.). Inadequate management or discharge of these wastes may result in impacts in water quality and/or marine fauna, in the areas where these vessels are operating or even further afield. An example includes wastes such as plastic material which may travel considerable distances and have negative impacts on marine turtles, which may mistake them as food. Food waste would be readily consumed and biodegraded in the marine environment and, as such, is not deemed

to pose a risk to water quality.

However this impact is unlikely given EEA's compliance with international and strict internal company standards with regards to waste management and adequate disposal. This is a *negative* and *indirect* impact, of *low* duration (temporary), *local* scale and *low* importance, resulting in a *low significance*.

Mitigation Measures

Despite the low significance of the pre-mitigation impact, standard good waste management should be applied in all project activities, in compliance with national and international regulations and guidelines, namely:

- Apply adequate handling, treatment and disposal of hazardous, non-hazardous and biomedical solid waste in order to comply with applicable environmental national regulations (Decree No. 13/2006), technical norms and international standards and best practices;
- The Project will ensure that a suitable Waste Management Plan in order to avoid pollution of marine waters. This should be based on the following guidelines:
    - Solid waste (kitchen waste) shall be treated in accordance with MARPOL (73/78) regulations. No garbage can be discharged closer than 12 nautical miles from the nearest land;
    - All other solid waste must be segregated and temporarily stored and contained on the vessel, for appropriate treatment and/or disposal at port, in compliance with Annex V of MARPOL. No hazardous wastes will be discharged to the sea, under any circumstances.
- Ensure that all crew members directly involved in waste management activities receive appropriate training in waste management procedures.

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects of solid waste disposal on marine ecology due to changes in water quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Apply adequate treatment and disposal of solid waste in order to avoid pollution of marine waters; - Apply all solid waste management measures according to national regulations and international standards and best practices; - Food solid waste will be treated in accordance with MARPOL (73/78) regulations; - All other solid waste must be segregated and temporarily stored and contained on the vessel, for appropriate treatment and/or disposal onshore in compliance with Annex V of MARPOL - Train crew members on waste management procedures.	Negative	
Type	Indirect			Indirect	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

Impact: Effects of the discharge of drill cuttings on marine ecology due to changes in water quality

Impact Assessment

As discussed in section 7.2.4.2 above, drill cuttings will be managed in one of two ways: transported onshore for final disposal on a licensed landfill (preferred option) or treated onboard and discharged to the sea. As discussed in section 7.2.4.2, in the preferred option no impacts on water quality are expected. This section

assesses the potential impacts of the second option (offshore treatment and discharge of cuttings) on water quality, and indirectly on marine ecology. These discharges could lead to an increase in the concentration of contaminants in the marine environment (degradation of water quality), and any significant reduction in water quality could lead to secondary effects on marine fauna in terms of morbidity or mortality, or simply displacement from preferred feeding or nesting areas.

The drilling rig will be equipped to properly process and handle the Low Toxic Oil Based Mud (LTOBM) drilling fluid, also known as Synthetic Based Mud (SBM), as well as Water Based Mud (WBM), and discharge the cuttings in accordance with applicable regulations. This new generation (environmentally friendly) of LTOBM that EEA will use in this project contains reduced concentrations of aromatic compounds and are totally recyclable. Water-based muds for use in the offshore oil and gas industry comprise mainly seawater (approximately 75%) with the addition of barite and bentonite to control mud density. Other compounds are added as necessary to achieve the desired properties for a particular situation (OGP, 2003). WBMs are generally used to drill the upper portions of a well where conditions are less demanding on the properties of the mud. WBMs are also relatively cheap compared to other mud types and are generally considered to be the least toxic of the drilling muds (Patin, 1999). However, WBMs do contain heavy metals in the barite component, which have the potential to pollute the marine environment. When WBMs are used, both muds and cuttings are discharged at the sea bottom due to the absence of a riser.

Once the initial portions of a well have been drilled, a riser will be installed, which allows material (drilling muds and cuttings) to be returned to the drilling rig. Due to the increased cost of LTOBM and environmental considerations, LTOBMs are recovered at the rig for recycling. This recycling process involves separating the muds from the cuttings using vibrating screens known as shale shakers. A residual fraction of drilling fluids will remain adhered to the cuttings but the majority will be separated by the shale shakers and returned to the drilling fluid system, which will be continuously re-circulated, while the cuttings will be discharged to the sea. The drill cuttings are generally inert but may contribute with small amounts of trace metals and/or hydrocarbons to receiving waters (as per eni standards, oil concentration lower than 1% by weight on dry cuttings will be adhered to discharged cuttings).

Water quality could potentially be affected in two ways through the disposal of drill cuttings: increased turbidity, and contamination.

Water-based muds and cuttings from drilling the upper parts of the well will be discharged directly to the seafloor, where they are unlikely to affect the turbidity of the water column above (the density of the mixture will lead to particles settling to the sea floor). The discharge of WBMs may temporarily reduce water quality, but this is likely to be restricted to the duration of the discharge and localized to the well site (Impacto, 2008a).

According to Neff (2005 in Impacto, 2008), when WBMs and cuttings are discharged to the ocean, the larger particles and flocculated solids, representing about 90% of the mass of the mud solids, form a plume that settles quickly to the bottom. The remaining 10% of the mud solids mass, which consist of fine-grained unflocculated clay-sized particles and a portion of the soluble components of the mud, forms another plume in the upper water column that drifts with prevailing currents away from the rig and is diluted rapidly in the receiving waters.

As mentioned above, once the initial portions of a well have been drilled, a riser will be installed, and muds and cuttings will be returned to the surface, where they will be treated (removal of LTOBM) and discharged

at mean sea level. These drill cuttings will still be "wet" when discharged from the rig and will tend to clump together and settle quickly to the seabed. As a result of rapid settling, these drill cuttings do not disperse in the water column or significantly increase water column turbidity (Neff *et al.,* 2000). Beyond the immediate vicinity of the drill site, the concentrations of suspended sediments introduced into the environment by drilling operations are typically less than the naturally occurring suspended sediments in the water column. Water turbidity only increases slightly at the discharge point and immediate vicinity.

This was corroborated by the modeling of the discharge of drill cuttings undertaken by ERM for this EIS (ERM, 2014b) (see section 7.2.4.2). Based on drill cutting and mud discharge volumes from wells previously drilled by EEA, ERM (2014b) modeled the expected increase in total suspended solids (TSS) concentrations, expected to occur from drilling four wells at the proposed FLNG location. The model indicated that fairly low increases to ambient concentrations of TSS are expected, with maximum concentrations of 6.3 mg/l to 8.4 mg/l, across all four modeled wells. For the well which presented higher TSS concentrations of 8.4 mg/l, maximum concentrations were located within 200 meters of the release location and took place during the initial well jetting. This concentration quickly drops with distance, and at 500 m from the drilled well they are in the order of 1 mg/l. These are fairly low TSS concentrations, which are well below the IFC guidance limit of 35 mg/l for effluent discharges of hydrotest water at LNG facilities (IFC, 2007)[9].

Drill cuttings discharges will thus produce localized turbidity within the water column, which will disperse and dilute rapidly at a rate dependent upon ambient oceanographic conditions. Once discharges cease, normal water quality conditions will return within minutes to hours (Impacto, 2008).

With regard to the potential contamination of the water column, experimental and field studies have shown that acute toxic effects of WBMs can be manifested only at high concentrations. Such concentrations can only be found within a few metres of the discharge point (Patin, 1999). Laboratory and field studies of 60 samples of SBMs showed that toxicity was lower than the limit set by the United States Environmental Protection Agency (USEPA) (96 h LC50[10] must exceed 30 000 mg/L). Almost 80 % of the samples tested were considered practically non-toxic (Patin, 1999).

The specific constituents of the drilling muds proposed in this project will be of inherently low toxicity and that it is therefore highly unlikely that significant negative impacts in water quality will occur as a direct result of routine project activities. Most cuttings from drilling will be discharged only after treatment (the exception being the cuttings resulting from the first phases of drilling, prior to the riser installation) and within the limit of oil content authorized by international standards, in order to minimize potential negative impacts.

Considering the discussed above, potential changes in water quality due to discharge of drill cuttings include increased turbidity and contaminant load. However, these changes are expected to be globally low, and restricted to the drilling sites and immediate proximities, as shown in the modeling undertaken (ERM, 2014b – see section 7.2.4.2). The area that would be more affected is the bottom water, close to the drilling rig. No significant increases in the concentration of contaminants are expected further afield, and such any indirect impact on marine biota will be restricted to a small portion of the benthic and pelagic environments surrounding the drilling sites. No impacts are expected on the more sensitive coastal habitats, given the

[9] The ambient seawater quality standards in Mozambique are established through Annex V of Decree 18/2004 (as amended by 67/2010). This regulation, however, does not set a quality standard for marine waters in what regards TSS. In the absence of a national standard, best practice international standards were adopted, namely IFC's guidelines for effluent discharges of hydrotest water at LNG Facilities (IFC, 2007b), which lists a guidance limit of 35 mg/l. The application of this standard to the FLNG EIS was proposed to MITADER and accepted by the environmental authority

10 Lethal Concentration 50 - Concentration in which 50% of test organisms die after exposure to constant conditions over a 96-hour period

distance.

Free-swimming organisms (marine mammals, turtles and fish) will be able to evade any areas where water quality is unfavorable and avoid any negative effects of toxicity. Given that the expected affected area would be close to the drilling rig, it is unlikely that these animals will be displaced from particular feeding grounds, or be unable to reach preferred nesting grounds. In terms of the benthic communities at the proposed drilling sites, they are characterized by relatively low densities and no sensitive habitat or species of conservation concern was identified.

Considering the text above, the potential impact on marine ecology due to changes in water quality associated with drilling activities is assessed as a *negative* and *indirect* impact, of *low* duration (any changes to water quality will be temporary, once discharges cease, normal water quality conditions will return within minutes to hours), *low* extent (restricted to a few hundred meters surrounding the drilling sites), and *low* importance (low increases of pollutants are expected and no sensitive habitats or species are likely to be affected), resulting in a *low significance*.

Mitigation Measures

Even though the impact was assessed as of low significance, the adoption of industry best practices in what regards management of drilling fluids and discharge of cuttings is still recommended, namely:

- Use low toxicity Water Based Muds (WMB) for the drilling of the initial well sections. The concentrations of mercury and cadmium in the barite used in the water-based drilling fluids should not exceed 1 mg/l and 3 mg/l, respectively, as per USEPA's recommendation;
- When Low Toxicity Oil Based Mud (LTOBM) is used, mud recovery systems are recommended;
- Cuttings should always pass through a solids control system prior to discharge into the sea, in compliance with international practices;
- All chemicals used should conform to internationally accepted standards and submitted to MITADER and INP for approval when necessary before the drilling activities begin;
- During all drilling operations, all safety protocols must be strictly followed and all personnel must be experienced and well trained to prevent and unplanned releases of oil based muds beyond the planned allowable quantities;
- Pre-start readiness checks and frequent periodic inspections of equipment shall be in place for LTOBM operations;
- The use of all drilling fluid components and other chemicals should be monitored and recorded;
- With the waste management applied offshore, during use of LTOBMs, monitoring must be performed onboard the rig to ensure that the oils are removed from the cuttings such that less than 1% oil remains adhered to the cuttings prior to disposal;
- WBM mud and cuttings and LTOBM cuttings will be discharged into sea in compliance with international practices;
- Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards, as defined in Annex V of Decree 18/2004 (as amended by Decree 67/2010).

The measures above are applicable for the onboard treatment option. If the onshore disposal option is adopted, as discussed above, only offshore recognized ships or tanks must be used for the transportation of cuttings.

Impact Assessment Summary:

The impact assessment summary is provided on the following table.

Impact: Effects of the discharge of drilling muds and cuttings on marine ecology due to changes in water quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Use lox toxicity WBMs only, for the drilling of the initial well sections; - When LTOBM are used, mud recovery systems are recommended; - Monitor and record the use of all drilling fluid components and other chemicals; - During use of LTOBMs, monitoring must be performed onboard the rig to ensure that the oils are removed from the cuttings such that less than 1% oil remains adhered to the cuttings prior to disposal; - Manage and discharge WBM mud and cuttings and LTOBM cuttings in compliance with international best practices; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.	Negative	
Type	Indirect			Indirect	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

Impact: Effects of discharge of drilling muds and cuts on deepwater benthic macrofauna due to smothering and burial effects

Impact Assessment

Beyond the potential changes to water quality caused by the discharge of drill cuttings (which has been assessed in the previous impact), this activity could also lead to impacts on deepwater benthic macrofauna due to smothering.

There is a prominent lack of infaunal and epifaunal data for benthos at Area 4. Deepwater benthic communities expected to occur in the vicinity of potential well sites would include soft bottom communities within sand and mud sediments.

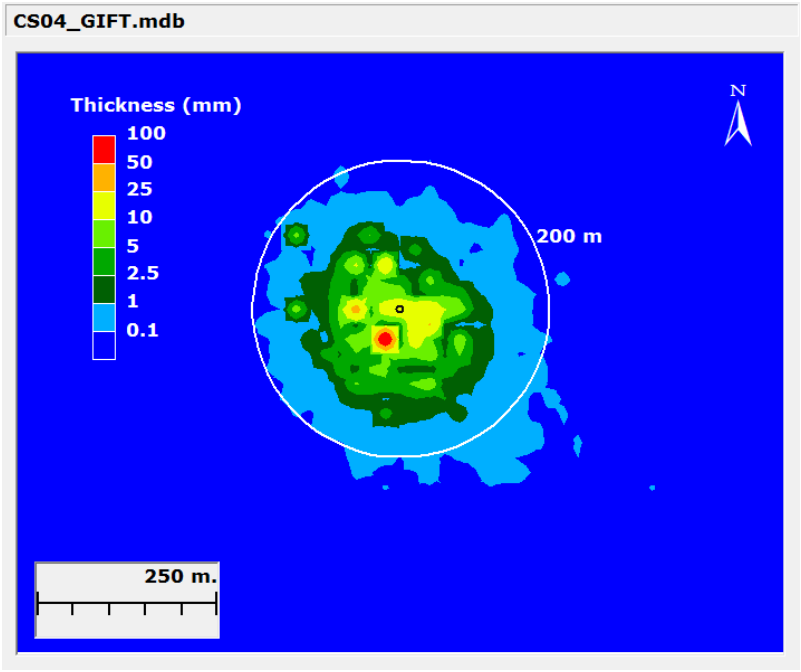
Based on the ROV imagery provided, the seabed around most of the observed sites in the project area bears limited structural complexity, and it does not show very dense cold reefs or other features of major interest. However, due to the extension of Area 4 and its environmental heterogeneity, the occurrence of higher sensitivity beds, namely denser cold reefs cannot be excluded. Exception to this goes to the relative abundance of stalked glass sponges and sea pens at Dugongo 1 and Mamba South 2 (these correspond to two wells drilled by EEA during the exploration phase) where the density of these sensitive colonies seems to justify classifying the specific sites as having important biodiversity value. These colonies are not only of interest per se, but also by attracting and supporting associated species thus enhancing biodiversity. At Mamba South 2, the smoke seen emanating from the sediment, with whitish sediments in the vicinity, may indicate the presence of cold seeps. However no sign of high biomass or biodiversity concentration was observed.

When drill cuttings are discharged to the sea, the larger fragments sink rapidly to the sea floor forming a pile and the finer particles are carried further away by residual currents. The cuttings pile can smother the benthos inhabiting the sea floor around the well site, regardless of the type of drilling fluid used. The shape and depth of the cuttings pile is determined by the quantity and rate of discharge as well as the oceanographic parameters in the region, such as water depth, current speed and current direction.

The potential smothering effect resulting from the discharge of drill cuttings during the drilling of the FLNG's production wells was assessed in the oceanographic specialist study undertaken for this EIS (ERM, 2014b). Based on the expected drill cutting discharge volumes (data estimated from wells previously drilled by EEA), ERM (2014b) modeled the expected maximum particle deposition thickness at sea bottom level, resulting from the settling of released cuttings for four production wells to be used in the FLNG project.

The model indicated that the maximum thickness of deposited material will range from 13.9 mm to 84.2 mm, across all modeled wells. The potential smothering effect resulting from such deposition thickness depends on the sensitivity of the specific benthic organisms that may be affected. There is thus no maximum accepted thickness threshold, above which significant impacts are expected to occur on benthic fauna, as this varies depending on the tolerance of the specific benthic species present, as well as the nature of the deposited materials. However, some authors recommend using threshold thickness value of 50 mm above a substratum for a month deposition as a threshold for impacting benthic communities (Ellis & Heim, 1985; MarLIN, 2011). Although threshold values as low as 1 mm have been reported (e.g. Smit *et al*., 2006), they are associated with instantaneous burial of material on benthic species, not a gradual sedimentation which would provide opportunity for organisms to remove the load. Therefore, a threshold of 50 mm is used in this study to examine the risk of benthic impacts related to a gradual burial.

Of the four wells modeled by ERM (2014b), only one exceeded this 50 mm threshold. Particles primarily settle over a 200 to 600 meter radius from the well location and create deposits estimated to reach a peak of 84.2 mm thick (ERM, 2014b). The area of depositional thickness that exceeded the 50 mm maximum threshold is approximately 215 m² (16.5 m diameter), adjacent to the well location (see **Figure 7.13** below). The deposits during jetting of Section 1, and riserless drilling in Section 2 are responsible for the first 48.6 mm of the peak.



Source: ERM (2014b).

Figure 7.13 – Maximum depositional thickness modeled for production well C_S04

As such, any smothering effect resulting from the drilling phase will be limited to a very small fraction of the benthic habitats of the study area.

In addition to the smothering effects of the cuttings, residual LTOBM adhering to the cuttings can contaminate the surrounding water and sediment. It is generally believed that the main agents of toxicity in drill cuttings are the oil and oil products, characteristic of Oil Based Muds (OBM) (Patin, 1999).

In this project, only WBM and new generation LTOBM will be used, which have low concentrations of aromatic compounds and are totally recyclable. Synthetic components are generally less toxic due to reduced concentrations of aromatic compounds and are less persistent in the environment (OGP, 2003).

The deposition of LTOBM cuttings on the seabed is likely to increase the BOD in the underlying sediment. This consumption of available oxygen in the sediments can lead to changes in the benthic systems until the drilling fluid has been sufficiently degraded to allow the re-establishment of the natural biota (OGP, 2003).

Studies in the Norwegian North Sea have shown that the discharge of cuttings associated with the use of WBMs and LTOBMs (as opposed to the more toxic OBMs) have little or no effect on benthic fauna more than 250 m from the well (OGP, 2003). This is also corroborated by the modeling undertaken for the EIS (ERM, 2014b), which shows that the suspended particles resulting from the drilling discharges (to which potential pollutants are adhered to) primarily settle in the first 200 m surrounding the drilling location (see **Figure 7.13**, previous page).

In view of the above considerations, the considered impact is *negative* and *direct*. It has a *medium* duration (recovery of the affected communities may last a few years) and *low* extent (local scale). Considering the possibility that the area may have an important biodiversity value the importance is rated as *medium*, resulting in a *medium significance*.

Mitigation Measures

Given the assessed significance, mitigation should be adopted to reduce the significance of the residual impact. The following is proposed:

- Prior to the start of drilling, a detailed ROV analysis of the drilling sites should be undertaken, in order to identify the presence of any sensitive benthic habitat or benthic community. If such a habitat or community is identified, the exact drilling location should be adjusted. Considering the calculated potential dispersion and deposition of released drill cuttings the drilling location should be at least 250 m away from any sensitive benthic habitat or community, in order to avoid impacting on these communities;
- The implementation of the proposed mitigation measures to avoid changes in water quality due to the discharge of drilling muds and cuttings will also help mitigate any impact on deep water macrobenthos.

Impact Summary

The impact assessment summary is provided on the following table. The proposed avoidance measures will reduce the importance and number of elements score, resulting in a low significance residual impact.

Impact: Effects of discharge of drilling muds and cuts on deepwater benthic macrofauna					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Undertake ROV analysis of the drilling sites prior to start of drilling. Adjust the exact drilling location, as much as possible, in order to avoid impacting on any sensitive benthic community or habitat that may be identified; - Use lox toxicity WBMs only, for the drilling of the initial well sections; - When LTOBMs are used, mud recovery systems are recommended; - Monitor and record the use of all drilling fluid components and other chemicals; - Manage and discharge WBM mud and cuttings and LTOBM cuttings in compliance with international best practices.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**7**		**Low**	**5**

Impact: Effects of noise on marine fauna in the drilling, installation, commissioning and decommissioning phases

Impact Assessment

Existing underwater noise levels in the project area are likely to be relatively low, as currently no relevant source of anthropogenic noise is present (beyond normal maritime traffic). The baseline underwater noise climate is thus expected to be determined mainly by natural sources (biological and oceanic). Background noise levels as documented in literature tend to be in the range 90 dB to 110 dB (re 1 µPa) (ERM, 2014f), representing the typical range for calm to windy conditions.

During the drilling operations, noise will be produced by the diesel-powered engines used to operate vessels, helicopters and drilling equipment. The project anticipates that the drilling activities will be conducted through a Dynamically Positioned (DP) Mobile Offshore Drilling Unit (MODU). These dynamically positioned vessels are noisier than anchor units due to additional noise from thrusters and propellers, and this is the expected noisier activity in these phases.

The drilling itself is a lower noise source than the use of DP system. Underwater noise from drilling peaks at frequencies below 500 Hz with a wide range of broadband values which are generally higher for drilling ships than for other drilling rigs (up to 185 dB re 1 µPa at 1 m (rms)) (Simmond *et al*., 2004).

Helicopters used during these phases will also generate noise that may startle marine mammals, as the aircraft pass overhead. The noise source associated with helicopters is the impulsive noise from the main rotor, with dominant tones below 500 Hz (ERM, 2014f). Underwater noise levels from a Bell 212 helicopter flying at 46 m above the sea were recorded as 149 dB re 1 µPa (rms) (ERM, 2014f). However, underwater noise due to helicopter movements is generally found to be restricted to a relatively narrow corridor beneath the aircraft, as much of the sound is generally reflected and does not penetrate the water. This is thus not considered to be a relevant effect.

The noisier project activity during the drilling, installation, commissioning and decommissioning phases will thus be the use of the drilling unit DP system. This will likely generate noise levels similar to the ones expected for the operational phase (resulting from the DP systems of the offloading vessels), although of a more temporary nature. According to Wyat (2008), the use of DP thrusters could generate underwater noise levels of 192 dB re 1 µPa at 1 m (rms), peaking in the frequency range of 25 to 50 Hz. These levels are applicable to the worst-case operational mode, which is offloading during the use of DP thrusters.

As the more intense noise source of the drilling, installation, commissioning and decommissioning phases will be the same as that of the operational phase (the use of DP thrusters) the impact will be very similar in these phases, in terms of intensity and areas affected. The impact during, installation, commissioning and decommissioning phases can only be differentiated due to its short-term duration.

The potential noise impact of the operational phase is assessed in detail in section 7.3.3 below, and the discussion presented there is fully applicable to these phases as well. The potential impacts of the installation, commissioning and decommissioning are expected to be lower. Please refer to section 7.3.3 for a more detailed discussion of the impact, which was based on noise modeling, and on the sensitivity of the marine fauna receptors to noise, including marine mammals, turtles and fish. The main conclusions of the noise assessment are the following:

- The noise levels generated by DP thrusters are not high enough to cause physical injury or mortality, even at short range, for any marine fauna;
- The project emissions are, however, high enough to elicit behavioral responses. Based on the sensitivity of different marine fauna groups to noise, and on noise modeling (again, please see section 7.3.3), the following can be expected:
    - Fish could experience noise levels high enough to cause behavioral responses at distances up to 700 m from the operating DP thrusters;
    - Turtles can be affected at distances of up to 400 m;
    - Toothed whales and dolphins (sensitive to mid-frequency) at distances of up to 1 900 m; and
    - Baleen whales (sensitive to low-frequency) at distances of up to 44 000 m.

In terms of fish and turtles, the potential behavioral impacts are thus limited to a very small area surrounding the drilling site, and are not considered to be significant in the context of the offshore environment where drilling will take place. In terms of marine mammals, the distances at which behavioral impacts are expected do not affect important areas for marine mammals in the region, as identified in the baseline section (refer to section 6.4.5 of Volume I), namely the coastal area between Olumbe Bay and Quifuqui Island, which is important for dolphins, and the area surrounding the Saint Lazarus Bank, which is likely important as a feeding ground for many marine mammal species.

The main expected impact will thus be on baleen whales occurring or migrating through the 44 km radius where the project generated noise will be high enough to elicit behavioral responses. The effect of noise on migration behavioral is not fully understood, however it is very likely that whales will tend to react by moving away, avoiding proximity to the noise source, as they have good mobility to avoid the sound disturbance. This may cause them to adjust their migration route but is unlikely to cause more severe impacts, such as interruption of the migration although, as stated, noise effects on these animals are largely unknown.

Considering the discussed above, and the more detailed analyses presented in section 7.3.3 below, the potential noise during the drilling, installation, commissioning and decommissioning phases is assessed as *negative* and *direct*, of *low* duration (short term), *medium* scale (low frequency marine mammals could show behavioral responses on a 44 km radius surrounding the drilling sites), and *medium* importance (no injury or physiological impacts are expected; behavioral impacts may manifest on marine mammals, but these are unlikely to result in severe effects, such as interruption of migration). The number of species potentially affected was assessed as *medium* (only baleen whales will be subjected to relevant impacts). The impact is thus of *medium* significance.

Mitigation Measures

Noise mitigation should focus on minimizing noise emissions. The following is proposed:

- The DP systems are likely to be the major source of noise. Therefore, selection of the drill ship (MODU) and support vessels should be carried out taking into account the noise emissions, and where possible selecting quieter DP systems;
- As far as reasonably practicable, vessels used in the project should incorporate measures to reduce cavitation thus reducing the amount of underwater noise generated (IMO, 2004), as follows:
    - Propeller designed/ selected to reduce cavitation;
    - Improve DP system to delay cavitation inception nearer to peak speed;
    - Vessels should also undergo regular maintenance regime to reduce noise which include the cleaning of propeller and underwater hull.
- If technically feasible, investigate the possibility of using mooring/anchoring to keep the drill ship on station rather than using DP systems. However, should mooring/ anchoring be undertaken, it will also be necessary to avoid noise generating anchoring techniques such as driven piling. Adherence to measures stated in JNCC (2010) throughout piling operations is recommended to minimize impact to marine fauna present in the area. These measures include the presence of dedicated Marine Mammal Observers (MMO) throughout piling activities, undertaking soft-start of pile driving activities, and establishment of a 500 m mitigation zone;
- Additionally, vessel transits should avoid sensitive marine areas as well as maintaining a 500 m exclusion[11] zone from any marine mammals encountered during transit. Any sightings of marine fauna throughout the project duration should be recorded to assess the effectiveness of mitigation measures applied.

Impact Assessment Summary

The degree of noise reduction from the application of measures recommended above is uncertain. However, should the design considerations are effective, it is expected that the generation of underwater noise may be reduced by up to 5 – 10 dB (Fischer, 2000) which will considerably lessen the disturbance zone for marine fauna. Additionally, avoidance of sensitive areas and individuals encountered during transit is also likely to reduce disturbance impacts to marine fauna present in the area.

The post-mitigation assessment considered the reduction in noise levels generated from project activities due to the application of the proposed mitigation measures. Noise reduction will reduce the extent of the impact and the number of individual animals which will be impacted by the noise. Hence, the post-mitigation significance has been evaluated to be Low.

[11] 500 m exclusion zone is used based on the JNCC (2010) guidelines to minimize risk of injuries or disturbance to marine mammals, in the absence of any definitive guideline relating to mitigating impacts from vessel movements to marine mammals.

Impact: Effects of noise on marine fauna in the drilling, installation, commissioning and decommissioning phases					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- The DP systems are likely to be the major source of noise. Therefore, selection of the drill ship (MODU) and support vessels should be carried out taking into account the noise emissions, and where possible selecting quieter DP systems; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - If technically feasible, investigate the possibly of using mooring/anchoring to keep the drill ship on station rather than using DP systems; - Avoidance of noise generating anchoring techniques such as impact piling; - Should piling option be used, mitigation measures such as soft starts, provision of dedicated MMOs and establishment of a 500 m mitigation zone throughout piling operations should be adhered to (JNCC, 2010); - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Medium	2		Low	1
Importance	Medium	2		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**7**		**Low**	**5**

Impact: Impacts related to artificial lighting on marine fauna in the drilling, installation, commissioning and decommissioning phases

Impact Assessment

Artificial lighting will be required throughout the project's lifecycle and may impact on marine fauna behavior. During the drilling, installation, commissioning and decommissioning phases, the illumination impacts will be associated with the navigational lighting of the vessels, drilling rig and helicopters.

Artificial lights can disrupt biological processes of marine fauna that rely on visual cues to natural light, resulting in disorientation and adverse effects on the maintenance of species populations, as increase of predation of zooplankton or fish species attracted by lights or changes in the natural behavior of turtles. An increase in marine mammals foraging on zooplankton and fish may be observed. The prey-predator relationships could be modified, affecting the ecosystems' equilibrium.

Plankton is the basis of the food web, serving as a food source for fish, birds, and marine mammals. Artificial light may cause changes in the lifecycle of some species (such as some zooplankton and invertebrates species) with vertical migrations based on the daily photoperiod. As marine zooplankton drifts passively with the movement of the water mass, the effects are presumed to be of low duration.

However, in these project phases, the increase of artificial light in the project area is expected to be relatively low, as it will be mainly associated with a few moving vessels and the drilling rig. The impact of artificial light on marine organisms is *negative* and *direct*, but during these project phases it will be *temporary*, of *local* scale and *medium* importance, resulting in a *low* significance.

Mitigation Measures

The illumination impact during drilling and installation phases is not expected to be relevant, and as such no specific mitigation is required. Light emissions should be kept as low as possible, in accordance with best practice environmental management.

Impact Assessment Summary

The impact is considered of *low* significance, slightly decreasing after mitigation but remaining low. The impact assessment summary is provided on the following table.

Impact: Impacts related to artificial lighting on marine fauna					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Light emissions should be kept as low as possible, in accordance with best practice environmental management.	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**5**		**Low**	**4**

Impact: Risk of collisions and entanglement on the marine fauna

Impact Assessment

The number of whales and marine turtles killed or injured by ships as a result of boat collisions is a worldwide concern. Vessel movements transiting to and from the project site will increase during these project phases, when compared to the baseline conditions. The potential risk of collision with whales during the migratory period with vessels is thus expected to increase. Cetaceans have low population turnover rates and the fact that the list of marine mammals potentially occurring in Mozambique has many species with Endangered and Vulnerable conservation status affects the importance of this impact.

Increased vessel traffic around Area 4 may also increase the risk of disturbance on sea turtles in terms of migratory and nesting routes, or even collisions. Sea turtles are difficult to sight from moving vessels and often rest on or just below the surface of the ocean. All five species of sea turtles occurring in the area are considered to be threatened at a global scale, making any adverse effects significant to the overall populations.

This impact on the marine fauna of the area will be *negative*, *direct* and of *local* extent. Although the duration of the vessel movements will be temporary, the effects on marine fauna populations could last longer because of the population turnover rates, and as such the duration is defined as *high*. The importance of the impact is also rated as *high* because of the presence of threatened and vulnerable species on the area. Considering the assessed criteria, the impact has a *medium* significance.

Mitigation Measures

Mitigation should be applied, in order to minimize the risk of collisions or entanglement with marine mammals, namely:

- Ensure constant bridge watch is kept on all vessels involved in the drilling, installation, commissioning and decommissioning phases to look out for cetaceans in danger of collision.

Impact Assessment Summary

The adoption of the proposed mitigation will reduce the risk of collisions with marine mammals, thus reducing the duration and importance scores of the mitigated impact, resulting in a *low* significance residual impact. The impact assessment summary is provided on the following table.

Impact: Risk of collisions and entanglement on the marine fauna					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Ensure constant bridge watch is kept on all vessels to look out for cetaceans in danger of collision.	Negative	
Type	Direct			Direct	
Duration	High	3		Medium	2
Extent	Low	1		Low	1
Importance	High	3		Medium	2
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**8**		**Low**	**6**

Impact: Risk of introduction of alien invasive species (AIS) due to discharge of ballast water during the drilling, installation, commissioning and decommissioning phases

Impact Assessment

The vessels used in the drilling, installation, commissioning and decommissioning phases are likely to be sourced from the international market. Any discharge of ballast water taken outside of Mozambican waters from these vessels has the potential to introduce invasive alien species.

It is now widely acknowledged that Alien Invasive Species (AIS) can cause major and often irreversible damage to the environment, economy and human health. Worldwide, they have been implicated in numerous species extinctions and remain a serious threat to many more species. This was confirmed recently by the findings of the Millennium Ecosystem Assessment, which found that AIS species have been a main direct driver of change in biodiversity and ecosystems over the past 50–100 years. The assessment also predicts that impacts are likely to continue or increase in all biomes globally (IPIECA, 2010).

Many AIS share common biological characteristics such as rapid reproductive capacity and fast growth, hence they can often adapt readily to disturbed or degraded environments, even before native species are able to adapt to the same conditions. Frequently, introduced AIS have no natural predators in the receiving environment, and numbers may be allowed to increase in the absence of predation. The impacts of AIS on biodiversity and ecosystems can be direct, indirect and synergistic.

Many marine species reproduce by dispersing planktonic eggs and/or larvae, and it is inevitable that ballast water will contain large numbers of a wide variety of organisms. Ballast is usually taken on in areas of relatively high shipping traffic, in shallow coastal or port waters that have a high natural abundance of plankton; these are usually the areas in which AIS will be present. While some organisms may not survive in ballast tanks, many do, and upon discharge at the destination port - if conditions are suitable - these organisms can complete their lifecycle (IPIECA, 2010).

Discharge and loading of ballast water has considerable potential for the transmission of AIS. Considering the above, the impact of ballast waters on marine biodiversity is *negative* and *direct*. It is likely to occur

during the drilling and installation phases, being *temporary*. It can affect the area of direct influence of the project, as well as the whole concession area, the coastline and near-shore area of Palma District and the islands located to the west of the FLNG location and therefore it has a *regional* scale. As it can affect areas of high biodiversity, it's an impact with a *high* importance and may involve a *great* number of individuals, habitats and ecosystems. The impact has a *medium* significance.

Mitigation Measures

Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010; IMO, 2011; eni & FFI, 2013). Some of those best practices are as follows:

- All vessels containing ballast water should carry a vessel-specific Ballast Water Management Plan, in accordance with IMO and MARPOL standards. The following should be considered in what regards ballast water management:
    - Full ballast exchange should be conducted in deep sea only, and at least 200 m from the nearest land;
    - If feasible, sterilize ballast water through filtration, heat treatments and/or de-oxygenation with nitrogen prior to discharge (EBI, 2002);
    - No discharge within 20km of FLNG operational site.
- All vessels should have a documented Biofoul Management Plan (as per IPIECA, 2010 and IMO, 2011). The following should be considered in what regards biofouling management:
    - Investigate all technologies to reduce biofouling - follow, for example, best practice in prevention and management of Alien Invasive Species (AIS) in the oil and gas Industry (IPIECA 2010);
    - Develop biofoul risk assessment and quarantine management system for all operational vessels and supply tankers:
    - Ensure anti-fouling treatment records are up-to-date as per IPIECA guidance;
    - Quarantine all ships which do not carry a Biofoul Management Plan outside of Mozambique territorial waters.

Impact Assessment Summary

If the international guidelines for management of ballast waters and biofouling are followed, as proposed, the risk of introduction of AIS from the project vessels will be similar to that of all the normal international traffic that operates in the project area. As such, the proposed mitigation lowers the score of the extent, importance and number of elements criteria, resulting in a low significance residual impact. The impact assessment summary is provided on the following table.

Impact: Risk of introduction of alien species due to discharge of ballast water during the drilling, installation, commissioning and decommissioning phases					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010); - All vessels should have a documented Biofoul Management Plan (as per IPIECA, 2010 and IMO, 2011)	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Medium	2		Low	1
Importance	High	3		Medium	2
No. of elements involved	High	3		Low	1
Significance	**Medium**	**9**		**Low**	**5**

Impact: Effects of increased vessel and helicopter movement on seabirds and migratory birds

Impact Assessment

The vessels employed to establish the offshore systems (drilling, installation, engineering work, security and services, etc.) will result, among other effects, in increased vessel movements. Offshore vessels will be operational 24 hours a day during the installation, and helicopters will also be employed as logistical support to project implementation.

The movement of vessels and helicopters may disturb the natural movement and behavior of seabirds by attracting (due to light) and disorienting (due to noise) certain species - in particular migrating birds - while collisions may occur with passing birds.

Although localized, the movement of vessels and helicopters might disturb flocks of migrating birds flying at low heights or marine birds feeding in foraging areas.

Bird foraging areas are areas where birds gather in order to catch food, and usually relate to the abundance of fish or other marine organisms. Given that no detailed avifauna survey has been conducted in Area 4 or the FLNG site, foraging areas will be identified at a later stage through a detailed field survey of the project area which will in turn allow for a better impact assessment.

However, current assessment suggests that the impact would be *localized* to the vicinity of the vessels and helicopter movement, and of *low* duration with behavioral disturbances such as disorientation and attraction considered temporary (*low* duration) and affecting *medium* number of elements. The potential impact is therefore evaluated as *low* significance.

Mitigation Measures

The objective of the mitigation measures outlined below is to reduce harmful interactions with marine birds by reducing noise and vessel and helicopter related effects:

- Instruct helicopter operators to maintain a minimum height of 500m over bird foraging areas unless this distance is essential for safety or emergency purposes;
- Keep any disoriented or otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme;

- Prohibit all crew members from killing or causing injury to seabirds and establish effective measures for the punishment of crew members found to have deliberately killed or caused injury to avifauna.
- Ensure systematic maintenance of all machinery and equipment in accordance with manufacturers' specifications

Impact Assessment Summary:

Impact: Effects of increased vessel and helicopter movement on seabirds					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Instruct helicopters to maintain a minimum height of 500m over bird foraging areas unless essential for safety or emergency purposes. - Keep any disoriented and unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme. - Prohibit all crew members from killing or causing injury to seabirds (any crew members found to have deliberately killed or caused injury to marine fauna shall be dismissed immediately and removed to shore).	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**Low**	**6**		**Low**	**4**

Impact: Effects of illumination on seabirds

Impact Assessment

The vessels employed to establish the offshore systems (drilling, installation, engineering work, security and services, FLNG, etc.) will result, among other effects, in increased lighting.

Offshore vessels will be operational 24 hours a day during installation, and the FLNG will also be permanently illuminated during commissioning. At night, light emitted by vessels and the FLNG may affect the movement and behavior of seabirds, and light from helicopters may also disturb seabirds. Lighting from the vessels may attract and disorient certain species, in particular migrating birds, while collisions may occur with passing birds.

The natural behavior of seabirds and migratory birds are considered to be highly sensitive to illumination. According to the Illumination Specialist Study (ERM 2014a), birds may be affected when entering the radial illuminated zone around the FLNG vessel, which will be visible from several kilometers. Intermittent and infrequent flaring events at night may also temporarily increase the zone of impact, owing to the brightness of the flare.

Artificial light from offshore platforms has been shown to attract migrating birds, and birds that migrate during the night are especially affected (Verheijen, 1985). Migratory bird species that are attracted to an artificial light source have been noted to circle the light source and remain for varying periods. This could lead to predation by other predatory bird species. Additionally, the energy levels required for travelling between foraging and feeding sites could be depleted to a point where the bird physically cannot reach its intended destination. Collisions with flares and illuminated structures have also been documented as a cause of avian fatalities.

Any behavioral disturbances such as disorientation and attraction are considered temporary (*medium* duration). Physical effects such as exhaustion and mortality may also potentially affect a small proportion of the population but this would be dependent on the number birds and type of species affected. The potential impact is therefore evaluated as *low* significance.

Mitigation Measures:

The objective of the mitigation measures outlined below is to reduce harmful interactions with marine birds by reducing lighting:

- Minimize non-essential lighting on vessels, and shield and/or reduce, whenever practicable, the number of lights shining directly onto the water as far as possible.
- Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights.
- Keep any disoriented or otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme.
- Prohibit all crew members from killing or causing injury to seabirds and establish effective measures for the punishment of crew members found to have deliberately killed or caused injury to avifauna.

Impact Assessment Summary:

The impact assessment summary is provided on the following table.

Impact: Effects of illumination on seabirds					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Minimize non-essential lighting on vessels, and shield and/or reduce the number of lights shining directly onto the water as far as possible. - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights. - Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme. - Prohibit all crew members from killing or causing injury to seabirds (any crew members found to have deliberately killed or caused injury to marine fauna shall be dismissed immediately and removed to shore).	Negative	
Type	Direct			Direct	
Duration	Low	1		Low	1
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**Low**	**6**		**Low**	**4**

Impact: Effects of vessel discharges on seabirds

Impact Assessment:

This impact considers the effects on water quality and the health of seabirds within the area of discharging sewage, deck drainage, bilge water and machinery space drainage, emissions to the atmosphere and galley and garbage waste originating from shipping operations. These impacts could potentially arise from contractors operating vessels that are not compliant with the provisions of MARPOL 73/78 or other relevant international and domestic instruments. Since this project will operate under strict international standards, it can be assumed that IMO and MARPOL requirements will be adhered to, both by EEA and all third parties involved in the project.

Directly or indirectly discharged solid and liquid wastes from marine vessels during any phase of the development could potentially result in the proliferation of litter and compromise sea water quality, which could harm seabirds. If the maritime laws are followed, the potential pollution impacts of routine operational emissions, discharges and effluent emissions at sea would be *localized* and of *medium* duration and affecting a *medium* number of elements, thus resulting in impacts of *medium* significance.

Mitigation Measures:

Proposed mitigation measures are as follows:

- Prior to the establishment of the Project, ensure all contractor vessels are compliant with MARPOL 73/78 and utilize MARPOL compliant waste facilities elsewhere for offloading wastes;
- All Project vessels will comply with MARPOL 73/78. This will, among other things, require the provision of Port Reception Facilities for vessels based at the facility (i.e. support vessels and tugs), as well as effective waste disposal sites/mechanisms

Impact Assessment Summary:

The impact assessment summary is provided on the following table.

Impact: Effects of ship operational discharges on seabirds					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Prior to the establishment of the Project (i.e. during the construction phase) vessels will comply with MARPOL 73/78 and utilize MARPOL compliant waste facilities elsewhere for offloading wastes. - All Project vessels will comply with MARPOL 73/78. This will, among other things, necessitate the provision of Port Reception Facilities for vessels based at the facility (i.e. support vessels and tugs), as well as effective waste disposal.	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**7**		**Low**	**5**

7.3.3 Operational Phase

7.3.3.1 Potentially Impact-Generating Project Activities

During the operational phase of the project, the FLNG will mainly extract natural gas from wells, process and liquefy natural gas and store and offload the LNG on carriers for export. The FLNG facility operations, the logistic support, the export of the gas and maintenance will lead to activities that can be a source of impacts namely:

- Liquid discharges – these include different types of discharges, with different potential impacts:
  - Wastewater discharges – discharge of liquid effluents normally associated with any marine vessel (including the FLNG vessel, support vessels and LNG carriers), including domestic wastewater, bilge water, etc.. These discharges may impact on water quality, and indirectly on marine biota;
  - Water discharges from the LNG plant – these include the discharge of produced water and cooling water. The former may impact on seawater quality and the latter may induce changes in the seawater temperature. Both these effects may impact on marine biota.
- Waste management – inadequate management and disposal of solid waste generated aboard the FLNG during operation could lead to impacts on water quality, and indirectly on marine biota;
- Increased marine traffic (vessel movements from supply vessels and export shipping) – leading to increased noise and light emissions, and an increase to the risk of collisions and entanglement with marine fauna and avifauna;

- Presence of the FLNG vessel – the FLNG vessel itself will be also source of noise and light emissions, with potential associated impacts on marine fauna and avifauna.

The potential impacts on marine ecology by these activities are discussed below.

7.3.3.2 Impact Assessment

Impact: Effects of liquid effluents on marine ecology due to changes in water quality

Impact Assessment

Liquid effluents will be produced during the operation of the FLNG and related operational vessels (including LNG carriers) and will include deck drainage, bilge water and sewage discharge (note that the FLNG operation will also result in the discharge of produced water and refrigeration water, but these are assessed in separate impacts below). These effluents will be similar to those generated by any marine vessel moving through the study area, including the current regional and international marine traffic. Liquid effluents may have the potential of damaging the marine environment, mainly through toxicity and oxygen depletion. These effects may then indirectly impact marine mammals, turtles, fish, benthic fauna and plankton.

The discharge of these waters usually occurs through the vessel's own drainage system in the case of vessels, while in the FLNG it will occur after treatment. However, in the presence of an emergency (*e.g.* a cyclone or collision with another vessel), these waters can be directly discharged to the sea.

However, it is considered that the FLNG facilities have adequate treatment facilities on board to comply with applicable regulation, and as such no significant changes to the marine water quality is expected. The impact is considered *negative* and *indirect*. The duration of the impact is *high* (long term, but reversible). However, the extent is *local* (as no relevant impacts on water quality are expected outside of the mixture zone) and the importance is *low*. The impact is thus of *low* significance.

Mitigation Measures

All discharge of deck drainage, bilge water and sewage from the FLNG and associated vessels will need to comply with relevant international maritime standards and regulations, namely those set out in MARPOL (73/78) regulations. The main environmental standards to be complied to are similar to those presented for the drilling and installation phase, and include the following

- Establish separate drainage systems for hydrocarbon-contaminated water (closed drains) and water from non-process areas (open drains). Bund all process areas to prevent contamination by storm waters, contain spills and leaks, and channel drainage water into the closed drains;
- Use drip trays to collect run-off and spills from equipment not contained within a bunded area and channel runoff to the closed drainage system;
- Disposal of deck drainage, bilge water and sewage in accordance with MARPOL 73/78:
    - Liquid effluents must be treated before discharged to the sea;
    - Sewage must be treated and disinfected (on-board treatment plant) prior to discharge;
    - Treated effluents shall achieve a BOD < 40 ppm, suspended solids < 50 ppm and a coliform count < 200 cells per 100 ml of effluent;
    - The discharge depth is variable, but it should not be less than 5m below the surface;
    - Route water from machinery spaces to the closed drainage system, or contain and treat the bilge water before discharge;

- The concentration of oil in the water after treatment in an IMO approved oil/water separator shall not exceed 15 ppm;
- Contain oil and chemical use areas and equipment (deck, mud tanks and pumps);
- Use efficient oil and water separators.

- Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills as soon as they occur.

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects of liquid effluents on marine ecology due to changes in water quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Discharge of deck drainage, bilge water and sewage shall comply with MARPOL 73/78 requirements; - Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills as soon as they occur.	Negative	
Type	Indirect			Indirect	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

Impact: Effects of solid waste disposal on marine ecology due to changes in water quality

Impact Assessment

The normal operation of the FLNG is expected to generate a significant quantity of solid wastes. These include non-hazardous wastes, similar to urban solid wastes (paper, plastic, metal, etc.), solid hazardous wastes (such as batteries, light bulbs, packages of hazardous materials, etc.) and other wastes associated with the productive process itself.

Inadequately management of such wastes (such as if discharged to the sea without treatment) could result in significant impacts on water quality, and therefore on marine ecology. However, it is expected that the FLNG will have in place a Waste Management Plan, which will ensure that all solid waste generated during the operation is adequately collected, sorted, temporarily stored and sent to final treatment or disposal.

No discharge of untreated solid waste to the sea is expected during the operational phase, and as such no relevant impact on water quality is predicted. As such, the indirect impact on marine ecology is assessed as *negative*, of *high* duration (during the operation), but of *low* extent and importance, resulting in a *low* significance.

Mitigation Measures

To ensure that the assessed impact remains of low significance, it is fundamental that the FLNG has in place a Waste Management Plan, to ensure that all solid waste generated in the facility is adequately collected, sorted, temporarily stored and sent to final treatment or disposal, as indicated in the mitigation measures for the drilling, installation, commissioning and decommissioning phases (see section 7.3.2 above). Training

should be provided to all workers, in what regards the need to reduce production of solid waste and the adequate procedures of waste management.

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects of solid waste disposal on marine ecology due to changes in water quality, during the operational phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Develop and implement a Waste Management Plan for the operational phase of the FLNG, in order to ensure that all solid waste generated in the facility is adequately collected, sorted, temporarily stored and sent to final treatment or disposal; - Provide training to all workers, in what regards the need to reduce production of solid waste and the adequate procedures of waste management.	Negative	
Type	Indirect			Indirect	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

Impact: Effects of noise on marine fauna during the operational phase

Impact Assessment

As previously noted, existing underwater noise levels are likely to be relatively low, being determined mainly by natural sources. Background noise levels are expected to be in the 90 dB to 110dB (re 1uPa) (ERM, 2014f), representing the typical range for calm to windy conditions.

In the operational phase, potential noise impacts from the FLNG project will from the presence of the FLNG facility and associated offloading vessels. The noise from the dynamic positioning system on the offloading vessel (from the on-board thrusters) is likely to give rise to the highest noise impact. Thrusters can result in high underwater radiated noise, associated with cavitating impeller. It is noted that, for most of the time when offloading is not taking place, the noise levels from the FLNG will be lower. The predictions in this report are based on the use of thrusters and therefore represent a worst-case assessment.

The prediction of the noise impact generated by the FLNG project during the operational phase is based on noise modeling, undertaken by the noise specialist study developed for the EIS (ERM, 2014f). The modeling considered the worst-case scenario noise impact, as noted above, associated with the noise from the dynamic positioning system on the offloading vessels. According to Wyat (2008), vessels associated with the FLNG are likely to generate noise levels of 192 dB re 1 µPa at 1 m (rms) during the use of dynamic positioning thrusters. The predicted noise levels peak in the frequency range of 25 to 50 Hz. Considering the emission of these noise levels at the source (the FLNG location), ERM (2014f) then modeled the propagation and attenuation of the noise with distance (see **Appendix XII**, Volume IV for more details).

Noise impacts on marine fauna can be grouped into two major types of impacts:

- **Injury or mortality** – auditory injury, in the form of a loss of sensitivity to sound, can occur from exposure to noise sources. A short-term shift in hearing threshold (i.e. the sound level that is just audible to the animal) from which an animal recovers is referred to as Temporary Threshold Shift (TTS). Higher intensity exposure over a longer time period can however result in Permanent

Threshold Shift (PTS). Hearing organs of most animals comprise sensory hair cells that are very sensitive to vibrations, and over-stimulation of these can lead to permanent physical damage. Very loud sounds can also cause (non-auditory) tissue damage, e.g. in animals with gas-filled cavities (e.g. swim-bladders in fish), the formation of micro-bubbles in blood and fat tissue, which could create an embolism and cause small capillaries to burst, or cause damage to fish eyes where tissue may have a high gas saturation (CBD, 2012). Effects can be lethal in extreme cases;

- **Behavioral responses** – underwater sounds may cause startle responses in most mobile marine animals, which would typically cease their current behavior to move away from the sound source. Behavioral responses are often hard to detect, and would depend on a wide range of factors, including the animal's behavioral state (foraging, migrating, etc.), nutritional state (hungry or not), reproductive state, etc. Single 'noise events' would have short term effects, while continued exposure can result in habituation, followed by a return to normal behavior. Underwater sounds can also cause interference with communication / masking of environmental sounds. While this effect is difficult to measure/assess, anthropogenic noise in the underwater environment is likely to interfere with sound based communication between animals or by muffling or even masking natural underwater sounds used by marine organisms for orientation or navigation.

The intensity and significance of noise impacts are dependent on the sensitivity to noise of the receptors. Sensitive receptors to underwater noise include several marine fauna, such as marine mammals, turtles and fish. The sensitivity of marine fauna to noise (including noise levels and frequencies) varies from group to group, and from species to species. Of the groups listed above, marine mammals (particularly cetaceans) are expected to be the most sensitive to anthropogenic noise, as many species are completely reliant on the use of underwater sounds for communication, predator avoidance, mate selection, social interactions and, in the case of some odontocetes (toothed whales, dolphins and porpoises), for orientation, navigation and prey detection through echolocation. Even within this group, however, sensitivity to noise is expected to vary significantly, as marine mammals include species which are more sensitive to low frequency (Baleen Whales) and species more sensitive to mid frequency (Toothed whales). As noted above, the FLNG project is likely to mainly generate noise of low frequency (the predicted noise levels peak in the frequency range of 25 to 50 Hz), and as such baleen whales are expected to be marine mammals more sensitive to the expected impact.

Unlike for human receptors, however, there are no regulatory noise thresholds above which significant impacts are expected on marine fauna, either for injury or behavioral effects. Relevant noise thresholds were thus sourced from the available scientific literature assessing noise impacts on fauna.

In terms of **marine mammals**, Southall *et al* (2007) sets out criteria for damage and behavioral reactions of marine mammals as a result of noise. The criteria in Southall *et al.* (2007) suggest that in order to cause instantaneous injury to cetaceans (whales and dolphins) resulting in a permanent loss in hearing ability (long-term impact), the PTS sound level must exceed 230 decibels (dB) re 1 micropascal (µPa). As noted above, the FLNG project is predicted to generate maximum noise levels of 192 dB re 1 µPa, thus not reaching the threshold for instantaneous injury to cetaceans. In addition to the instantaneous noise criterion, there are also criteria for the avoidance of auditory damage which set lower limits if the exposure to the noise source is likely to be prolonged. Since mammals are expected to avoid continuous or semi-continuous sound sources that may cause harm, the likelihood of PTS as a result of longer term exposure to lower levels of noise is considered to be low and has been excluded from further assessment.

In terms of behavioral effects, there is little available information on hearing sensitivity for baleen whales (low-frequency hearing cetaceans which are more likely to be affected by the project emissions). However, it is presumed they hear over the same approximate frequency range as the sounds they produce, which gives a hearing sensitivity range of 10 Hz to 10 kHz with the greatest sensitivity below 1 kHz (DCENR, 2007). Southall *et al.* (2007) also quotes a frequency range between 7 Hz and 22 kHz for these species. Baleen whales have shown behavioral responses to received sound levels of 120-150 dB re 1 µPa (rms) (Southall *et al.*, 2007). Based on the studies that show observable reactions, a criterion of **120 dB** re 1 µPa (rms) has been adopted for all low-frequency species (baleen whales).

A study of killer whales that were exposed to Acoustic Harassment Devices found individuals displayed strong reactions to noise levels of 140-150 dB re 1 µPa (rms) (Morton & Symonds, 2002). They are considered to be representative of mid-frequency hearing cetaceans. A criterion of **140** dB re 1 µPa (rms) has therefore been assumed to apply to toothed whales, which also includes all dolphin species (mid-frequency cetaceans).

No criteria are available for dugongs and it has been assumed that their hearing sensitivity is similar to those of high-frequency cetaceans. Based on observable responses shown by other high-frequency cetaceans (Southall *et al.*, 2007), a criterion of 158 dB re 1 µPa (rms) has been applied for dugongs in this assessment.

As for **marine turtles**, available data on marine turtle hearing is limited, but show that turtles can detect low-frequency sounds (as low as 60 Hz), with greatest auditory sensitivity between 250 – 700 Hz (Ridgway *et al*., 1969; Wever *et al*., 1978 *in* McCauley 1994; O´Hara & Wilcox, 1990; Moein–Bartol *et al*., 1999). No studies definitively determine marine turtle hearing thresholds or detection limits. It has been proposed that marine turtles are most sensitive to low tones, and whilst the exact frequency of their hearing varies by species it is thought to be less than 1 kHz for all turtles (Bartol, 2008). No information on physiological effects, injury or mortality in response to sound sources could be sourced from the literature.

Behavioral changes in response to anthropogenic sounds have been reported for some sea turtles. Controlled exposure experiments on captive turtles found startle responses and an increase in swim speed and erratic behavior, indicative of avoidance (O´Hara & Wilcox, 1990; McCauley *et al*., 2000; Lenhardt *et al*., 1983). Moein *et al*. (1994) and McCauley *et al*. (2000) investigated responses of caged loggerhead and green turtles to impulses of very high noise levels (generated by seismic airguns) by measuring avoidance behavior, physiological response and electroencephalogram measurements of hearing capability. Results indicated that significant avoidance response occurred at received levels ranging between 172 and 176 dB re 1 µPa at 24 m. McCauley *et al*. (2000) reported that above levels of 166 dB re 1 µPa turtles increased their swimming activity. Above 175 dB re 1 µPa turtle behavior became more erratic possibly reflecting an agitated behavioral state at which unrestrained turtles would show avoidance response by fleeing an operating sound source.

Shell (2009), however, indicates that turtles have been reported to increase their swimming activity at lower sound levels, namely at 155 dB re 1 µPa (rms), and show more erratic swimming patterns at 164 dB re 1 µPa (rms).

Based on the references listed above, a criterion of **155 dB** re 1 µPa (rms) has been assumed to apply to turtles, in what regards eliciting a behavioral response.

In what regards **fish**, most species of fish are able to detect sounds from well below 50 Hz (some as low as 10 or 15 Hz) to upward of 500 – 1,000 Hz (Popper & Fay, 1999; Popper, 2003; Popper *et al*., 2003), and consequently can detect sounds within the frequency range of most widely occurring anthropogenic noises.

Studies have shown that fish can be directly exposed to very loud noise emissions (generated by a seismic airgun) without lethal effects, except for a very localized range of physiological effects. Physiological effects of impulsive airgun sounds on fish species include swim-bladder damage (Falk & Lawrence, 1973), transient stunning (Hastings, 1990 *in* Turnpenny & Nedwell, 1994), short-term biochemical variations in different tissues typical of primary and secondary stress response (Smith *et al*., 2004), and temporary hearing loss due to destruction of the hair cells in the hearing maculae (McCauley *et al*., 2003; Popper *et al*., 2005; Smith *et al*., 2006). Seismic airguns, however, generate noise levels far above those expected for the FLNG project, in the range of 250 dB re 1µPa @ 1m. As such, it is very unlikely that the FLNG noise emissions will result in any physiological effect to fish.

Fish behavior criteria are not well established. Studies have indicated that the level at which behavioral effects (increased activity) start to appear is about 160 dB re 1 µPa (rms) (Shell, 2009). The Fisheries Hydroacoustic Working Group (FHWG, 2009) suggests a criterion of **150 dB** re 1 µPa (rms), which has been adopted here.

The discussion above shows that it is unlikely that the FLNG project's noise emissions will cause any physical injury, mortality or relevant physiological effects to marine fauna, even at very short range to the emitting source. Behavior responses, however, are likely, given the thresholds discussed above and summarized in **Table 7.16** below.

Table 7.16 – Summary of Noise Assessment Criteria of Behavioral Responses

Faunal Group	Hearing Capabilities (Hz)	Noise Criterion for Behavioral Response (dB re 1 µPa (rms))
Baleen whales (low-frequency hearing)	7 – 22 000	120
Toothed whales (mid-frequency hearing)	150 – 160 000	140
Dugongs (high-frequency hearing)	200 – 180 000	158
Turtles	100 – 1 000	155
Fish	20 – 1 000	150

Source: Southall *et al*. (2007).

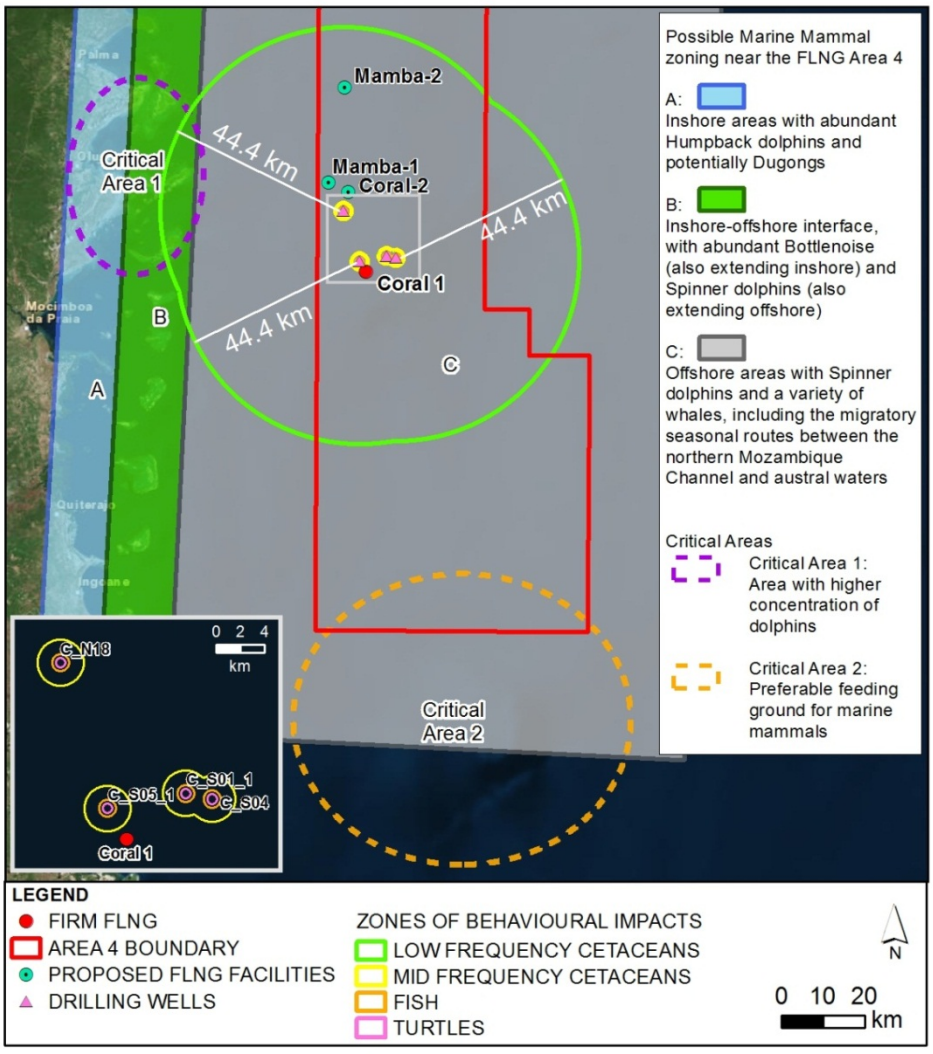
Marine fauna occurring in any area where the ambient noise levels resulting from the project's emissions are higher than those listed in **Table 7.16** above are thus likely to show behavioral responses. As noted above, the FLNG project is predicted to generate levels of 192 dB re 1 µPa at 1 m (rms). Noise, however, attenuates with distance, the degree of which depends on the propagation conditions. ERM (2014e) calculated the maximum distances at which project generated noise levels are expected to be higher than the considered thresholds for each marine fauna group, and these are showed in **Table 7.17** below.

Table 7.17 – Calculated Distances for the Adopted Noise Disturbance Criteria

Species	Calculated Distance for Adopted RMS Criteria (m)
Baleen whales (low-frequency hearing)	44,400
Toothed whales and dolphins (mid-frequency hearing)	1,900
Turtles	400
Fish	700

Table 7.17 above shows that marine mammals are the group for which the noise disturbance is expected to be more relevant, in particular for baleen whales, for which the project generated noise can be experienced at levels high enough to elicit a behavioral response at more than 40 km from the FLNG location. The behavior threshold for turtles and fish is exceeded only at a short distance from the FLNG site (400 m and 700 m, respectively).

These distances are illustrated in **Figure 7.14** below, which also shows the areas considered to be of more critical importance for marine mammals, as discussed in the baseline section (refer to section 6.4.5 of Volume I). The latter include important habitats close to the coast, including an area between Olumbe Bay and Quifuqui Island where higher concentration of dolphins are found (Critical Area 1 in **Figure 7.14**), and the area to the south around Saint Lazarus Bank, where marine mammals are common and which was identified as a potential feeding ground (Critical Area 2 in **Figure 7.14**). Migration routes for whales and turtle also pass through the study area.



Source: ERM (2014e).

Figure 7.14 – Noise Zones resulting in Behavioral Impacts on Marine Fauna

Critical Area 1 is important for dolphin species (mid-frequency hearing). The behavior threshold for these species is only exceeded at 1900 m from the project site and as such no relevant noise impacts are expected on this area (as illustrated in **Figure 7.14** above) (note that the 44.4 km zone of disturbance shown in the figure, which touches Critical Area 1, is only applicable for low-frequency hearing species, and

therefore does not represent an impact on the mid-frequency hearing species in Critical Area 1). Similarly, the important area around Saint Lazarus Bank (Critical Area 2) will also not be affected by the project noise emissions.

However, baleen whales susceptible to low frequency sounds occurring within the 44 km impact area, such as when during migrations, may react negatively to project noise. The effect of underwater noise on migration behavioral is not fully understood and there are migration routes that have been identified for humpback whales that run between the Mozambique Channel (please see the marine ecology baseline section in Volume I) with the possibility that it may overlap or be sufficiently close to the zone of low-frequency acoustic disturbance of the project. Since there are no conclusive data on the effects of underwater noise on migration patterns, a precautionary approach has been taken and impacts have been assessed assuming that disturbance to migrating low frequency cetaceans would be possible. It is considered likely that whales will tend to react by moving away, avoiding proximity to the noise source, as they have good mobility to avoid the sound disturbance. This may cause them to adjust their migration route but is unlikely to cause more severe impacts, such as interruption of the migration.

In what regards high-frequency hearing cetacean species (such as dugongs), exceedances of the behavioral criteria do not exceed 2 km distance from the noise source. Thus, no impact is identified for these species, as they occur mainly nearshore, due to their dependency on seagrass habitats, which are only found in the nearshore areas.

In addition to cetaceans, other species such as turtles and fish (e.g. tuna) are also known to utilize the area as part of their migratory pathway. However, based on modeling results, the extent of noise disturbance to these species will only likely to occur within 400 m of the noise source, for turtles, and 700 m for fish. Furthermore, impacts from noise will not result in physical injuries thus and recovery period of these species are expected to be rapid. Thus, it is unlikely that exposure to noise generated from Project activities will affect migratory behavior of turtles and fish species in the area.

Considering the discussed above, the potential noise impact of the FLNG during operation is assessed as *negative* and *direct*, of *high* duration (long term, but reversible), *medium* scale (low frequency marine mammals could show behavioral responses on a 44 km radius surrounding the site), and *medium* importance (no injury or physiological impacts are expected; behavioral impacts may manifest on low-frequency hearing marine mammals, but these are unlikely to result in severe effects, such as interruption of migration). The number of species potentially affected was assessed as *medium* (only baleen whales will be subjected to relevant impacts). The impact is thus of *medium* significance.

Mitigation Measures

General noise mitigation best practice follows the following hierarchy: mitigation at source (reduction of noise emissions), mitigation on the propagation pathway (such as implementing noise barriers) and lastly mitigation at the receptor level (such as noise insulation of a building).

For underwater noise, however, only the first priority is an option. As such, noise mitigation for the FLNG project is only possible by minimizing noise emissions at source. As discussed above, the main source of noise in the project operation will be the used of the dynamic positioning thrusters. The following mitigation is proposed:

- The design of the FLNG and offloading vessels should be investigated in order to minimize noise, particularly during use of dynamic positioning thrusters, through the selection, where possible, of quieter DP systems;
- As far as reasonably practicable, vessels used in the project should incorporate measures to reduce cavitation thus reducing the amount of underwater noise generated (IMO, 2004), such as:
    - Propeller designed/ selected to reduce cavitation;
    - Improve DP system to delay cavitation inception nearer to peak speed;
    - Regular maintenance program to clean propeller and underwater hull surface.
- Additionally, vessel transits should avoid sensitive marine areas as well as maintaining a 500 m exclusion zone from any marine mammals encountered during transit. Any sightings of marine fauna throughout the project duration should be recorded to assess the effectiveness of mitigation measures applied.

Impact Assessment Summary

The degree of noise reduction from the application of the recommended measures recommended is uncertain. However, should the design considerations are effective, it is expected that the generation of underwater noise may be reduced by up to 5 – 10 dB (Fischer, 2000) which will considerably lessen the disturbance zone for marine fauna. Additionally, avoidance of sensitive areas and individuals encountered during transit is also likely to reduce disturbance impacts to marine fauna present in the area.

The post-mitigation assessment considered the reduction in noise levels generated from project activities due to the application of the proposed mitigation measures. Noise reduction will reduce the extent of the impact, subsequently reducing the number of individual animals which will be impacted by the noise. However, due to the long-term duration of the FLNG operations, although the post-mitigation significance decreases, it remains rated as of medium significance.

Impact: Effects of noise on marine fauna during the operational phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- The design of the FLNG and offloading vessels should be investigated in order to minimize noise, particularly during use of dynamic positioning thrusters; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Medium	2		Low	1
Importance	Medium	2		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**9**		**Medium**	**7**

Impact: Impacts related to artificial lighting during the operational phase

Impact Assessment

Artificial lighting will be necessary throughout the project's operational phase and may impact on marine fauna behavior. The FLNG will require 24 hours external illumination to meet maritime and operational safety standards. Navigational lighting will be required on supply, security and export vessels, as well as on helicopters. The flare stack will also require navigational lighting to prevent potential collisions with

helicopters. Flaring will not occur during normal operations, except the pilot flame. The FLNG vessel illumination will be approximately 500 times brighter than light conditions on a clear full moon light, the effect being emitted radially and attenuate within a short distance.

Potential artificial illumination impacts vary for different groups of marine fauna, depending on their sensitivity to increased nocturnal light levels and the potential associated effects.

In what regards zooplankton, increased nocturnal light levels could suppress the migration of zooplankton from deep water to the surface. An increase of predation of zooplankton, due to fish species attracted by the light, can also be observed.

Effects of light emissions on fish is expected to differ depending on species and habit. Experiments using light traps have found that some fish are attracted to light sources (Meekan *et al.*, 2001), with traps drawing catches from up to 90 metres (Milicich *et al.*, 1992). Lindquist *et al.* (2005) concluded from a study of larval fish populations around an oil and gas platform in the Gulf of Mexico that an abundance of clupeids (herring and sardines) and engraulids (anchovies), both of which are highly photopositive, near the platforms resulted from attraction to the platforms' light fields. Shaw *et al.* (2002) in a similar study noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms.

Adult turtles may also temporarily alter their normal behavior if they become attracted to the light glow, and may approach the FLNG vessel. Other than that temporary change to behavior, however, no relevant impacts on turtles from illumination are expected. Turtle nesting grounds onshore in Cabo Delgado are too far away for hatchlings to be affected by the FLNG light spill.

Light glow from illumination is expected to extend only a short distance radially from the FLNG vessel. These potential effects on zooplankton, turtles and fish will thus occur in a much localized area surrounding the FLNG vessel, likely extending 90-100 m from the source (ERM, 2014a). This is a minor fraction of the available deepwater pelagic environment, and no relevant impact on these groups, at population level, is expected to arise from the FLNG's illumination scheme.

Seabirds and migratory birds are more sensitive to artificial illumination. Light from off shore platforms has been shown to attract migrating birds and birds that migrate during the night are especially affected (Verheijen, 1985). Marquenie *et al*. (not dated) indicated that birds travelling within a 5 km radius of illuminated off shore platforms in the North Sea deviated from their intended route and either circle or landed on the nearby platform.

According to the illumination specialist study (ERM, 2014a), the radial illuminated zone surrounding the FLNG vessel will be visible from several kilometers from birds flying through the region. Flaring events at night may increase the area of visibility for birds, owing to the brightness of the flare. It is thus likely that the FLNG vessel will be an attraction point for seabirds and migratory birds, and may cause them to change their course whilst in transit and approach the FLNG site.

Whilst attraction to light sources is well documented, the potential impacts on the population viability of migratory seabirds, if any, which result from this attraction to light sources is not well understood (Shell, 2009). Induced behavioral disturbances, such as disorientation and attraction, are assumed to be temporary. Such disturbances during migrations could, however, lead to physical effects such as exhaustion and mortality. These effects, however, will likely only affect a small proportion of the population.

There is no evidence to suggest that artificial light sources impact on the migratory, feeding or breeding behaviors of cetaceans such whales and dolphins (ERM, 2014a).

Considering the discussed, the illumination impact of the FLNG vessel on marine fauna is assessed as *negative*, *direct*, of *high* duration (long-term but reversible), of *local* extent (even for the more sensitive receptors, seabirds, the zone of attraction will be a relatively small area, when compared to the extent of the offshore pelagic environment), of *medium* importance (as no significant impact at population level is expected) and affecting a *high* number of species (considering the high number of seabirds and migratory birds existing in the regional). The impact is thus of *medium* significance.

Mitigation Measures

The FLNG vessel illumination scheme should be design in order to minimize the emission of artificial light to the marine environment, as much as possible. According to Van De Laar (2007), birds are particularly sensitive and attracted to the orange to red portion of the visible light spectrum. As most off shore infrastructure and vessels contain primarily white and orange (sodium vapor) colored luminaries, a significant proportion of the total light emitted is within this range. Van De Laar (2007) documented that by replacing 152 of a possible 176 orange, red and white lights with primarily green and blue lights on and off shore oil platform, two to ten times fewer birds were noted to be attracted to and circled the platform. If all lights were to be replaced, it was estimated that 90% of all bird attraction could be eliminated.

The following measures are thus proposed to minimize the FLNG light spill and its impacts on marine fauna:

- Placement and direction of lighting used, in accordance with relevant standards, to avoid direct lighting of the sea surface;
- Shading to direct light inward and downward;
- Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights;
- Flat black paint may reduce whale response to brightly reflective objects such as oceanographic cables.

Impact Assessment Summary

Considering the implementation of the recommendations above, the impact is considered *medium*, slightly decreasing after mitigation but remaining medium. The impact assessment summary is provided on the following table.

Impact: Impacts related to artificial lighting during the operational phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Placement and direction of lighting used, in accordance with relevant standards; - Shading to direct light inward and downward; - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights; - Flat black paint may reduce whale response to brightly reflective objects such as oceanographic cables.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	High	3		Medium	2
Significance	**Medium**	**9**		**Medium**	**7**

Impact: Risk of collisions and entanglement for marine fauna

Impact Assessment

As discussed in section 7.3.2, collisions and entanglement of marine mammals and turtles with vessels and other structures is a source of main concern worldwide. The risk of vessel collisions with marine mammals and its effects were discussed in section 7.3.2 for the drilling, installation, commissioning and decommissioning phases.

In what regards the operational phase, the risk is expected to be greater, as vessel movements transiting to and from the FLNG plant will be more intense during the operational phase, in particular due to the incoming and outgoing LNG carriers.

The FLNG vessel itself, as a stationary object in the sea, will likely present a low risk to marine fauna. However, the subsea infrastructures (anchors, flexible risers, flowlines, etc.) will present a risk of entanglement for marine mammals and in particular for turtles.

As previously discussed in section 7.3.2, several marine mammals and turtles of conservation concern occur in the offshore areas of Cabo Delgado, which affects the importance of this impact.

Considering the discussed above, the risk of collisions and entanglement for marine fauna during the operational phase is assessed as a *negative* and *direct* impact. The duration of the vessel movements transiting to and from the FLNG plant will be noted during the project life period, 25 years, which attributes a *critical* duration to this impact (also considering that the effects on marine fauna populations is of long-term duration due to low population turnover rates). The importance of the impact is assessed to be *high* because of the occasional presence of threatened and vulnerable species on the area. The impact has thus a *high* significance.

Mitigation Measures

The following mitigation is proposed:

- Ensure constant bridge watch is kept on all vessels and at the FLNG to look out for cetaceans in danger of collision;
- The risers should be periodically checked to detect any entanglement with marine fauna, in particular with turtles. If entanglement is frequently detected, more detailed studies should be developed in order to devise additional mitigation measures.

Impact Assessment Summary:

The proposed mitigation is expected to reduce the risk of collision and entanglement, lowering the impact importance and resulting in a *medium* significance residual impact. The impact assessment summary is provided on the following table.

Impact: Risk of collisions and entanglement for marine fauna					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Ensure constant bridge watch is kept on all vessels and at the FLNG to look out for cetaceans in danger of collision; - Periodically check risers to detect any entanglement with marine fauna, in particular with turtles. If entanglement is frequently detected, more detailed studies should be developed in order to devise additional mitigation measures.	Negative	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	Low	1		Low	1
Importance	High	3		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**High**	**10**		**Medium**	**7**

Impact: Effect of ballast water on the marine biodiversity during the operational phase

Impact Assessment

As discussed in section 7.3.2 for the drilling, installation, commissioning and decommissioning phase, the release of ballast waters which has been taken up outside of Mozambican waters carries the risk of introduction of alien species, which may have significant impacts on local biodiversity (please see 7.3.2 for this discussion).

In the operational phase, the risk of introduction of alien species due to the release of ballast water from international vessels will be higher, in particular due to the LNG carriers through which the LNG will be exported. Vessels that are designed to carry a heavy cargo, such as LNG carriers, are potentially unstable at sea once they have offloaded the cargo at the destination port. Therefore, after offloading they take on ballast to weigh down and correctly balance the vessel. Vessels take on ballast water into specially designed tanks, which is then pumped out on arrival at the port where cargo is to be loaded. It has been estimated that 14 billion tonnes of ballast water is transferred annually. As such, discharge and loading of ballast water has considerable potential for the transmission of AIS.

Considering the above, the risk of AIS introduction due to ballast waters release during the operational phase on the local marine biodiversity is considered to be a *negative* and *direct* impact. It is likely to occur throughout the operation phase. It can affect the area of direct influence of the project, as well as the whole concession area, the coastline and near-shore area of Palma District and the islands located to the west of the FLNG location and therefore it has a *regional* scale. As it can affect areas of high biodiversity, it's an impact with a *high* importance and may involve a higher number habitats and ecosystems. The impact has a *high* significance.

Mitigation Measures

Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010). Some of those best practices are as follows:

- All vessels containing ballast water should carry a vessel-specific Ballast Water Management Plan;
- Ballast exchange should, as far as practicable, be conducted in deep water (at least 200 m) and as far as possible from land;
- Treat small vessels as potentially significant AIS pathways;
- Use careful cleaning and inspection to minimize AIS transmission.

Impact Assessment Summary

The impact is considered high. It lowers with mitigation measures to a Medium significance impact. The impact assessment summary is provided on the following table.

Impact: Risk of introduction of alien species due to discharge of ballast water during the operational phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010).	Negative	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	Medium	2		Medium	2
Importance	High	3		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**High**	**11**		**Medium**	**9**

Impact: Effects of cooling water discharges on marine ecology

Impact Assessment

The LNG production process will require a refrigeration system. Seawater will be drawn from the ocean at about 150 m for the cooling of machinery engines and in the production process. As result of this process, the seawater used to cool down the system will be heated. The heated water will be discharged to the ocean, with the potential of locally increasing ambient temperature. Changes in ambient temperature could lead to the loss or gain of species, depending on physiological adaptations to temperature.

Studies by Saetre and da Silva (1982) indicate that in summer, temperatures on the surface of the water range from 28 to 28.5°C and during winter months, they range between 25 and 25.5°C. There is a notable decline in temperature with depth: at 100m depth the average temperature is 24°C, while at 300 m the temperature is 14°C, reaching 10º C at 500m. This happens because most of the heat energy of sunlight is absorbed in the first few centimeters at the ocean's surface, which heats up during the day, and cools at night (as heat energy is lost to space by radiation). Waves mix the water near the surface layer and distribute heat to deeper water, such that the temperature may be relatively uniform for up to 100 m. Below 100m, the temperature of the deep ocean drops gradually with depth.

Marine ecosystems can be sensitive to even the most modest temperature change. Organisms such as corals, for example, are vulnerable to temperature change. There is evidence that reefs will bleach (eject their endosymbiotic algae) at even a slight persistent temperature rise. Bleaching slows coral growth, makes them susceptible to disease, and can lead to large-scale reef die-off. While there are no coral areas near the FLNG, which may be impacted by the discharges, other organisms such as plankton can also experience changes in their life cycle dynamics. Warmer sea temperatures are also associated with the spread of invasive species and marine diseases. The evolution of a stable marine habitat is dependent upon a myriad of factors, including water temperature. If an ecosystem becomes warmer, it can create an opportunity where outside species or bacteria can suddenly thrive where they were once excluded. This can lead to forced migrations and even species extinctions. Many marine mammal species also require specific temperature ranges in which they must live.

The potential temperature impacts from cooling water discharge on the receiving marine water were assessed through modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014c), through the application of a hydrodynamic and dispersion modeling software (see **Appendix VIII** for more information on the modeling approach).

The modeling approach considered the total flow rate of the FLNG's thermal discharges, for normal and peak operations, and simulated their expected influence in seawater ambient temperature. The modeling results are presented in section 7.2.4.3 above, in the oceanographic impact assessment section, and thus are not repeated here.

Even in the worst-case scenario, the modeling indicates that the temperature increases to the receiving marine waters are expected to be fairly low. At the edge of the mixing zone (100 m from the point of discharge), the maximum expected temperature increase is of only 0.2 ºC. This is well below IFC's guidelines for thermal discharges, which state that any thermal discharge should not result in a temperature increase greater than 3 ºC at the edge of the mixing zone.

Such a small temperature increase from the FLNG thermal discharge (less than 1ºC) is not expected to be relevant and will not result in any significant impact on marine ecology.

Considering the above, the impact of the heating of water from the FLNG cooling water is considered to be *negative* and *direct*, and of *high* duration (long term, but reversible). Considering the rapid dilution and mixture of the heated water, and the fact that it won't affect deeper habitats, the impact is considered to have a *local* scale (low increases in temperature occur only in the mixing zone, being negligible more than 100 m away from the discharge), *low* importance (as such a small increase in temperature is unlikely to result in significant changes to the ecological processes) and small number of species affected. The significance of the impact is *low***.**

Mitigation Measures

No relevant impact was identified, and as such no specific mitigation is required. To ensure the impact remains of low significance, good management of the cooling system is recommended, including:

- Maintain the proper operation of the cooling system, to maintain designed discharge temperatures;
- Shut down of cooling system when cooling is not required; and
- Online (continuous) monitoring of cooling water discharge temperature and periodic monitoring of the receiving seawater temperature, to ensure compliance with the end of mixing zone standard. The discharge should not induce increases in temperature greater than 3ºC at the edge of the mixing zone or within 100 meters of the discharge point, in compliance with IFC's guidelines.

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects of cooling water discharges on marine ecology					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Maintain proper operation of the cooling system, to maintain designed discharge temperatures; - Ensure that the pumping of cooling water through the system is turned off when cooling is not required; - Continuous monitoring of the discharge temperature; - Periodic monitoring of the receiving seawater temperature, to ensure compliance with the end of mixing zone standard.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

Impact: Effects of produced water discharges on marine ecology, due to potential degradation of seawater quality

Impact Assessment

Gas reservoirs frequently include a percentage of water, which will be abstracted together with the natural gas. During the LNG process, this water is separated from the gas, treated and discharged into the sea. This is referred to as produced water.

Produced water can consist of a suite of potential contaminants (hydrocarbons, heavy metals). The FLNG is equipped with a Produced Water Treatment Package, which will remove most of these contaminants, prior to discharge. However, the discharge produced water will still present hydrocarbons (oil and greases), suspended solids and Biological Oxygen Demand (BOD), and the potential impact of the discharge of these pollutants on seawater quality needs to be considered.

The potential impacts on seawater quality resulting from the FLNG's produced water discharges were assessed through modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014d), through the application of a hydrodynamic and dispersion modeling software (see **Appendix IX**, Volume IV).

The modeling approach considered the total flow rate of the FLNG's produced water discharges, for normal and peak operations, and simulated their expected influence in seawater ambient quality, considering the expected pollutant concentrations in the discharge produced water after treatment.

The modeling results are presented and discussed in detail in section 7.2.4.3 above (oceanographic impact assessment section), and thus are not repeated here. For the marine ecology impact assessment, it is relevant to note that the modeling indicates that very low increases in pollutant concentrations are expected, even at short distances from the discharge point. At roughly 70 m from the produced water discharge point, the following increases are expected:

- 0.02 mg/l of oils and greases;
- 0.05 mg/l of BOD5; and
- 0.07 mg/l of TSS.

The resulting increases in the ambient concentration of oil and greases, BOD5 and total suspended solids (TSS) are all very low and well below the ambient seawater quality standards in Mozambique (Annex V of Decree 18/2004, as amended by Decree 67/2010). No relevant degradation of seawater quality is thus expected, resulting from the FLNG's produced water discharges.

As the impacts on water quality are low, no relevant impacts are expected on the marine biota. The impact of on marine ecology resulting from the discharge of produced water is considered to be *negative* and *direct*, and of *high* duration (long term, but reversible). However, given that no relevant degradation of water quality is expected, the impact is considered to be of *low* importance, and of *local* scale, resulting in a *low* significance.

Mitigation Measures

No relevant impact was identified, and as such no specific mitigation is required. To ensure the impact remains of low significance, good management of the produced water treatment system is recommended, including:

- Maintaining the proper operation of the treatment system, to maintain designed discharge concentrations;
- Periodic monitoring of the produced water effluent, to verify compliance with the emission limits;
- Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards, as defined in Annex V of Decree 18/2004 (as amended by 67/2010).

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects of produced water discharges on marine ecology, due to potential degradation of seawater quality					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Maintain proper operation of the treatment system, to maintain designed discharge concentrations; - Periodic monitoring of the produced water effluent, to verify compliance with the emission limits; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

Impact: Effects of lighting from the FLNG structure on seabirds

Impact Assessment:

The collision of birds with vessels and FLNG platforms, and behavior disorders that light pollution may bring on birds can have serious consequences. Due to the use of strong spotlight on vessels and FLNG platforms, birds may have difficulties seeing the full structure at night. Therefore, nocturnal seabirds migrating or feeding in the area can hit parts of the platform which can result in increased bird mortality. On the other hand, during their migratory journey and when facing bright lights, birds are often huffed and start flying in circles, thus disturbing their migration process.

As mentioned in Illumination Specialist Study (ERM 2014a), it is expected that only a small number of individuals would pass within the potential zone of impact whilst in transit, while any behavioral disturbances such as disorientation and attraction are considered temporary. Physical effects such as exhaustion and

mortality may also potentially affect a small proportion of the population depending on the number of birds affected and species.

This impact will be of long term duration (but reversible), of local extent, high importance and low number of involved elements, thus resulting in impacts of medium significance.

Mitigation Measures:

Proposed mitigation measures are as follows:

- Minimize non-essential lighting on vessels, and shield and/or reduce the number of lights shining directly onto the water as far as possible.
- Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights.
- Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. If any ringed/banded birds will be found on vessels, the ring should be photographed and recorded for subsequent communication to the appropriate ringing/banding scheme, such as African or European Bird Ringing Scheme (http://afring.adu.org.za/introduction.htm or http://www.euring.org/).
- Prohibit all crew members from killing or causing injury to seabirds and establish effective measures for the punishment of crew members found to have deliberately killed or caused injury to marine fauna .

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects of lighting from the FLNG structure on seabirds					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Minimize non-essential lighting on vessels, and shield and/or reduce the number of lights shining directly onto the water as far as possible. - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights. - Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme. - Prohibit all crew members from killing or causing injury to seabirds (any crew members found to have deliberately killed or caused injury to marine fauna shall be dismissed immediately and removed to shore).	Negative	
Type	Direct			Direct	
Duration	Long-term but reversible	3		Long-term but reversible	3
Extent	Local	1		Local	1
Importance	High	3		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**8**		**Low**	**6**

7.3.4 Impacts Associated with Unplanned Events

7.3.4.1 Potentially Impact Generating Project Activities

The effects of unplanned events are largely related with the spillage/release of hydrocarbons. It can be a diesel spill during transfer or caused by vessel collision, cyclone or other emergency scenario, such as fires or explosions. While these events are unlikely to occur, they may result in extensive negative impacts if the released hydrocarbons enter nearshore waters and coastline habitats. Cyclones may occur in the region of Area 4. Bad atmospheric conditions can result in vessel accidents and thus in oil spills.

There are many different types of oil; therefore each oil spill is different depending on the type of oil accidentally released into the environment. Each oil spill will have a different impact on sensitive resources and the surrounding environment depending on the following:

- Type of oil spilled – physical and chemical characteristics of oil, susceptibility to evaporation, mousse formation, dispersion, etc., and degree of oil weathering that occurs prior to contact;
- Spill location – distance from sensitive resources;
- Species present – temporal (e.g., seasonal presence, migrants), spatial (i.e., distribution, tendency to occur in schools, herds, etc.), and behavioral characteristics (e.g., species-specific response to oil); and
- Timing of breeding cycles and seasonal migrations.

In general, direct oil effects typically include smothering, toxicity from ingestion and/or inhalation, increased levels of hydrocarbons in water and air, and area exclusion. Indirect impacts include adverse effects on prey organisms and/or destruction of habitat. The primary hydrocarbons of concern are the soluble aromatics (DAH - dissolved-phase aromatic hydrocarbons) which are potential sources of acute toxicological impacts on marine fauna, due to narcosis. Impacts are dependent on the species, life stage, exposure duration and concentration. In addition, the oil as a whole may cause injury to marine fauna due to contacting the animal and being ingested.

With respect to exposure to oil, sensitive receptors consist of marine fauna – zooplankton, fish, marine turtles, seabirds, migratory shorebirds and cetaceans. Sensitive coastal habitats, such as corals, seagrass beds and mangroves can also be affected, if the oil spills reach the coastline.

Considering the planned activities, the potential unplanned events that may result in oil spills are the following two scenarios:

- Scenario 1 – diesel spill associated with vessel collision happening either during drilling of wells, operation phase or decommissioning. Diesel spills could result in impacts to marine and coastal fauna and habitats due to direct exposure to an oil slick and increased concentrations of DAH; and
- Scenario 2 – release of low toxicity oil-based muds (LTOBM) due to the accidental disconnection of the riser occurring during drilling phase. This could affect marine fauna and habitats for the same reasons given above (exposure to oil slick and increased concentrations of DAH) and may also have an additional impact on benthic communities and habitats, due to smothering (deposition of particles) and increase in suspended solids.

It should be noted that spills and leaks of LNG have not been considered below because this liquid is non-toxic and it will have a minimal impact on the marine environment in the unlikely event of a spill.

The potential impacts of unplanned oil spills and releases on marine fauna and habitats are discussed below.

7.3.4.2 Impact Assessment

Impact: Effects on marine fauna resulting from accidental diesel spills due to vessel collisions (unplanned event)

Impact Assessment

The FLNG Project will generate an increase in maritime traffic throughout its life cycle: during the drilling, installation and commissioning phases, this increase will come from the drilling and support vessels involved such activities; during the operational phase, the increase will come from support vessels and from LNG carriers, used in the export process.

This increased traffic will generate an increased risk of vessel collisions. If such an accidental collision happens, it could result in the release of significant quantities of hydrocarbons to the marine environment, namely the release of diesel oil used as fuel by these vessels. This section assesses the effects such an accidental release may have on marine fauna and habitats.

The potential impacts of an oil spill resulting from a vessel collision were assessed through modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014e), through the application of a hydrodynamic and dispersion modeling software (see **Appendix X**, Volume IV for more information on modeling).

The consequences of a potential diesel spill, due to vessel collision, was evaluated by ERM (2014e) for releases throughout three different months from 2009 to 2013 – January, July, and November[12] with releases at four different locations within Area 4, for a total of 12 model simulations. Each of the 12 simulations were run for 75 iterations to cover a range of hydrodynamic and meteorological conditions across by selecting spill start dates across the five years, with 15 iterations per year for each of the three selected months. The rate of release simulated was of 800 m^3, assumed to last for 1 hour. The model was then run to simulate the dispersion of the released oil during 14 days following the spill event.

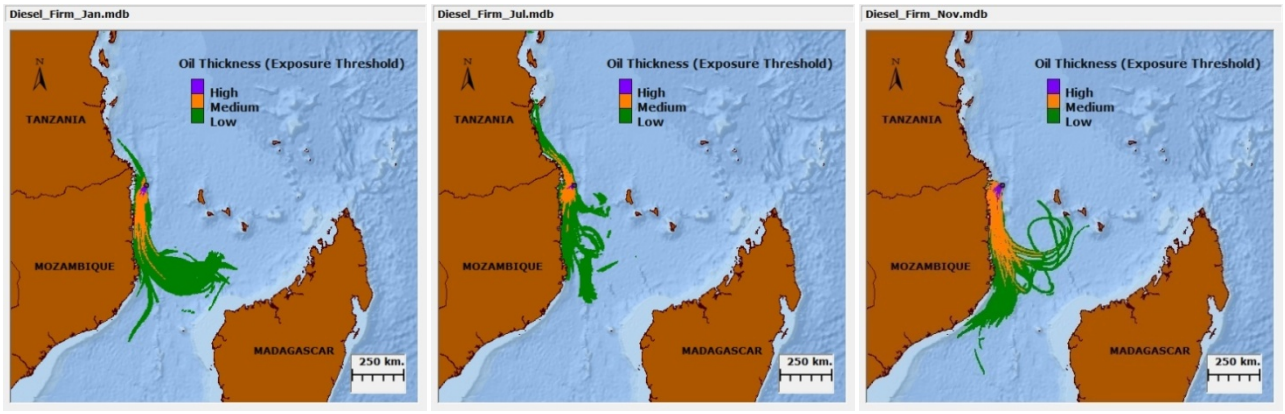
As noted above, the main impacts on marine fauna and habitats associated with oil spills are physical fouling from contact with the oil (to which a range of negative effects are associated) and mortality due to dissolved concentrations of DAH above lethal concentration threshold values. Research has been done in estimating exposure thresholds for birds and mammals contacting an oil slick. Peakall *et al*. (1985) and French (2009) found that oil slicks less than 1 µm were not harmful to seabirds. Additional studies found that aquatic birds and marine mammals may be affected at slick thicknesses in the range of 10 µm and 25 µm [Engelhardt (1983), Clark (1984), Geraci and St. Aubin (1988), Jenssen (1994), and Scholten *et al* (1996)]. As such, the following thresholds were adopted in the modeling study (ERM, 2014e) in what regards the potential effects of oil slicks on marine fauna:

- A low risk exposure thickness threshold - visible oil between 0.1 µm and 1 µm;
- A moderate exposure threshold - oil with a thickness between 1 µm and 10 µm;
- A high exposure threshold - any oil with a thickness above 10 µm.

According to ANZECC and ARMCANZ (2000) and French (2000), dissolved aromatic 96-hour LC_{50} values range between 100 and 1,000 parts per billion (ppb). Low Reliability Triggers, concentrations below which no toxic effects would be expected (effectively a No Observable Effects Concentration or NOEC), are assumed to be 10 to 100 times less than the 96-hour LC_{50}. To enable a significant margin of safety, a highly conservative value of 5 ppb was chosen as a 96-hour Low Reliability Trigger threshold for sensitive organisms.

[12] These were the months for which the modeling study identified the greatest risk of an occurring oil spill reaching mainland, considering the climatic and oceanographic conditions along the year. They are thus the worst-case scenario.

Figure 7.15 below shows the modeling results for the maximum oil thicknesses for a Vessel Collision Diesel Spill at Coral-1 in January, July, and November, at or above the low thickness thresholds described above. Some areas near the release location exceed the high impact threshold, but fall to the medium or low impact threshold before contacting shoreline. In many cases, oil at thicknesses at risk to wildlife exists (medium to high impact areas, > 1 µm) along the coastline of the Palma District at the northeast corner of Mozambique, and along the islands of the Quirimbas Archipelago. The total of all areas >1 µm posing a risk to wildlife (exceeding medium and high thickness thresholds) ranges from 8,208 km² to 23,088 km².

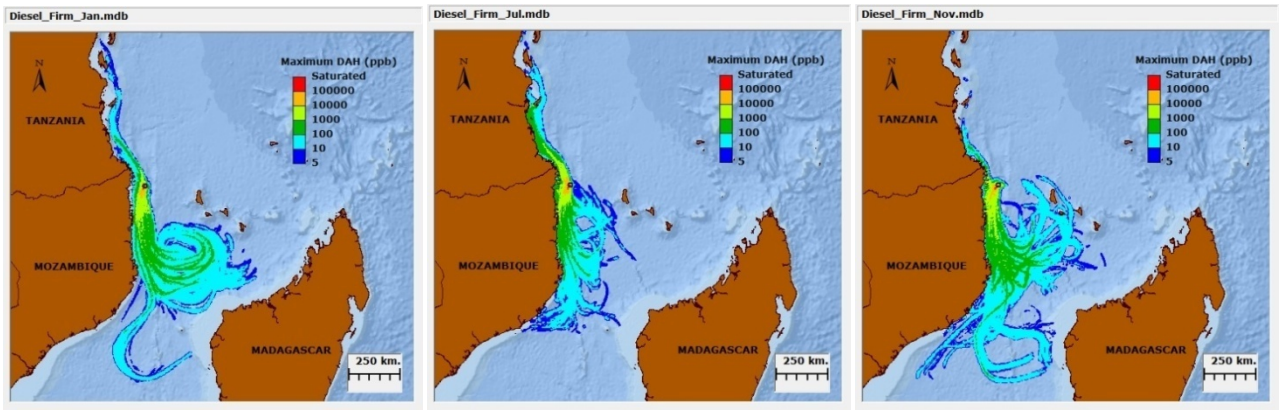


Source: ERM (2014d).

Figure 7.15 – Maximum oil thickness resulting from a Vessel Collision Diesel Spill at Coral-1 (left: January; middle: July; right: November)

These regions with oil above the wildlife injury threshold (1 µm) are typically parallel to the coast, with trajectories travelling north and south from the release location through the Saint Lazarus Bank and potentially south towards Nacala. In some cases especially in November, the trajectory may turn east towards Madagascar. While most trajectories with oil above 1 µm travel south, in the extreme cases traveling north, the slick may extend up to the Lindi Region of Tanzania.

Figure 7.16 below shows maximum DAH concentrations for a vessel collision diesel spill in January, July, and November. As described above, the aquatic life toxicity threshold is considered to be 5 ppb. Potential areas where soluble aromatics in the diesel release may exceed this threshold range from 120,220 to 254,140 km².



Source: ERM (2014d).

Figure 7.16 – Maximum DAH concentrations resulting from a Vessel Collision Diesel Spill at Coral-1 (left: January; middle: July; right: November)

The following sections provide a more detailed discussion of the potential impacts on marine turtles, mammals, birds and fish.

Marine Mammals

Marine mammals may be exposed to oil in several ways, including inhalation of hydrocarbon vapors, direct contact between oil and the skin, ingestion of oil droplets or contaminated prey, and fouling of baleen plates. Whales and dolphins can apparently detect oil slicks on the sea surface, but do not always avoid them and have been seen surfacing in oil slicks, without apparent deleterious effects. Because cetaceans apparently do not avoid oil slicks, they may be vulnerable to inhalation of hydrocarbon vapors.

The effects of oil spills on marine mammals depend on the level of exposure and potential for ingestion or inhalation. Direct oiling of whales and dolphins is not considered to be a serious risk as their skin contains a resistant dermal shield that acts as a barrier to toxic petroleum compounds. Cetacean skin is highly impermeable to oil and is not seriously irritated by brief exposure to oil.

However, the inhalation of hydrocarbon vapors may lead to irritation and congestion of the lungs and bronchi. Absorption of volatile hydrocarbons through the lungs can lead to liver damage and may be a greater hazard to cetaceans than ingestion of oil or oil-contaminated prey. Vapor concentrations of volatile hydrocarbons may be high enough just above a fresh slick to cause systemic damage for a few hours after a spill.

There is no evidence that ingestion of oil as droplets or contaminated prey represents a significant risk to baleen and toothed cetaceans. Fouling of the baleen feeding apparatus of baleen whales has not been observed; if it does occur, it is probably transitory and not debilitating. Preferred prey items are not likely to be sufficiently contaminated to pose a significant health risk to cetaceans.

Dugongs are generally scarce within Mozambique, distributed primarily in southern Mozambique within the nearshore waters of Maputo Bay (near Inhaca Island) and Inhambane Bay, Pomene, the Bazaruto Archipelago, and between Inhassoro and the Save River. Their occurrence in Cabo Delgado is reported, but the current state of the population is unknown.

Direct and indirect impacts of diesel fuel upon these highly mobile animals are liable to be very short term and insignificant on a regional scale. If an oil spill reaches dugong coastal habitat in large volumes, the potential exists for longer-term exposure if oil becomes trapped in embayments (see the following impact for an assessment of the risk of a diesel fuel spill offshore reaching the coastal area).

Turtles

Turtle nesting occurs throughout Mozambique, although most nesting activity appears to be distributed in the south. Adult turtles utilize a variety of habitats for feeding, including seagrasses, coral reefs, mud flats, and mangroves. All species nest on sandy beach habitats in Mozambique, although current information on turtle nesting sites (especially within northern Mozambique) is lacking.

Sea turtles usually do not avoid contact with oil either on the sea surface or onshore, and may even seek out and ingest tar balls. If a sea turtle does encounter a large oil slick on the sea surface, there is a high probability that the turtle will suffer injury or possible death.

All species and life stages of sea turtles are vulnerable to injury from encounters with oil. Oil can adhere to the body surface and cling to the nares, eyes, and upper esophagus of sea turtles, causing contact

dermatitis. Mucus membranes around the eyes, nose, and mouth may become irritated and damaged by oil contact.

Short-term contact with or ingestion of the oil may cause significant changes in respiration, blood chemistry, energy metabolism, and diving behavior. The salt gland function has shown to be inhibited immediately after oil exposure, returning to normal within several weeks following exposure.

These responses to oil would cause a variety of sub-lethal physiological effects that may lessen the ability of the turtle to cope with normal environmental stresses. Inhalation of hydrocarbon vapors may cause respiratory pathology and systemic toxicity.

Adult and juvenile turtles can survive and, through their swimming ability, avoid oil slicks. Hatchlings are the most vulnerable stage in the turtle life cycle if oil slick reaches beaches where they are about to emerge and migrate to the sea. An oil slick may disorientate the hatchlings what may increase their exposure time to predators on the beaches and/or interfere with their swimming abilities. Hatchling survival is not high in any case and any increased mortalities can be reflected in the overall population.

Birds

For birds, impacts may occur due to stains of oil on the plumage, for areas where oil exceeds the thickness threshold of 1 µm (Peakall et al., 1985 and French, 2009), which may destroy the insulating and water repelling properties and which may ultimately cause the death of the bird. Also, there may be toxic effects after the ingestion of oil during preening, ingestion of oiled prey, inhalation of oil fumes or absorption of oil through skin or eggs may also lead to death. Indirect effects may result from destruction of bird habitats or food resources.

Diving or swimming species are particularly vulnerable because they react to an encounter with floating oil by diving (as opposed to flying out of the contaminated area) and quickly become totally oiled (Bourne, 1968b and 1970). In small patches of oil, swimming or diving birds could avoid coming into contact with oil, but not in the case of large slicks. Diving is a poor escape mechanism for large oil slicks.

The effect of oil on the plumage causes the fine element of the feathers to stick together losing the insulation value and water repellent capacity of the feathers. Birds with oil contaminated plumage lose their buoyancy and flying capability becoming exposed to cold with an increasing metabolic rate, while being unable to replenish the energy needed.

The most affected birds would be ones in direct contact with the water while feeding such as albatrosses that feed on squid, fish and krill by either scavenging, surface seizing or diving; procellariine petrels (*Procellaria* and *Bulweria* genus) that feed on fish and mollusks; feeding mostly on squid, some fish and crustaceans by dipping and surface-seizing and mainly at night (del Hoyo et al. 1992); the gannets (*Morus* spp.) that capture fish by diving from a height into the sea and catching fish much deeper than most airborne birds by pursuing their prey underwater (Harrison, *et al*, 1997).

Fish

Pelagic fish (adults, larvae) mortalities as a result of oil spills are limited in size and have not translated into measurable effects on fish stocks. However, local mortalities especially in fish larvae and fish eggs can occur, although apparently rare (Baker *et al.*, 1990). Demersal, near-shore, and estuarine stocks, especially those species feeding on the sediment surface may suffer mortalities through ingesting contaminated sediments.

Fish are mobile and can move out of an impacted area. However, the overall habitat range can be significantly decreased, leading to major implications for the fish populations as a whole. An oil spill, therefore, can have a major negative impact upon these near-shore and shallow water species. Crude oil exposure has been found to result in toxicity effects on fish, with localized mortality to fish eggs and larvae also possible. Similar effects may be expected following exposure to diesel fuel.

The regions of the ocean at risk of impacting fish stock are primarily the top few meters beneath the travelling diesel slick where the dissolved plume of aromatics may cause narcosis. Although this region at risk extends from Jibondo Island off the coast of Tanzania and south along a loop current towards Madagascar, in an actual event, the region at risk to fish is a fraction of this area. To cause narcosis, the organism must remain exposed for threshold concentration for 96-hours; shorter durations would require greater concentrations to cause equivalent effects. Juvenile and adult fish are able to swim below the plume and avoid injury. Also, the threshold concentration was selected as a conservative value associated with sensitive test organisms, below which no acute toxicological effects are expected. Other species of fish may be less sensitive to narcosis and able to survive concentrations one to two orders of magnitude greater.

Impact Assessment

As showed by the modeling results, without response efforts a diesel spill of this magnitude may impact both Mozambique and Tanzania's coastline and waters off the coast. The maximum area at risk of exceeding the oil thickness threshold is 594 km² out of all of the diesel spills examined.

Considering the modeling results, the impact on marine fauna resulting from an unplanned vessel collision diesel spill is assessed as a *negative* and *direct* impact. While any hydrocarbon spill has a short duration, the effects on marine fauna can extend in time, and as such the duration is assessed as *medium* (1 to 5 years for full recovery). The extent is of *international* scale (the oil spill may reach Tanzania, although with low probability). The importance and number of elements are *high* (considering the presence of several threatened species of marine mammals and turtles that may be impacted by a spill). The impact is thus assessed as of *high significance*.

Mitigation Measures

Mitigation measures should focus on the prevention of hydrocarbon spills from occurring. The following prevention, response and planning measures should be considered.

Prevention

Ensure that the FLNG vessel and the supply vessels comply with the following:

- International certification and approval by the Mozambican Authorities.
- Good operational conditions and serviced according to maintenance plan.
- Crews trained for emergency response in what concerns the cargo they transport and operations they perform.
- Maintain contact with the Port Authorities.
- Have updated information on the weather conditions in the area.
- Safety measures such as BOPs (Blowout Preventer).
- Fuel tanks or drums capped, not overfilled, marked with contents, and valves closed between connected fuel tanks.
- Store petroleum products and hazardous substances in adequately labeled approved containers.

- Store petroleum products and hazardous substances in bunded areas where spills can be contained and collected.
- Use oil collector trays or drip pans under equipment.
- Ensure that pipes and hoses are in good condition, properly connected and closed.
- Monitor tank levels.
- Make available absorbent pads near the area where spills may occur.
- Conduct transfer operations during calm weather conditions.
- Ensure that transfer hoses have the length and strength necessary to maneuver vessels as required by the sea conditions.
- Only conduct transfer operations during the day and hoist the “bravo” flag.
- When transfer under reduced visibility conditions (night or overcast), hoist a red light flag.
- Conduct transfer under favorable wind and tide conditions that would carry any spill away from sensitive habitats.
- Post warning signals before transfer operations begin.
- During transfers, maintain effective communication between the supply vessel and the drilling rig and monitor the transfer.
- Implement drilling rig fuel transfer procedure.

Planning

- Review and submit site-specific Oil Trajectory Models, Oil Spill Contingency and Emergency Response Plan (OSCP/ERP) to the MITADER and the INP before drilling activities. This Plan must be submitted to INP at least 5 weeks before the start of the drilling operations (according to Article 26 of the Petroleum Law);
- Incorporate results of the site-specific Oil Trajectory Models in the OSCP/ERP.
- The Mozambique draft National Oil Spill Contingency Plan (NOSCP) should be considered.
- Drilling operations **will not commence** until the OSCP/ERP has been updated and addresses local environments.
- Compliance to the OSCP/ERP is mandatory.

Response

- Response procedures will be outlined in the site-specific OSCP/ERP.
- Typical actions to initiate a response include:
    - Assess health and safety issues
    - Report the spill (including the type and size, etc.)
    - Prevent subsequent spills (containing the spill is possible)
    - Assess the type of spill
    - Develop a response strategy
- Tier 1 oil spill response equipment will be staged on support vessels and/or at shore.
- Limit the spill at the source to the possible extent and contain or recover the material before it reaches the coastal or marine resources.
- Clean-up actions are required if hydrocarbons reach shore.
- Inform the port authorities immediately in the event of any spill or accident that could result in a spill.
- Report all leaks and spills in accordance with the OSCP/ERP.

Impact Assessment Summary

Post mitigation, operational controls may help minimize the risk of occurrence of a vessel collision and response efforts will help minimize extension of the oil slick, if such a collision does occur. For the post mitigation assessment, it was assumed all spill response protocols were applied, all trained staff reacted appropriately, and all containment methods were deployed to minimize the spread of the spill. As a result, the spill would be prevented from reaching the shorelines and surface oiling maintained within a much closer vicinity to the ruptured vessel, and not traveling into Tanzania's waters. This will reduce the extent from international to medium, the duration from lasting over a year to less than a year; and the importance from high to moderate. The overall significance score is reduced to low after successful application of mitigation measures. The impact assessment summary is provided on the following table.

Impact: Effects on marine fauna resulting from accidental diesel spills due to vessel collisions					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement prevention measures, as listed above; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Low	1
Extent	International	4		Regional	2
Importance	High	3		Medium	2
No. of elements involved	High	3		Low	1
Significance	**High**	**12**		**Low**	**6**

Impact: Effects on coastal habitats resulting from accidental diesel spills due to vessel collisions

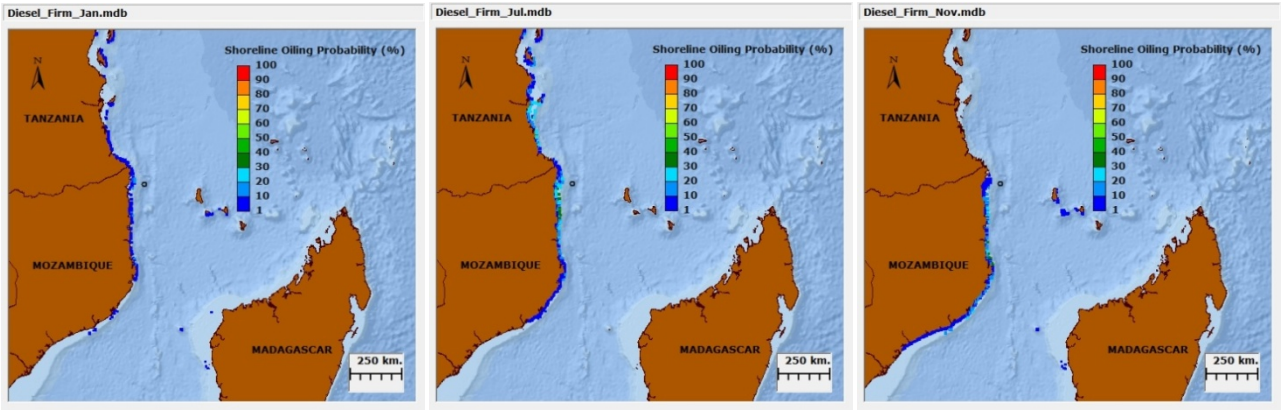
Impact Assessment

The previous impact assessed the potential impacts of an unplanned diesel spill from a vessel collision on marine fauna. This impact assesses the potential impacts on sensitive coastal habitats, namely coral reefs, seagrass beds and mangroves. If an oil spill reaches these coastal areas, the impacts of oil fouling of these sensitive habitats could be very significant, affecting a wide range of species that depend on these habitats for their survival, such as dugongs (which feed on seagrass beds) and turtles (which nest on coastal and island beaches).

The risk of an oil spill reaching the coastal areas of Cabo Delgado was assessed through the same modeling approach described in the previous impact (see **Appendix XI** for more information), and thus that information is not repeated here.

Figure 7.17 below shows the probability of shoreline oiling for a vessel collision diesel spill in January, July, and November. The simulation in January showed a potential for oil contacting shorelines at a low probability (<10%) across Tanzania, northern and central Mozambique, the Comoros islands, and islands off the central west coast of Madagascar. Potential shorelines at risk of contacting oil in July ranged from central Tanzania to southern Mozambique, with the most likely shoreline contact (up to 30% probability) in northern Mozambique and central Tanzania. Potential shorelines at risk of contacting oil in November include Tanzania, Mozambique, Comoros Islands, and Madagascar, with the most likely shoreline contact (up to

30% probability) in central Mozambique. The total of all shorelines with a potential for contact with oil above the minimum probability (1.33% probability, i.e., one in 75 iterations) range from 256 to 594 km.



Source: ERM (2014e).

Figure 7.17 – Shoreline oiling probability resulting from a Vessel Collision Diesel Spill at Coral-1 (left: January; middle: July; right: November)

Simulations at all four FLNGs indicated a risk of shoreline oiling at sensitive habitats along the coastline for sea turtles, coral, and mangroves. A diesel spill may travel along the coastline from Tanzania, to central Mozambique, and towards Madagascar. While contact with the Mozambique coastline, along the Cabo Delgado and Nampula Provinces, is predicted to occur in every simulation performed (assuming no protection from response efforts), the probability of a spill reaching Tanzania is less than 10%. In general, the islands in the Quirimbas Archipelago contact oil more frequently (reaching a high of 43% probability for Vamizi Island and 36% to 39% at the islands within Macaloe Canyon and Medjumbe Canyon) than the mainland's coastline .

The soonest possible shoreline contact is between 1 and 2 days in north Mozambique for all diesel release simulations. In most scenarios, there is a less than 10% chance of oil contacting shorelines in the Palma District except in the January release from Mamba-2 (26% chance of contacting the northern most shoreline by Quionga) and in July's releases (22% to 26% at the southern -most coast).

Considering the modeling results, the impact on coastal sensitive habitats an unplanned vessel collision diesel spill is assessed as a *negative* and *direct* impact. The duration is assessed as *medium* (1 to 5 years for full recovery). The extent is of *regional* scale (the probability of a spill reaching coastal areas in Tanzania is less than 10%). The importance and number of elements are *critical* (considering the presence of several sensitive habitats on the potentially affected coastal areas, of which the coastal ecosystem is dependent). The impact is thus assessed as of *high significance*.

Mitigation measures

The applicable mitigation measures are the same presented in the previous impact, which are also applicable here. The mitigation effort should focus on the prevention of hydrocarbon spills from occurring. If an oil spill reaches the coastal areas, cleaning efforts will need to be undertaken, to remove the spilled oil from the coastal area as soon as possible.

Impact Assessment Summary

Post mitigation, operational controls may help minimize the risk of occurrence of a vessel collision and response efforts will help minimize extension of the oil slick, if such a collision does occur. If all spill

response protocols were applied, all trained staff reacted appropriately, and all containment methods are deployed to minimize the spread of the spill, any unplanned spill should be prevented from reaching the shorelines. This will reduce the extent from regional to local, the duration from lasting over a year to less than a year; and the importance from critical to moderate. The overall significance score is reduced to low after successful application of mitigation measures. The impact assessment summary is provided on the following table.

Impact: Effects on coastal habitats resulting from accidental diesel spills due to vessel collisions (unplanned event)					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement prevention measures, as listed above; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Low	1
Extent	Regional	2		Local	1
Importance	Critical	4		Medium	2
No. of elements involved	Critical	4		Medium	2
Significance	**High**	**12**		**Low**	**6**

Impact: Effects on marine fauna resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase

Impact Assessment

During the drilling of a production well, two different drilling phases can be identified:

- In the first phase of drilling, during drilling of the riserless open hole section, there will be a direct discharge of cuttings at sea bottom level, due to the absence of a riser;
- Once the initial portions of a well have been drilled, a riser will be installed, and muds and cuttings will be returned to the surface, where they will be treated and discharged at mean sea level with a maximum of 1% oil by weight on dry cuttings.

The potential impacts of the planned discharges of drill cuttings have been assessed above. This section addresses the potential impacts of an unplanned event, resulting from an accidental disconnection of the riser during the drilling of the lower sections of a production well (a malfunction above the wellhead causing the accidental release of the drilling fluid within the volume of the riser pipe). In such an event, there will be a direct discharge of the drilling fluid (low toxicity oil based mud – LTOBM) at sea bottom level. One of the constituents of LTOBM is a base oil, which can then rise to the surface and form a slick.

The potential impacts of a LTOBM release due to accidental riser disconnection were assessed through modeling, in the oceanographic specialist study developed for the EIS (ERM, 2014e), through the application of a hydrodynamic and dispersion modeling software (see **Appendix XI**, Volume IV).

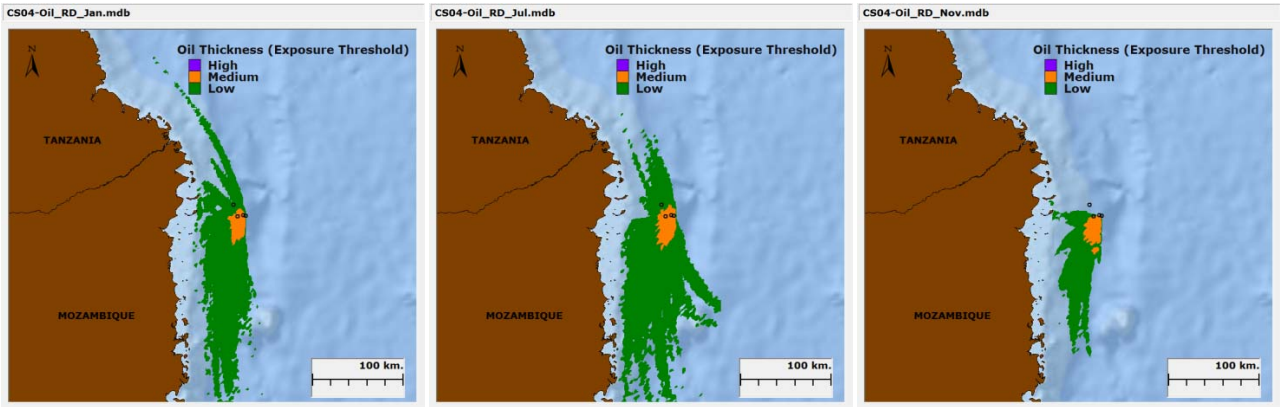
The consequences of a potential accidental LTOBM release, due to disconnection of the riser, were evaluated by ERM (2014e) for releases throughout three different months from 2009 to 2013 – January, July, and November[13] with releases at four different locations within Area 4 (location of likely production

[13] These were the months for which the modeling study identified the greatest risk of an occurring oil spill reaching mainland, considering the climatic and oceanographic conditions along the year. They are thus the worst-case scenario.

wells), for a total of 12 model simulations. Each of the 12 simulations were run for 75 iterations to cover a range of hydrodynamic and meteorological conditions across by selecting spill start dates across the five years, with 15 iterations per year for each of the three selected months.

The volume of released LTOBM simulated was of 229 m^3 (volume of oil within an average riser pipe). The release was assumed to occur 3 m above the seafloor, and last for 1 hour. The model was then run to simulate the dispersion of the released base oil during 7 days following the release event.

Figure 7.18 below shows the modeling results for maximum oil thicknesses for a riser disconnect release of LTOBM at C_S04 in January, July, and November, at or above the low thickness threshold previously described, associated with potential effects on marine fauna[14] (please see **Appendix XI** for more results). Visible oiling travels up to about 40 km off the coast of the mainland of Tanzania and Mozambique, while contacting some of the islands of the Quirimbas Archipelago. All oil reaching shorelines is at or below the low impact threshold, unlikely to cause injury to wildlife, but may be visible as a thin silvery sheen. The total of all potential areas on the surface where oil may be visible ranges from 3,380 to 12,870 km². The total of all areas >1 µm posing a risk to wildlife ranges from 340 km² (C_S05_1 January) to 632 km² (C_S04 July).



Source: ERM (2014e).

Figure 7.18 – Maximum oil thickness resulting from a Riser Disconnect Base Oil Release at C_S04 (left: January; middle: July; right: November)

For the riser disconnect scenario, oil above the visible thickness threshold was not predicted to contact the African mainland. There is a low chance (less than 10 % probability) of visible oil contacting the shoreline near Vamizi Island, which has sensitive coral in the vicinity. Dissolved concentrations of aromatic hydrocarbons are estimated to be below any concentrations of concern when compared to acute toxicity criteria.

The types of impacts with marine fauna (mammals, turtles, fish and birds) resulting from such a spill will be in all similar to those previously described, and as such that discussion is not repeated here. It should be noted that the risk of a LTOBM release reaching the sensitive coastal habitats has been assessed as low, and as such the impacts of such a release on marine fauna will mostly be felt on the offshore areas.

Considering the modeling results, the impact on marine fauna resulting from an unplanned LTOBM release due to riser disconnection is assessed as a *negative* and *direct* impact. While any hydrocarbon spill has a short duration, the effects on marine fauna can extend in time, and as such the duration is assessed as

[14] Low risk exposure thickness threshold - visible oil between 0.1 µm and 1 µm; Moderate exposure threshold - oil with a thickness between 1 µm and 10 µm; High exposure threshold - any oil with a thickness above 10 µm.

medium (1 to 5 years for full recovery). The extent is of *regional* scale (offshore areas of Cabo Delgado and Nampula could be affected). The importance is *high* (considering the presence of several threatened species of marine mammals and turtles that may be impacted by a spill), but the number of organisms at risk is classified as *moderate* since the base oil slick is fundamentally a two-dimensional impact on the surface of the water. Dissolved concentrations are not predicted to cause any significant injury within the water column. Only those organisms may be affected that surface or land in the water in allocation where the slick is greater than 1 µm thick and at a given moment in time. Note that the diagrams depicting the thickness and probabilistic surface slick regions in this report show all the locations at risk over the entire duration of the spill and over all iterations; an actual slick will only cover a fraction of the areas at any moment in time.

The impact is thus assessed as of *medium significance*.

Mitigation measures

Mitigation controls are mostly in terms of preventive measures to eliminate a riser disconnection and any associated impacts from occurring. They also include response activities to minimize the impacts if a riser disconnect occurred.

To avoid an unplanned release from a riser disconnect, all drilling staff, drilling supervisors and all third party contactors must be ensured to be competent and fully trained to undertake drilling operations with all the necessary certifications.

If an unplanned event occurs, all response activities must be conducted according to EEA's policies and procedures. Prior to commencement of operations, EEA's well control manual and procedures must be bridged to ensure alignment and consistency to the highest standard. Additionally, once drilling operations are initiated periodic safety drills should be conducted by EEA drilling supervisors to ensure readiness of drilling crews and third party service providers. Additional mitigation controls include:

- Well Plans: EEA should conduct reviews of the well drilling plans by subject matter experts to assure operational readiness;
- Oil Spill Response Plan: EEA will develop and implement a comprehensive oil spill response plan (OSRP);
- Incident Management and Crisis Management Support Teams: EEA will develop these teams of highly trained leaders to respond quickly to emergencies;
- Equipment: Tier 1 oil spill response equipment will be staged on support vessels and/or at shore.
- Stakeholder Agreements: EEA will communicate with stakeholders prior to spill response operations informing potentially affected communities of the Oil Spill Response Plan (OSRP) procedures.

Impact Assessment Summary

Post mitigation, operational controls may help minimize the risk of a riser disconnection and response efforts will help minimize extension of the oil slick, if such an accident does occur. For the post mitigation assessment, it was assumed all spill response protocols were applied, all trained staff reacted appropriately, and all containment methods were deployed to minimize the spread of the spill. As a result, the spill would be contained in the proximity of the drilling rig. This will reduce the extent from regional to local, the duration from lasting over a year to less than a year; and the importance from high to moderate. The overall significance score is reduced to low after successful application of mitigation measures. The impact assessment summary is provided on the following table.

Impact: Effects on marine fauna resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement prevention measures, as listed above; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Low	1
Extent	Regional	2		Local	1
Importance	High	3		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**9**		**Low**	**5**

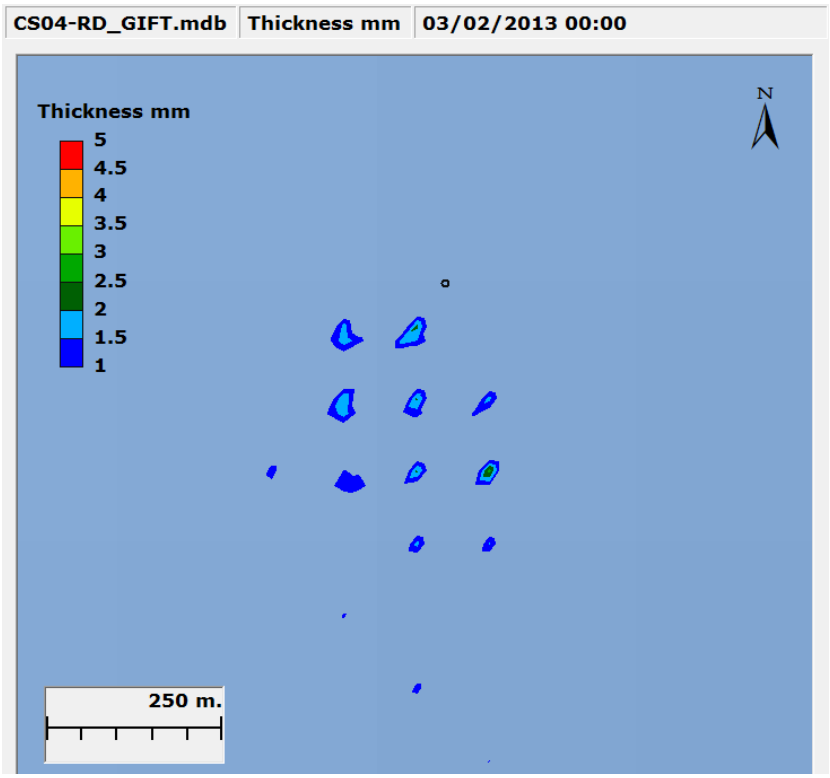
Impact: Effects on deepwater benthic habitats and macrobenthic communities resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase

Impact Assessment

The previous impact assessed the potential impacts of an accidental LTOBM release, in terms of the resulting oil slick and its impacts on marine fauna. Further to this effect, however, an accidental LTOBM release due to a riser disconnection will also generate impacts on benthic habitats and communities, due to smothering effects (deposition of particles on the seabed) and increased concentration of suspended solids, similarly to the discussed for the drilling phase, in what relates the discharge of drill cuttings and muds.

These potential effects of a LTOBM release due to accidental riser disconnection were also assessed in ERM (2014e). **Figure 7.19** (following page) shows the modeling results for maximum thickness of deposited material for a riser disconnect release of LTOBM at C_S04. Particles spread over an area (approximately a 300 m diameter near well C_S04) creating a thin depositional layer as a result of the small settling velocity. The maximum depositional thickness at the end of all the simulated periods was 4.6 mm at C_S01_1. At site C_N18 the depositional thickness is an order of magnitude below the thicknesses at other sites due to a bathymetric drop from the release location allowing for more particle transport.

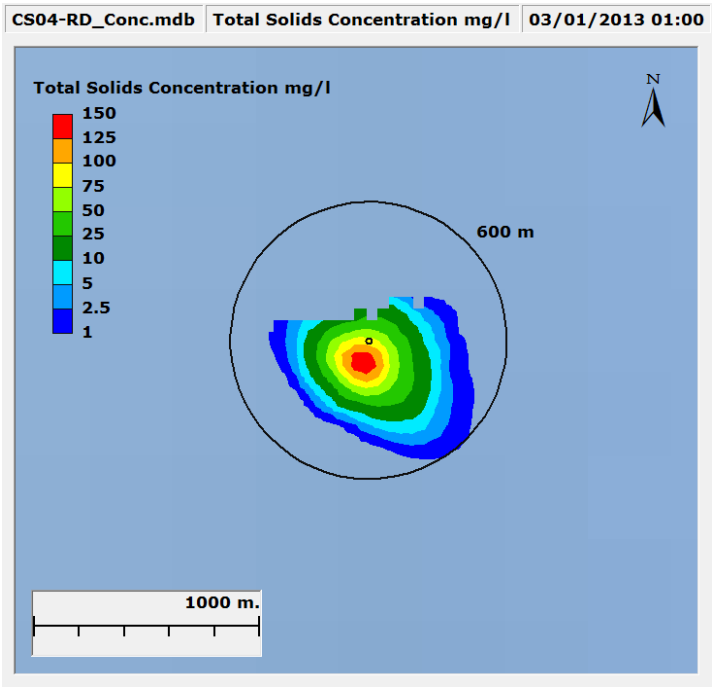
As discussed in section 7.3.2, there is thus no maximum accepted thickness threshold, above which significant impacts are expected to occur on benthic fauna. However, a threshold of 50 mm was adopted in this study to examine the risk of benthic impacts related to a gradual burial (following Ellis & Heim, 1985; MarLIN, 2011). All depositional thicknesses were below the smothering threshold, and thus no significant smothering effect is expected from a riser disconnection.



Source: ERM (2014d).

Figure 7.19 – Maximum Depositional Thickness resulting from Riser Disconnect Particles at C_S04

Figure 7.20 below shows the TSS plume for C_S04. All sites presented elevated concentrations of TSS, located within 1 km of the release location. However, these elevated TSS concentrations persisted for less than an hour before falling below 10 mg/l.



Source: ERM (2014d).

Figure 7.20 – Maximum Total Suspended Solids resulting from Riser Disconnect Particles at C_S04

The potential impact of a LTOBM release on benthic habitats and communities is *negative*, *direct* and of *medium* duration (to allow time for the deposited oily muds to be buried due to natural sedimentation). However, the impact is of *local* scale (limited to a small area surrounding the drilled well) and of *medium* importance (considering the possibility that some of these wells may have an important biodiversity value). The impact is thus assessed as of *low* significance.

Mitigation Measures

The applicable mitigation measures are those described on the previous impact. Mitigation controls are mostly in terms of preventive measures to eliminate a riser disconnection and any associated impacts from occurring. They also include response activities to minimize the impacts if a riser disconnect occurs.

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Effects on deepwater benthic habitats and macrobenthic communities resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase

Criteria	Pre-mitigation assessment		Key Mitigation	Post-mitigation assessment	
Nature	Negative		- Implement prevention measures, as listed above; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Low	1
Extent	Low	1		Low	1
Importance	Medium	2		Medium	2
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**5**

7.4 Impact Assessment: Socio-economic Environment

7.4.1 Fisheries

7.4.1.1 General Considerations

The assessment of the fisheries sector has revealed three main types of fisheries in the areas of influence of the project, namely commercial, sports and recreational, and artisanal sectors.

Of these, the commercial fishing sector is likely to be potentially more impacted, given that it makes direct use of the local fishing grounds located in Area 4. While sports and recreational fisheries also operate offshore, they do not usually move close to Area 4, fishing instead along the axis of the Quirimbas Islands or targeting specific areas such as the Saint Lazarus Bank (located approximately 17 km from Area 4 and 106 km from the proposed FLNG site).

The artisanal fisheries sector is widespread along the coast of the District of Palma, including the islands but not extending beyond 3 nm (circa 5.5 km) from the islands. As such, their natural fishing grounds are well away from Area 4 and only indirect impacts are expected, as discussed below.

7.4.1.2 Potentially Impact Generating Project Activities

Project activities that may result in impacts on fisheries and which will occur in all project phases namely drilling and installation, commissioning, operation and decommissioning include:

- Restricted access areas due to project safety zones around the installation/FLNG site;
- Increased vessel movements including drilling, support, construction and tankers;
- Increased noise and light emissions from vessels and the FLNG;
- Discharge and loading of ballast waters from vessels and the FLNG;
- Production of solid waste from vessels and the FLNG;
- Discharge of effluents including drill cuttings and mud as well as thermal and cooling water.

While the same impacts are expected to occur during all project phases, impact assessment has been grouped in the following two stages mainly due to the duration of the impact: (1) drilling and installation, commissioning and decommissioning – where impacts will be temporary; and (2) operational phase – where impacts will be largely of long term duration. To avoid repeating the assessment of the same impact, an impact assessment summary table has been provided for impacts during the operational phase (as in this phase only the duration score is different).

The impact related to changes in water quality during the operational phase is discussed and assessed below given that it is linked to the production of effluent discharges that differ from the drilling and installation phase.

In addition, non planned events have also been considered and are mainly linked to accidental hydrocarbon releases.

7.4.1.3 Drilling, Installation, Commissioning and Decommissioning Phase

Impact: Loss of access to fishing grounds by commercial fisheries

Impact Assessment

The above referred activities are likely to affect commercial fishing operations in the area as vessels would lose access to potential fishing grounds located within the drilling and installation areas and safety zones (i.e., 2 nm or 3.7 km around the FLNG site). This loss of access to potential fishing grounds by fishermen may lead to increased competition for resources in the remaining areas, or increased changes in the routes used by commercial vessels, with an increased time spent by fleets looking for fish. This situation may further result in potential conflicts between fishermen searching for and using alternative fishing grounds they traditionally do not occupy. Being this impact located in the area of direct influence, it will likely affect mostly the commercial fisheries sector, in particular purse seiners given they are more active than long liners.

The impact is *negative* and *direct* and of *low* extent, given that it will only be felt in the project site and its immediate environs, which constitutes a minute portion of the fishing grounds available for these fisheries. The potential loss of access to fishing grounds is therefore assessed as *low* significance impact prior to mitigation. With the implementation of the proposed mitigation measures, and considering that the loss of fishing grounds would be of *medium* duration, the significance of the impact remains *low* throughout the duration of this project phase.

Mitigation Measures

The following control measures are recommended:

- Implement a Communication Plan to inform commercial fishing operators about the proposed project spatial use (surface and subsurface) to enable the identification of alternative fishing grounds. This should be done through National and Provincial Fisheries Administrations (ADNAP and DPPCD) and other relevant government institutions,
- Implement an appropriate Grievance Mechanism to report any complaints from commercial fishing operators regarding FLNG operations.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Loss of access to fishing grounds by commercial fisheries					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from fishing operators regarding FLNG operations; - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**5**

Impact: Loss of access to fishing grounds by sports and recreational fisheries

Impact Assessment

Sports and recreational fisheries are an important tourism activity performed by local tourism operators, which is mainly done between 3 and 15 nautical miles (5.6 and 27.8 km) offshore, but can sometimes go further offshore to areas close to the Lazarus Bank which is located 17 km from Area 4 and about 106 km from Coral-1. However, sports and recreational fisheries have their routes along the latitudinal axis close to the Quirimbas Islands, thus not likely overlapping Area 4, where drilling and installation activities will be concentrated.

However, interviews with local recreational fishing operators indicate an overall perception that project implementation will lead to severe impacts on this activity, either by scaring fish away, polluting the waters, scenery/horizon enjoyed by recreational fishers, as well as risks of eventual leaks and spills.

While no actual loss of recreational fishing grounds is expected, the *perceived* loss of access to fishing grounds by sports and recreational fishing activities is a *negative* impact of *low* significance.

Mitigation Measures

Even though there will be no impacts on recreational and sports fishing activities, the establishment of appropriate communication channels (through the implementation of a Communication Plan and appropriate Grievance Mechanisms) with relevant tourism operators and organizations is recommended.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Loss of access to fishing grounds by sports and recreational fisheries					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from tourism operators and organizations	Negative	
Type	Perceived			Perceived	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**5**		**Low**	**5**

Impact: Increased fishing competition in remaining fishing grounds due to project installation

Impact Assessment

Artisanal fishing takes place by local fisherman and migrants from nearby areas within the District of Palma coastal zone. It is generally restricted within an area of up to 5.6 Km from the offshore east coast of the islands, and the routes and fishing grounds are clearly outside Area 4. The planned installation of the FLNG is thus well offshore of the areas frequented by artisanal fishermen, and the loss of access to fishing grounds will not likely be felt by this type of fisheries, unless the commercial and recreational fisheries move their fishing areas to grounds closer to the shore due to project implementation, causing increased competition for fishing grounds and resources in these areas.

This impact is *negative* and *indirect*. The potential effects of increased competition for fishing grounds and resources normally used by artisanal fishermen would be of *medium* duration and of *medium* significance.

Mitigation Measures

- Implementation a communication plan with local fishing communities, in coordination with ADNAP and IDPPE.
- Implement a Grievance Mechanism.

Impact Assessment Summary

With the implementation of the proposed mitigation measures, the number of elements affected may lower, and thus the residual impact significance will decrease to *low*. The impact assessment summary is provided in the following table.

Impact: Increased fishing competition in remaining fishing grounds due to project installation					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from artisanal fishermen - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Medium	2		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**7**		**Low**	**6**

Impact: Decreased catch rates due to noise emissions

Impact Assessment

Drilling, installation and commissioning activities are not expected to generate high levels of noise in general. However, these activities will involve the use of vessels which are likely to be equipped with DP systems. Drilling will also include the use of a DP support vessels which perform functions such as anchor handling. Individual vessels are expected to spend between 200 and 400 days on site.

Noise generated during these activities has the potential to affect the behavior of some fish species. The mechanisms that some marine fish species use to detect sound are the inner ear system of otolithic bones, the lateral line system and the gas swim bladder in the abdominal cavity.

Fish behavior criteria are not well established but studies indicate that the level at which behavioral effects (increased activity) star to appear is at 160 dB re 1μPa rms (Underwater Noise Specialist Report – ERM 2014a) and the Fisheries Hydroacoustic Working Group (FHWG) suggest a criterion of 150 dB re 1μPa rms, which was adopted for this EIS. Noise levels during these phases of the project will be produced by vessels associated with the project (up to 192 dB re 1μPa rms), drilling (up to 185 dB re 1μPa rms) and helicopters, values that are over the Noise Criterion for Behavioral Response defined for fish.

However and according to underwater noise modeling conducted for this project (ERM 2014a), these noise levels will quickly attenuate with distance and are not expected to affect fish behavior further than 700 m away from the noise source.

As such, while noise emissions may lead to the temporary displacement of fish shoals, this would occur in the immediate vicinity (~700m) from the noise source and, as such, a potential decline in catch fishing levels in surrounding fishing areas as a result of the escape, possibly temporary, of fish is not expected.

The impact is assessed as *negative*, *indirect* and very localized (i.e. within 700 m from the noise source).

The areas targeted by commercial fishing operators are vast and they have access to larger and motorized vessels, making them very mobile and able to follow displaced fish populations and ensure the maintenance of catch rates, lowering the significance of the impact. The potential impact of noise emissions on fish catches is therefore assessed as *negative* and *indirect* and of *low* significance.

Mitigation Measures

No mitigation measures are required other than the ones specified for effects of underwater noise on marine fauna, namely:

- The DP systems are likely to be the major source of noise. Therefore, selection of the drill ship (MODU) and support vessels should be carried out taking into account the noise emissions, and where possible selecting quieter DP systems;
- As far as reasonably practicable, vessels used in the project should incorporate measures to reduce cavitation thus reducing the amount of underwater noise generated (IMO, 2004), as follows:
    - Propeller designed/ selected to reduce cavitation;
    - Improve DP system to delay cavitation inception nearer to peak speed;
    - Vessels should also undergo regular maintenance regime to reduce noise which include the cleaning of propeller and underwater hull.
- If technically feasible, investigate the possibility of using mooring/anchoring to keep the drill ship on station rather than using DP systems. However, should mooring/ anchoring be undertaken, it will also be necessary to avoid noise generating anchoring techniques such as driven piling. Adherence to measures stated in JNCC (2010) throughout piling operations is recommended to minimize impact to marine fauna present in the area. These measures include the presence of dedicated Marine Mammal Observers (MMO) throughout piling activities, undertaking soft-start of pile driving activities, and establishment of a 500 m mitigation zone;
- Additionally, vessel transits should avoid sensitive marine areas as well as maintaining a 500 m exclusion[15] zone from any marine mammals encountered during transit. Any sightings of marine fauna throughout the project duration should be recorded to assess the effectiveness of mitigation measures applied.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Decreased catch rates due to noise emissions					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- The DP systems are likely to be the major source of noise. Therefore, selection of the drill ship (MODU) and support vessels should be carried out taking into account the noise emissions, and where possible selecting quieter DP systems; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - If technically feasible, investigate the possibly of using mooring/anchoring to keep the drill ship on station rather than using DP systems; - Avoidance of noise generating anchoring techniques such as impact piling; - Should piling option be used, mitigation measures such as soft starts, provision of dedicated MMOs and establishment of a 500 m mitigation zone throughout piling operations should be adhered to (JNCC, 2010); - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**5**		**Low**	**5**

[15] 500 m exclusion zone is used based on the JNCC (2010) guidelines to minimize risk of injuries or disturbance to marine mammals, in the absence of any definitive guideline relating to mitigating impacts from vessel movements to marine mammals.

Impact: Decreased catch rates due to light emissions

Impact Assessment

Light emissions associated with the drilling, installation, commissioning and decommissioning phases have the potential to impact on commercial fishing activities due to visual disturbance.

According to the Illumination Specialist Study (ERM 2014b), the effect of light emissions on fish is expected to differ depending on species and habit. Broadly, illumination will change light regimes and pose risks of increased mortality through changes to natural day-night time distribution and consequently alter prey predator relationships, feeding and mating behaviors. Light disturbance may deviate shoals from fishing grounds, attracted by lights within the vicinity of the FLNG site. The use of lighting during night-time operations can also result in impacts by attracting marine organisms, affecting feeding and/or mating behaviors and increasing predation, which will affect available fish stock and in turn affect fishing activities.

The potential disturbance to fish of light emissions from rigs, platforms and vessels is however expected to be restricted to localized attraction, extending 90-100 m from the source. As such, any impacts to fish arising from light emissions are considered to be minor and localized to a small proportion of the population.

The impact is *negative* and *indirect* and very localized (~100m from the illumination source). Considering the referred AoI, the importance/sensitivity of the fisheries resources and the number of elements involved are *low*. The overall significance is thus *low*.

Mitigation Measures

Light emissions should be kept as low as possible, in accordance with best practice environmental management.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Decreased catch rates due to light emissions					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Light emissions should be kept as low as possible, in accordance with best practice environmental management.	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**5**		**Low**	**5**

Impact: Effect of discharge and loading of ballast waters on fishing catch rates

Impact Assessment

Vessel movements in the area will increase during the lifecycle of the project (support, supply and export vessels) with the potential to introduce invasive alien species through loading and discharge of the hull

ballast. Discharge and loading of ballast water has considerable potential for the transmission of Alien Invasive Species (AIS).

It is widely acknowledged that AIS can cause major and often irreversible damage to the environment, economy and human health. Worldwide, they have been implicated in numerous species extinctions and remain a serious threat to many more species. This was confirmed recently by the findings of the Millennium Ecosystem Assessment, which found that AIS species have been a main direct driver of change in biodiversity and ecosystems over the past 50–100 years. The assessment also predicts that impacts are likely to continue or increase in all biomes globally (IPIECA, 2010).

Many AIS share common biological characteristics such as rapid reproductive capacity and fast growth, hence they can often adapt readily to disturbed or degraded environments, even before native species are able to adapt to the same conditions. Frequently, introduced AIS have no natural predators in the receiving environment, and numbers may be allowed to increase in the absence of predation. The impacts of AIS on biodiversity and ecosystems can be direct, indirect and synergistic.

Considering the above, the impact of discharge and loading ballast waters on the area may affect marine biodiversity, cause species extinctions and may therefore affect fisheries.

It can affect the area of direct influence of the project, as well the coastline and near-shore area of Palma District and the islands located to the west of the FLNG location.

The impact is *negative* and *indirect***.** As it can affect areas of high biodiversity (for example if it reaches the Quirimbas Archipelago), it's an impact with a *medium* importance to catch rates, and may involve a *medium* number of fishing elements (from artisanal through to commercial fishing enterprises). The impact has a *medium* significance prior to mitigation.

Mitigation Measures

- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010). Some of those best practices are as follows:
    - All vessels containing ballast water should carry a vessel-specific Ballast Water Management Plan (BWMP).
    - Ballast exchange should, as far as practicable, be conducted in deep water (at least 200 m) and as far as possible from land.
    - Treat small vessels as potentially significant AIS pathways.
    - Use careful cleaning and inspection to minimize AIS transmission.

Impact Assessment Summary

The impact assessment summary is provided in the following table. Assuming adherence to the applicable best management, the residual significance will be *low*.

Impact: Effects of discharge and loading of ballast water on fisheries					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010).	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Medium	2		Medium	2
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**7**		**Low**	**6**

Impact: Decreased catch rates due to changes in water quality from general waste, drill cuttings and mud

Impact Assessment

Solid waste related to the drilling, installation, commissioning and decommissioning phases and related to catering (food waste, plastics, etc.) and sanitary (clinic waste etc.) will be produced and may impact on water quality. Daily offshore routines will produce domestic waste, which may result in impacts in the vicinity or even travel if not properly managed or disposed of. Food waste will be readily consumed and biodegraded in the marine environment and as such, is not deemed to pose a risk to water quality. Increase in vessels in the vicinity and going to and from the FLNG will also be a source of solid waste.

Other routine project activity during the drilling phase that may impact on water quality and hence on catch rates would be the disposal of some drill cuttings and residual muds. Water quality could potentially be affected in two ways through the disposal of drill cuttings and residual muds: increased turbidity, and contamination.

All these discharges could potentially damage the marine environment through toxicity, oxygen depletion, thermal and salinity stress, which could in turn impact on fish resources and therefore on catch rates.

However, the oceanographic specialist studies (ERM 2014c) suggest that water turbidity and contamination from drill cuttings and mud would be very localized at the point of discharge and below internationally accepted threshold levels. On the other hand, it is recognized that both EEA and its contractors will adhere to best waste management practices during all its operations.

As such, decreased water quality and the impact on fish populations and catch rates is not likely to occur. Considering the above, the impact is *negative* and *indirect* and of *low* significance.

Mitigation Measures

Even though the significance of this impact is assessed as low prior to mitigation, the following is recommended:

- Implement all mitigation measures outlined in Section 7.2.4.2 for impact: Potential seawater quality degradation due to the discharge of drill cuttings;
- Implement a Waste Management Plan and train crew members on waste management procedures;

- Food waste will be discharged offshore in accordance with MARPOL (73/78) regulations given that it is the most international convention concerning vessel-source operational marine pollution and is widely regarded as a successful instrument.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Decreased catch rates due to changes in water quality from general waste, drill cuttings and mud					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement all mitigation measures outlined in Section 7.2.4.2 for impact: Potential seawater quality degradation due to the discharge of drill cuttings; - Implement a Waste Management Plan and train crew members on waste management procedures; - Food waste will be treated in accordance with MARPOL (73/78) regulations.	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**5**		**Low**	**5**

7.4.1.4 Operational Phase

Impact: Loss of access to fishing grounds by commercial fisheries

Impact Summary

The impact assessment summary is provided in the following table. In the operational phase, the duration score is of very long term, thus raising the significance of this impact to *medium*.

Impact: Loss of access to fishing grounds by commercial fisheries					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from fishing operators regarding FLNG operations; - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.	Negative	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**8**		**Medium**	**7**

Impact: Loss of access to fishing grounds by sports and recreational fisheries

Impact Assessment Summary

The impact assessment summary is provided on the following table. In the operational phase, the duration score is of very long term, thus raising the significance of this impact to *medium.*

Impact: Loss of access to fishing grounds by sports and recreational fisheries					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from tourism operators and organizations	Negative	
Type	Perceived			Perceived	
Duration	Critical	4		Critical	4
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**7**		**Medium**	**7**

Impact: Increased fishing competition in remaining fishing grounds due to project installation

Impact Assessment Summary

The impact assessment summary is provided in the following table. In the operational phase, the duration score is of very long term, thus raising the significance of this impact to *medium*.

Impact: Increased fishing competition in remaining fishing grounds due to project installation					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from artisanal fishermen - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.	Negative	
Type	Indirect			Indirect	
Duration	Critical	4		Critical	4
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**9**		**Medium**	**7**

Impact: Decreased catch rates due to noise emissions

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Decreased catch rates due to noise emissions					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- The design of the FLNG and offloading vessels should be investigated in order to minimize noise, particularly during use of dynamic positioning thrusters; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).	Negative	
Type	Indirect			Indirect	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

Impact: Decreased catch rates due to light emissions

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Decreased catch rates due to light emissions					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Placement and direction of lighting used, in accordance with relevant standards; - Shading to direct light inward and downward; - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights; - Flat black paint may reduce whale response to brightly reflective objects such as oceanographic cables.	Negative	
Type	Indirect			Indirect	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**6**

Impact: Effect of discharge and loading of ballast waters on fishing catch rates

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Effect of discharge and loading of ballast waters on fishing catch rates					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010).	Negative	
Type	Indirect			Indirect	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**7**		**Low**	**6**

Impact: Decreased catch rates due to changes in water quality from general waste, thermal and cooling water discharges

Impact Assessment Summary

Solid and other waste related to catering (food waste, plastics, etc.) and sanitary (clinic waste etc.) will be produced during the operational phase. Daily routines in the FLNG will produce domestic waste, which may result in impacts in the vicinity or even travel if not properly managed or disposed of. Food waste will be readily consumed and biodegraded in the marine environment and as such is not deemed to pose a risk to water quality. The increase in vessels in the vicinity and going to and from the FLNG will also be a source of solid waste.

Another source of potential effects on water quality would be related to water discharges from the FLNG facility. Liquid effluents would include deck drainage, bilge water and sewage discharge as well as thermal and produced water.

These liquid effluents may have the potential of damaging the marine environment through toxicity, oxygen depletion, thermal and salinity stress, which can impact on fish resources and therefore on catch rates.

However, the FLNG facilities have adequate effluent treatment facilities on board to comply with applicable regulation, and the oceanography studies suggest that, even in the worst case scenario, the thermal and cooling water discharges would result in fairly low temperature increases in the receiving marine waters and comply with national regulations.

Considering the above no significant impacts on catch rates are expected. The impact is assessed as *negative* and *indirect* with a *medium* significance**.**

Mitigation Measures

- Implement all mitigation measures outlined in Section 7.2.4.3 for Impact: potential increase of marine water temperature due to the discharge of the FLNG's cooling water and Impact; Potential seawater quality degradation due to the discharge of produced water in the operational phase.
- Adequate treatment and disposal of the solid waste has to be applied in order to avoid localized pollution of marine waters.
- All mitigation measures to avoid and, if not possible, minimize the potential impacts shall be applied according to national regulations and international standards and best practices.
- Food solid waste will be discharged offshore in accordance with MARPOL (73/78) regulations.
- All vessels must be certified for seaworthiness through an appropriate internationally recognized marine certification body.
- Establish separate drainage systems for hydrocarbon-contaminated water (closed drains) and water from non-process areas (open drains). Bund all process areas to prevent contamination by storm waters, contain spills and leaks, and channel drainage water into the closed drains.
- Use drip trays to collect run-off and spills from equipment not contained within a bunded area and channel runoff to the closed drainage system.
- Disposal of deck drainage, bilge water and sewage discharge in accordance with MARPOL 73/78, namely:
    - Liquid effluents must be treated before discharged to the sea.
    - Sewage must be treated and disinfected (on-board treatment plant) prior to discharge.
    - Treated effluents shall achieve a BOD < 40 ppm, suspended solids < 50 ppm and a coliform count < 200 cells per 100 ml of effluent.
    - The discharge depth is variable, depending on the draught of the rig at the time, but it should not be less than 5m below the surface.
    - Route water from machinery spaces to the closed drainage system, or contain and treat the bilge water before discharge.
    - The concentration of oil in the water after treatment in an IMO approved oil/water separator shall not exceed 15 ppm.
    - Contain oil and chemical use areas and equipment (deck, mud tanks and pumps).
    - Use efficient oil and water separators and ensure that spills are immediately cleaned.

- Discharge of produced water and cooling water (thermal discharge) in compliance with national and international limits and standards;
- Train crew members regarding the risks of water contamination.

Impact Assessment Summary

The impact assessment summary is provided in the following table.

Impact: Decreased catch rates due to changes in water quality from general waste, thermal and cooling water discharges					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Mitigation measures outlined above.	Negative	
Type	Indirect			Indirect	
Duration	High	3		High	3
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**8**		**Low**	**6**

7.4.1.5 Unplanned events

The effects of unplanned events are largely related with the spillage/release of hydrocarbons. It can be a condensate and diesel spill during transfer or caused by vessel collision, cyclone or other emergency scenario, such as fires or explosions. While these events are unlikely to occur, they may result in extensive negative impacts if the released hydrocarbons enter nearshore waters and coastline habitats. Cyclones may occur in the region of Area 4. Bad atmospheric conditions can result in vessel accidents and thus in oil spills.

There are many different types of oil; therefore each oil spill is different depending on the type of oil accidentally released into the environment. Each oil spill will have a different impact on sensitive resources and the surrounding environment depending on the following:

- Type of oil spilled – physical and chemical characteristics of oil, susceptibility to evaporation, mousse formation, dispersion, etc., and degree of oil weathering that occurs prior to contact;
- Spill location – distance from sensitive resources;
- Species present – temporal (e.g., seasonal presence, migrants), spatial (i.e., distribution, tendency to occur in schools, herds, etc.), and behavioral characteristics (e.g., species-specific response to oil); and
- Timing of breeding cycles and seasonal migrations.

In general, direct oil effects typically include smothering, toxicity from ingestion and/or inhalation, increased levels of hydrocarbons in water and air, and area exclusion. Indirect impacts include adverse effects on organisms and/or destruction of habitat and therefore on fishing catch rates.

Impact: Decreased catch rates due to changes in water quality from hydrocarbon spills

Impact Assessment

An oil spill could affect marine water quality by increasing hydrocarbon concentrations due to dissolved components and small oil droplets. Natural weathering processes are expected to rapidly remove the diesel fuel from the water column and dilute the constituents to background levels. While lighter fractions of oil will also weather, more complex compounds will tend to persist. The highly evaporative and dispersive components of oil are expected to result in its ready dispersal into the water column.

According to the marine ecology specialist study (Consultec 2014), pelagic fish (adults, larvae) mortalities as a result of oil spills are limited in size and do not translate into measurable effects on fish stocks. However, local mortalities in fish larvae and fish eggs can occur, although rare (Baker et al., 1990). Demersal, near-shore, and estuarine stocks, especially those species feeding on the sediment surface may suffer mortalities by ingesting contaminated sediments.

While fish are mobile and can move out of an impacted area, the overall habitat range can be significantly decreased, leading to major implications for a fish population as a whole which could in turn lead to severe implications on catch rates.

The impact of hydrocarbon release on catch rates in negative and indirect. While any hydrocarbon spill would have a short duration, the effects on fish populations can extend in time, and as such the duration is assessed as medium. Mostly small diesel leaks and spills are expected, however if a large diesel spill occurs, the extent will be regional. The importance is assessed as medium. The impact is thus assessed as of medium significance.

Mitigation Measures

Implement all mitigation measures outlined Section 7.2.4.4 and 7.3.4.2.

Impact Assessment Summary

The impact assessment summary is provided on the following table.

Impact: Decreased catch rates due to changes in water quality from hydrocarbon spills					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement all mitigation measures outlined Section 7.2.4.4 and 7.3.4.2.	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Medium	2		Local	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**Medium**	**8**		**Low**	**5**

Impact: Decreased catch rates due to effects of potential LNG and natural gas releases

Impact Assessment

The potential for LNG releases are linked to accidental spills or leaks, which can result in hazards such as oxygen deficiency and fire hazards. LNG releases can occur from various components of the process including:

- During uploading of LNG into tankers
- From flowlines
- From accidents with tankers

On the other hand, natural gas releases could occur from gas blowouts or leaks.

While very unlikely to occur based on historic industry records (Keltic Petrochemicals Inc., 2007; La'o Hamutuk, 2008), impacts associated with LNG and natural gas spills or leaks into the sea are assessed below.

According to Keltic Petrochemicals Inc. (2007), LNG is not persistent nor toxic below water surface, and eventual spills in the sea would therefore be unlikely to contaminate fishing resources below the water surface. A spill of LNG on marine water can however still result in very serious consequences, especially if large amounts are released onto the sea surface. According to La'o Hamutuk (2008), a large spill could result in a 'flameless explosion from rapid evaporation of LNG on the ocean, forming pieces of ice and gas clouds followed by combustion and explosions'. These explosions could result in the destruction of most living creatures within an area of 10 km (La'o Hamutuk 2008) thereby affecting commercial fisheries due to cryogenic and thermal radiation effects.

LNG spills are however unlikely to affect bottom fisheries and given that it is non persistent nor toxic in water, an eventual spill would not contaminate fishery resources if properly managed. It is in fact believed that the persistence of environmental effects on commercial fisheries would have a shorter duration from an LNG spill than spills of other hydrocarbons (Keltic Petrochemicals Inc., 2007).

Natural gas on the other hand (which is mainly made of methane), when leaked into the ocean (i.e. water) is likely to dissolve before reaching the surface and, once dissolved, is eaten by bacteria resulting in limited harm to the environment. However, gas can still rapidly penetrate fish through their gills and disturb their respiratory, nervous, and other systems (Patin 1999). In the unlikely case of a blowout or a gas leak, the short term increase in fish mortality might be expected around the well due to the increase of methane in the water. Researchers conducted detailed observations after accidental gas blowouts on drilling platforms during summer-autumn of 1982 and 1985 (GLABRYBVOD, 1983; AzNIIRKH, 1986) showed a cause-effect relationship between mass fish mortality and large amounts of natural gas input into the water after the accidents. There is however very little data on the environmental impacts of gas blowouts as the amount of gas leaked is difficult to estimate and the gases are quickly assimilated by the marine environment or lost to the atmosphere[16]. Once methane is dissolved, it is then eaten by bacteria. Furthermore, the impact of any accident of this nature will be localized in the vicinity of the FLNG facility or vessel.

Given this is a gas offshore facility and the significant distance from the coastline (50km) and the nearest island (~46km), combined with the highly adaptable nature of commercial fishermen (as they can avoid the accident areas and fish in different areas); it is unlikely that any accidents from the FLNG and its subsea facilities will have any significant impact on artisanal, commercial and recreational fisheries. The impact is assessed as *local* and of *low* duration, affecting *low* number of fishermen who can easily adapt (i.e., low sensitivity). The significance of the impact is *low*.

[16] SINTEF Chemistry and Materials has established a research project to learn more about the effects and hazards of underwater gas blowouts and gas leaks with support from industry actors. This project is established as a Joint Industry Program and is developing SURE, an advanced modeling tool for Subsea Gas Release.

Mitigation Measures

- Train personnel in well-control programs so that they can spot signs of potential leaks and blowouts and react accordingly;
- Conduct an appropriate risk assessment;
- Establish exclusion zone for tankers travelling in shipping lanes thereby reducing the potential for collision and spills.

Impact Assessment Summary

Impact: Decreased catch rates due to effects of potential LNG and natural gas releases					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Train personnel in well-control programs so that they can spot the signs and react accordingly; - Conduct an appropriate risk assessment; - Establish exclusion zone for tankers travelling in shipping lanes thereby reducing the potential for collision and spills.	Negative	
Type	Indirect			Indirect	
Duration	Low	1		Low	1
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

7.4.2 Socio-economic

7.4.2.1 General Considerations

The different project phases that may result in socio-economic impacts are described below.

I. Drilling, Installation and Commissioning - The installation phase will mainly comprise the preparation of the seabed and installation and testing of subsea items, mooring chains and anchors installation, towing and hook up of FLNG and hydraulic testing. Well drilling and completion will also be done at this stage, followed by commissioning. A number of vessels will be active in Concession Area 4 at these project phases, including the FLNG vessel itself and a number of support vessels. These activities will lead to increased marine traffic as well as noise (particularly due to marine traffic and general activities), visual (due to lighting and emergency flaring) and waste impacts. There will be an exclusion zone of 2 nautical miles (3.7km) around the FLNG. This phase will also lead to an increase in marine traffic as well as involve a significant number of short/medium-term highly skilled expatriate workers as well as Mozambicans.

II. Operation and Maintenance - The main activities surrounding the operation and maintenance phase will include the operation of the FLNG facility (turning the natural gas into liquid form, storage and offloading it) including support and logistics, and the maintenance of these facilities and subsea infrastructures. These activities will result in a permanent presence and operations of the FLNG vessel at the site; promulgation of safety zones around the FLNG vessel; and gas tankers shuttling between the FLNG vessel and further offshore. Employment opportunities during this phase will be smaller (i.e. 320 people).

III. Decommissioning of the Project – the decommissioning of the project will result in the removal of the FLNG facility from the area, proper abandonment of the network of flowlines and sealing off of wells. This will see an increase in a number of support vessels in the area as well as a few employment opportunities.

It is important to note that the FLNG facility will be served by onshore offices that will act as logistic support and ancillary services to the project and whose current envisaged location is set as Pemba City. These support structures are yet to be defined during a separate project outside the scope of this EIS and will be subject to an independent EIA process.

Based on the assessment methodology presented in section 7.1.2 and a description of the activities involved in each phase above, the main socio-economic impacts foreseen are assessed in the following sections and briefly illustrated below:

Impacts on tourism operators

- Effects on recreational diving and sports fishing;
- Effects on cetacean (whales and dolphins) sightseeing excursions;
- Economic effects on the tourism industry in the study area;
    - Visual/aesthetic effects on tourists, especially on the islands;
    - Effects on the image of the Quirimbas Archipelago as a medium- to high-end tourism destination;
    - Effects on planned and future tourism developments in the Quirimbas Archipelago;
    - Effects on the number of tourists;

Impacts on fishermen

- Effects of the safety zones on commercial fishing;
- Effects of changes in fish behavior and movement on artisanal fishing;
- Economic effects on artisanal and commercial fishermen;
- Effects on first order fish traders;

Impacts on communities and government

- Effects on migrant workers;
- Effects on community expectations;
- Effects on employment; and
- Effects on employment opportunities, revenue to local businesses and Government

Impacts on health

- Effects on regional health infrastructure
- Effects related to sexually-transmitted infections and high risk sexual practices

These impacts are assessed below and have been grouped to cover Drilling, Installation, Commissioning and Operation. However, when relevant, some impacts are assessed separately for the drilling, installation and commissioning phases and for the operational phase, when there are significant differences in the effect between these project phases.

The main activities that could generate impacts on the social, cultural and economic aspects of the communities in the AII during the decommissioning phase of the Project would be mainly related to the loss

of employment and some out flow of workers to other areas. This would have a negative impact on the economy of the AII, as employment would be terminated and purchasing power of the communities would be diminished. Indirect impacts of this decrease of purchasing power could include closing of certain business such as hotels or support businesses to the offshore facilities. The Government of Mozambique will also lose an important source of revenue which will potentially have implications to the allocation of the state budget.

Social and economic impacts in the decommissioning phase are dependent on the degree of dependency of the communities to the project with a high degree of dependency resulting in a highly significant negative impact and a low degree of dependency resulting in a low significant negative impact, as other industries and formal employment options absorb the impact of losing an industry and related employment.

Given the lack of knowledge of this dependency at this stage of this study, the final assessment of the decommissioning will not be further elaborated and it is recommended that the project undertake an economic impact and dependency study two years prior to decommissioning that will provide more specific and focused recommendations to mitigate the potential impacts from this phase.

7.4.2.2 Drilling, Installation, Commissioning and Operational Phases

Impact: Effects on recreational diving and sports fishing; effects on cetacean (whales and dolphins) sightseeing excursions

Impact Assessment

Sports and recreational fisheries are an important tourism activity performed by local tourism operators, who perform their activity offshore Palma. However, according to the Fisheries Specialist Study (Consultec 2014a), the sports and recreational fisheries seem to have their routes along the latitudinal axis close to the Quirimbas Islands, thus not likely overlapping the Project Area 4. The potential decrease of revenue and/or utility from the loss of access to fishing grounds of sports and recreational fishing activities is therefore unlikely to occur.

With regards to sightseeing excursions, whale sightseeing is usually done between July and November and dolphins are seen throughout the whole year. The most common migratory whales seen in the Mozambique waters are the Southern right Whales and the Humpback Whales. They migrate to cold waters in high latitudes to feed and then move on to warmer waters to mate and give birth. Tourism operators sightseeing excursions stay within the archipelago boundaries and, whilst there is no data on how far they travel to watch whales and dolphins, it can be assumed that they do not travel beyond the areas used by commercial fishermen (who operate from 22 km from the coast).

Given this spatial dimension, there is likely no overlap between the sightseeing excursions of any tourism operated island in the AII and the Project in Area 4. This impact is therefore unlikely to occur.

However, the potential impact on local tourism activities is considered a *perceived* impact given that tourism operators believe that the FLNG will significantly affect their operations. The impact is *negative* and *direct*, likely to affect a *low* number of elements and of *low* significance

Mitigation Measures

The main mitigation measures proposed should be focused on maintaining a good flow of communication between the project proponent and tourism operators.

Impact Assessment Summary

Impact: Effects on recreational diving and sports fishing; effects on cetacean (whales and dolphins) sightseeing excursions					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Draft and implement a Communication Plan and Grievance Mechanism	Negative	
Type	Perceived			Perceived	
Duration	Low	1		Low	1
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

Impact: Effects on the image of the Quirimbas Archipelago as a medium to high-end tourism destination; Visual/aesthetic effects on tourists, especially on the islands

Impact Assessment

The Quirimbas islands (of which Tecomaji, Rongui, Vamizi, Metundo, Queramimbi, Quifuqui and Tambuzi are within the area of indirect influence) are specialized mainly in high-end tourism, providing a luxury package that combines luxurious accommodation and services with pristine nature and isolation. However, within the AII there is currently only one operational luxury lodge (Vamizi 5 star hotel), with Metundo having closed down recently and another five currently in the development phase. This type of luxury branding is easily affected by changes in the scenic context it is inserted in, such as for example, the sight of a commercial type vessel or the glow from the project site.

When assessing the significance of this potential impact, the spatial dimension of the island activities and potential visual reach was undertaken.

- Daytime visual Impacts: During the drilling and installation phase, one will see an increase in marine traffic which increases the likelihood of visual contact. The visual contact from the island to the FLNG seems highly unlikely as research shows that if one stands on the beach, one can see about 4.5 Km across the ocean and if one goes up, for instance, 15 meters high on a sand dune, one can see about 13.5km across the ocean which is well under the 46 km minimum distance between Coral 1 site and Metundo Island;
- Night time visual Impact: Tourists staying at the operational five-star resorts on coastal islands could be exposed to functional illumination from sea-based structures and navigational lights from vessels and helicopters over the course of many nights during their stay. This activity will be particularly intensified during the drilling and installation phase, as well as decommissioning phase. It will be less intense during the operation and maintenance phase but more permanent.

This visual impact, can lead to a lower utility derived from tourists and in the long run, result in less income from tourists in the area. It should be noted, however, that according to the results of the illumination specialist study (see section 7.2.3.4) the illumination impact of the FLNG unit during the operational phase will be relatively low. From the distance at which the tourism resorts are located, it is expected that the light glow from the FLNG vessel would be seen as a noticeable but not conspicuous glow on the far horizon (see **Figure 7.7**, page 26), and only when visibility conditions are conducive, generally between June and

October, and occupying a narrow angle of the 360 degree panoramic view. In the rest of the year, the FLNG vessel will barely be noticeable.

This impact on the tourism industry will be *negative*, *direct*, *critical* duration (throughout the life of the project) and local. It will however affect a *low* number of people (only the tourists during their stay) and the impact itself will be of *low* importance, thus resulting in a *medium* significance.

Mitigation Measures

The main mitigation measures will follow from the illumination study and will include:

- Illumination will be designed on permanent facilities with the objective to reduce light glow while meeting workplace health and safety, and navigational requirements.
- The use of non-reflective surface treatments.

Impact Assessment Summary

Impact: Effects on the image of the Quirimbas Archipelago as a medium- to high-end tourism destination;					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Illumination will be designed on permanent facilities with the objective to reduce light glow while meeting workplace health and safety, and navigational requirements; - The use of non-reflective surface treatments.	Negative	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**7**		**Medium**	**7**

Impact: Halting effects on planned and future tourism developments in the Quirimbas Archipelago

Impact Assessment

Interviews with the various planned tourism development operators have shown that there is a fear from the tourist operators in the AII that the pristine, isolated image of the Quirimbas islands in the AII will be compromised with the FLNG Area 4 project. As reported by these operators, this fear has already resulted in the temporary halting of new investments for the five new lodges in development until more information on the impacts of the FLNG is obtained as well as the effects on the tourists are assessed. This fear will most likely persist at a diminishing rate during the drilling, installation and commissioning phase as these phases will see more activity, and as more information is obtained and a better perception is obtained on the real impacts to the individual tourist utility.

The impact is assessed as negative, *indirect*, of *local* extent since it will mainly affect tourism developments in the Quirimbas Archipelago. The impact would affect highly sensitive tourism operators given that the pristine environment is their only resource base, and a high number of operators given that all would be affected. The impact would have a medium duration given that it will most likely persist (however at a diminishing rate as information is obtained) until the first couple of years of operation of the FLNG.

Mitigation Measures

Mitigation measures for this negative impact are mainly around efficient and continuous communication.

- Include tourism operators in project's stakeholder mapping, with direct lines of frequent and informative communication of project activities, with emphasis on sea based activities and that can influence tourism in order to allow management of expectations from tourism operators and adaptive measures. It is recommended that these measures be implemented prior to project initiation activities considering the impact is already occurring.

Impact Assessment Summary

With the implementation of the proposed communication, it is expected that the concerns of the tourist operators will be diminished, lowering the importance of the perceived impact and number of elements (operators) affected. As such, the residual significance score is reduced to *low*.

Impact: Halting effects on planned and future tourism developments in the Quirimbas Archipelago					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Include tourism operators in project's stakeholder mapping, with direct lines of frequent and informative communication of project activities that are sea based and that can influence tourism.	Negative	
Type	Perceived			Perceived	
Duration	Medium	2		Medium	2
Extent	Local	1		Local	1
Importance	High	3		Low	1
No. of elements involved	High	3		Medium	2
Significance	**Medium**	**9**		**Low**	**6**

Impact: Stimulation of business tourism

Impact Assessment

Pemba, where the support logistic base for the FLNG project will be located, will see a significant increase in outside workers working for the FLNG and associated facilities throughout the life of the project, with a higher number of migrant workers during the drilling, installation, commissioning and operational phases. Employment numbers for these project phases are estimated at 820 during the operational phase and to peak at 1350 personnel (of which 280 for service contracts) during the initial project phases (drilling, installation and commissioning).

There is no information regarding the potential number of migrant versus Mozambican workers, but given the high level of skill required for the various activities, one can assume that the majority of the personnel will be hired from other places in Mozambique and outside. This increase in personnel will result that Pemba will see an increase in business tourism throughout the life of the project.

Further to this, it is expected that the support activities, to be developed in the logistic base in Pemba, will generate a significant effect of economic stimulation (see the following impact), given the supply services that will be required for the offshore FLNG. This will result in a greater number of business opportunities, including the expansion of existing companies and the creation of new companies, which will also increase the number of business tourist visiting Pemba.

The increase in business tourism from personnel working in the FLNG and from the regional economic stimulation effect will likely result in an increase in new types of accommodation and expansion of existing ones in Pemba City, to accommodate this new wave of tourists throughout the life of the project is expected.

1. Drilling, Installation and Commissioning Phases

This impact is considered to be *positive* and *indirect*, of *medium* duration, of local extent and *medium* importance (as it depends on the accommodation that contractors and company personnel will use) and affecting a *high* number of individuals and enterprises (potentially all adequate accommodation options in the area), resulting in an impact of *medium* positive significance.

Enhancement Measures

No enhancement is required for this positive impact. However, the overall effect on the tourism industry is still unpredictable with many potential impacts leading to positive effects and others leading to negative effects without a clear view if the positive outcomes outweigh the negative outcomes. As such, it is recommended that 1) the impacts to the tourism industry are monitored throughout the project (including cumulative impacts) and 2) tourism operators, particularly in more sensitive areas like island tourism operators are engaged and informed of project activities in a continuous manner, and 3) their grievances properly recorded.

Impact Assessment Summary

Impact: Stimulation of business tourism – Drilling, Installation and Commissioning Phases					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- No enhancement required.	Positive	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Local	1		Local	1
Importance	Medium	2		Medium	2
No. of elements involved	High	3		High	3
Significance	**Medium**	**8**		**Medium**	**8**

2. Operational Phase

This impact is considered to be positive and indirect, of critical duration (throughout the project's life cycle), local extent and medium importance (as it depends on the accommodation that contractors and company personnel will use) and affecting a high number of individuals and enterprises (given the high economic stimulation effect which will be generated by the FLNG, due to the high number of supply and support services required), resulting in an impact of high positive significance.

Impact Assessment Summary

Impact: Stimulation of business tourism – Operational Phase					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- No enhancement is required	Positive	
Type	Indirect			Indirect	
Duration	Critical	4		Critical	4
Extent	Local	1		Local	1
Importance	Medium	2		Medium	2
No. of elements involved	High	3		High	3
Significance	**High**	**10**		**High**	**10**

Impact: Economic stimulation effect on local and regional services

Impact Assessment

The implementation of the FLNG project will create a direct and indirect stimulation of the local and regional economy, mostly related to the following:

- The procurement of services, goods and materials needed for both the drilling and installation phases and the operational phase, with a greater emphasis on the latter. The FLNG will require stationing a significant workforce in the offshore vessel (estimated to be a total of 320 people, working in shifts), which will need to be continuously supplied with goods and services. Although it is likely that some specialized services will need to be sourced at national or international levels (as they may not available locally), many goods and services will be procured locally;
- The logistic base in Pemba, which will lodge all support services (such as the marine terminal, maintenance workshop, offices, training centre, logistic facilities, etc.) and which is estimated to directly employ 150 people, will also generate a relevant increase in the demand for goods and services, such as in the hotel and food industry;
- And lastly, the increased income of the hired workforce will lead to an increase of levels of consumption, both by the personnel of the logistic base and the offshore personnel, in the periods where they are stationed onshore.

These effects will lead to an increase in demand for consumer products, goods and services. This greater demand will develop the local markets, benefiting the local and provincial economies, stimulating the creation of businesses and jobs, increasing tax collection and increasing the revenue of families and individuals, which will in turn generate additional indirect economic positive impacts.

1. Drilling, Installation and Commissioning Phases

During the initial project phases, this impact is considered to be *positive* and *indirect*, of *medium* duration, of *regional* extent and *medium* importance and affecting a *high* number of individuals and enterprises, resulting in an impact of *medium* positive significance.

Enhancement Measures

Even though a significant positive impact is already expected, some enhancement measures can be developed to increase the local and regional economy stimulation, namely:

- The procurement of goods and services should give priority to sourcing from the local and provincial markets, whenever possible. To the effect, it is recommended that EEA:
    - Identify the goods and services required by the project that can be supplied locally and encourage and support local companies in the production and supplying of these goods and services;
    - Timely disclose information regarding the types of goods and services that will be required, to enable local entrepreneurs the possibility of training, improvement of skills and services to offer;
- Develop empowerment and training initiatives directed at small and medium sized local businesses, in coordination with relevant governmental institutions and businessmen associations, to increase the development of local and regional companies' capabilities to provide quality services and goods, so as to take advantage of the commercial opportunities being created by the project.

Impact Assessment Summary

With the implementation of the proposed mitigation, the importance of the impact will increase, resulting in a enhanced positive impact of *high significance*.

Impact: Economic stimulation effect on local and regional services – Drilling, Installation and Commissioning Phases					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- The procurement of goods and services should give priority to sourcing from the local and provincial markets, whenever possible; - Small and medium sized local businesses should get involved in empowerment, training and providing of quality services so as to take advantage of the commercial opportunities being created by the project.	Positive	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Regional	2		Regional	2
Importance	Medium	2		High	3
No. of elements involved	High	3		High	3
Significance	**Medium**	**9**		**High**	**10**

2. Operational Phase

During the operational phase, this impact will be even more relevant, given the greater needs of goods and services that will be required to supply and support the offshore activities and personnel. During this phase, this impact is considered to be positive and *indirect*, of *critical (very long term)* duration (throughout the project's life cycle), *regional* extent (as it is expected that the increased demand for goods and services will affect not only Pemba, but stimulate the creation of companies and the production of goods at a regional level), of *medium importance* and affecting a *high number* of companies and enterprises, resulting in *high significance*.

Enhancement Measures

The same enhancement measures proposed above are also applicable to the operational phase.

Impact Assessment Summary

The proposed mitigation will increase the impact's importance, although that does not change the significance of the enhanced positive, which remains *high*.

Impact: Economic stimulation effect on local and regional services – Operational Phase					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- The procurement of goods and services should give priority to sourcing from the local and provincial markets, whenever possible; - Small and medium sized local businesses should get involved in empowerment, training and providing of quality services so as to take advantage of the commercial opportunities being created by the project.	Positive	
Type	Indirect			Indirect	
Duration	Critical	4		Critical	4
Extent	Regional	2		Regional	2
Importance	Medium	2		High	3
No. of elements involved	High	3		High	3
Significance	**High**	**11**		**High**	**12**

Impact: Economic impact on commercial fisheries

Impact Assessment

Potential impacts on commercial fishing activities will be a consequence of the safety zones imposed which could lead to reduced catches and hence reduced sales/income and revenue. This is only likely to affect commercial fisheries given that project safety zone (3.7 km around the FLNG vessel), as well as the areas of influence of noise (~700 m from noise source) and illumination (~90-100m from illumination source) from project activities are confined to the offshore environment, where artisanal fisheries do not operate. .

The loss of revenue to commercial fisheries is a *direct* impact due to the loss of access to potential fishing grounds located within installation and drilling areas as well as within the FLNG site and its respective safety zone (radius of 2 nm or 3.7km). The impacts on commercial fisheries were assessed in the Fisheries section above (see section 7.4.1), including the effects of loss of access to fishing grounds and potential decreases in catches, with no high significance impacts having been identified (impacts rated as medium to low). As such, the economic impact on commercial fisheries is also not expected to be of high significance.

1. Drilling, Installation and Commissioning Phases

During the initial project phases, this impact is considered to be *negative*, *direct*, of *medium* duration, of *low* extent and *medium* importance and affecting a *low* number of fishing vessels, resulting in an impact of *low* significance.

Mitigation Measures

The proposed mitigation measures by the fisheries study should be implemented, such as the establishment of appropriate communication channels with relevant fishing associations and institutions, providing information on the Project spatial usage, and the implementation of a detailed communication plan with fishing operators and vessels, in partnership with the National and Provincial Fisheries Administrations.

Impact Assessment Summary

Impact: Economic impacts on commercial fisheries – Drilling, Installation and Commissioning Phases					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Establishment of appropriate communication channels with relevant fishing associations and institutions, providing information on the Project spatial usage. - Implementation of a detailed communication plan with fishing operators and vessels, in partnership with the National and Provincial Fisheries Administrations.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**6**		**Low**	**5**

2. Operational Phase

During the operational phase, the impact assessment is the same, but the duration will be of *very long term*, increased the impact's significance to *medium*.

Mitigation Measures

The mitigation measures proposed for the drilling and installation phase are also applicable to the operational phase.

Impact Assessment Summary

The proposed mitigation lowers the impact's importance, but the residual significance remains as *medium* given that the impact is of *very long term*.

Impact: Economic impacts on commercial fisheries – Operational Phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Establishment of appropriate communication channels with relevant fishing associations and institutions, providing information on the Project spatial usage. - Implementation of a detailed communication plan with fishing operators and vessels, in partnership with the National and Provincial Fisheries Administrations.	Negative	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**8**		**Medium**	**7**

Impact: Influx of workers into the Area of Indirect Influence

Impact Assessment

As stated above, the FLNG project will need the following number of personnel:

- Operation and maintenance phase will see approximately 820 of personnel;
- In the drilling, installation and commissioning phases a peak of 1350 personnel (of which 280 for service contracts) is foreseen.

Even though the onshore support facilities are outside of the scope of this EIS, it was assumed that impacts related to the influx of workers will manifest mainly in Pemba, as that is where the logistic base is planned to be implemented. However, it is also possible that issues related to influx of work-seeking people are experienced in Palma, although of lesser intensity. Given that in the project region formal employment is scarce (with Palma Village having very little formal employment opportunities) talks of the FLNG project may attract an influx of migrant workers seeking employment to Palma, that erroneously assume that the Project will generate job opportunities in Palma, due to EEA's presence there. A detailed assessment should be carried out once onshore facilities have been identified and adequately described.

Even though there is no data regarding estimates of numbers of migrant workers seeking employment, past experience has shown that this migration can put significant pressure in the functioning of already distressed community structures such as health and education structures and police services. In addition, this influx can result in an increase in the overall cost of basic goods and services as land becomes scarcer and more expensive, and demand for food, charcoal, basic goods, among others outweighs supply.

Furthermore, influx of workers (mainly men in a productive age) can lead to an increase in community conflicts (increase in crime and security issues) as well as an increase in sexual transmitted infections (ITDs and HIV/AIDS) - impact assessed separately, see Section 7.4.4.3.

This impact if unmanaged is considered to be *negative*, *indirect*, of *medium* duration (the attraction effect from the FLNG on migrant workers will manifest itself mainly in the first years of activity, when the project is a new presence in the region and its workforce needs are not well known by the communities) and *local*.

However, the offshore location of the project may deter migrant workers from coming into Pemba or Palma, thereby affecting a *low* number of people. The impact is thus of *medium* significance prior to mitigation

Mitigation Measures

Given that the impact of the influx of migrant workers to host communities is an indirect impact of project activities, it is broad and outside the company's control, this study will not provide hard commitments but will provide recommendations for the company to monitor potential impacts and focus their corporate social responsibility activities in areas that will help decrease some of the pressure resulting from the influx.

As such, it is recommended that EEA should focus their monitoring and corporate social responsibility activities, in Pemba City and Palma Village in particular. It is further recommended that EEA have continuous communication with key social structure of the communities, particularly in Palma village, to clarify the real job opportunities created by the Project and to better understand their current needs and monitor any increase in demand on these structures.

Finally, it is recommended that EEA prepare a community development plan with the aim of alleviating some of the pressure potentially caused by influx of workers as well as actions that have a direct impact on creation of economic activities. This should be done in collaboration with local authorities.

Some examples of potential areas of improvement include

- Improvement of food security through improvement of existing livelihood strategies;
- Introduction of new livelihood strategies;
- Improvement of health structures (quality and quantity);
- Improvement of education structures (quality and quantity);
- Identification of other key infrastructures for improvement of community lives (e.g. boreholes, sanitation programs, waste management, etc.).

Impact Assessment Summary

Impact: Influx of workers into the Area of Indirect Influence					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Communication plan with key relevant social structures (Education, health) on current obstacles and increases in pressures; - Community development plan.	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Medium	2
Extent	Local	1		Local	1
Importance	High	3		Medium	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**7**		**Low**	**5**

Impact: Increased community expectations

Impact Assessment

In addition to the influx of workers, the mere fact that the FLNG project exists creates community expectations regarding potential employment opportunities and community benefits from the project. These expectations are a product of the social and economic context that is described in the baseline assessment,

such as low level of education, lack of knowledge and understanding of the project's activities, over-stressed community structures, low formal employment, and diminished government capacity to provide adequate supply of basic services. Community expectations can be further exacerbated by hearsay from other communities, unfounded fears, and an historical dependence on aid. Unmanaged high community expectations can have a negative impact on project activities and company reputation.

This impact if unmanaged is considered to be *negative*, *direct*, *critical*, *local*, of *high* importance and reaching *great* numbers. The impact is thus of *high* significance prior to mitigation.

Mitigation Measures

In order to manage community expectations, it is recommended that EEA undertakes the following:

- Elaborate a stakeholder mapping and strategy and a respective communication plan for the communities. This will allow the company to identify who the key and influential stakeholders are; it will allow the company to start developing a trust based relationship; and will allow for a smother communication flow between the company and the communities.
- Elaborate and disseminate a local recruitment plan using local structures for local recruitment, local language and taking into account low level of education of the recipient audience. Ensure consistent and continuous information regarding the level of employment the company is seeking. In the communication to the public, and interested parties, clearly state the available job opportunities and type of skills required to avoid creating unreal expectations. Specify the number of low skilled people the project is seeking per task/phase of the project and provide examples of what this means within the total population of the recruitment source. E.g. "During this phase of drilling, the project is seeking to employ 55 low skilled people from the community that have basic skills in welding, mechanic, carpentry (or none at all) – Given the numbers of people in this community, this means that only 1 family in 10 will have one member working for the project".
- Provide contractors with training in recruitment messaging and procedures to ensure consistency in the employment message provided to communities.
- Elaborate and disseminate a community grievance mechanism. The grievance mechanism will also allow the company to receive early indication of unfounded fears and unmet expectations and deal with them accordingly through their communication plan.

Impact Assessment Summary

Impact: Increased community expectations					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Stakeholder engagement plan and communications plan; - Community grievance mechanism; - Training plan on recruitment message and procedures to contractors; - Elaborate a local recruitment plan adapted to the local context.	Negative	
Type	Direct			Direct	
Duration	Critical	4		Low	1
Extent	Local	1		Local	1
Importance	High	3		Medium	2
No. of elements involved	High	3		Medium	2
Significance	**High**	**11**		**Low**	**6**

Impact: Employment generation

Impact Assessment

The project proponent will provide employment through direct employment to the company and via contractors which can be either national or international. The provision of employment will occur throughout the entire life of the project, with the exception of the decommissioning phase, and will peak during the drilling, installation and commissioning phases (~1350 workers) which are temporary activities. At the operational phase, the total number of workers is expected to be 820.

Some of these workers will require low to medium skilled labor, and staff will need to be trained on the specifics of the work. Employment will occur with a combination of training of new skills that can be later used for the development of other businesses or improvement of existing ones, as well as the personal development of the employee making them more attractive to other industries.

Given that the number of workers required varies substantially during the drilling, installation and commissioning phases and the operational phase of the project, the employment generation impact has been assessed separately below for these two project phases.

1. Drilling, installation and commissioning Phases

The employment and associated training is considered to be of medium significance during these project phases. It is a positive direct impact with a medium duration (up to 5 years) and likely to be felt at the national scale (as services and workers are expected to be drawn from different places in Mozambique), of medium importance and involving a medium number of elements (i.e., ~1350 workers in the context of available employment opportunities both locally and nationally).

Enhancement Measures

Whilst this impact does not require enhancement measures, it is recommended that the company elaborate a recruitment plan with clear steps to ensure a trickle down of skills in phases, giving priority to national employees: first to national citizens, secondly to provincial citizens and thirdly to local citizens. It is further recommended that this recruitment policy and plan include a non-discriminatory clause and a focus on gender.

Impact Assessment Summary

Impact: Employment generation – Drilling, Installation and Commissioning Phases					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- Recruitment policy and plan with a long term vision of skill trickledown effect.	Positive	
Type	Direct			Direct	
Duration	Medium	2		Medium	2
Extent	National	3		National	3
Importance	Medium	2		Medium	2
No. of elements involved	Medium	2		Medium	2
Significance	**Medium**	**9**		**Medium**	**9**

2. Operational phase

Impact Assessment

The operational phase will see a reduction in employment opportunities (from 1350 to 820), with this employment likely to be highly specialized but with a few opportunities for Mozambicans, at least during the first years of project operation, before national workers can be trained to occupy technical and specialized positions. The number of job positions occupied by national workers is expected to increase gradually throughout the operational phase, as job training and skill transfer is developed. The impact is assessed as *medium* significance, given its *critical duration* (i.e. for the entire duration of the project), but involving a *low* number of elements at a national scale.

Mitigation Measures

The same measures identified above for the drilling, installation and commissioning phases are also applicable to the operational phase.

Impact Assessment Summary

Impact: Employment generation – Operational Phase					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Positive		- Recruitment policy and plan with a long term vision of skill trickledown effect.	Positive	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	National	3		National	3
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Medium**	**9**		**Medium**	**9**

Impact: Transfer of work and technical skills to national labor

Impact Assessment

The FLNG project will introduce new technologies and industrial processes to the Mozambican industry. Both the drilling and installation phase and the operational phase will require highly specialized workers. During the drilling and installation phase, given its short duration, it is likely that most of the specialized work will be sourced internationally. This is also likely to happen during the first years of operation, as currently the specialized skills required to operate the LNG unit do not exist in the national labor market.

However, as the FLNG will remain in operation for at least 25 years, it is expected that national workers will be continually trained to perform the specialized activities, gradually reducing the need for expatriate workers and transferring the specialized skills and knowledge to the national workforce. This will result in a transfer of know-how and skills to the national workforce market, which will enhance the nation's capacity of developing similar projects in the future.

1. Drilling, Installation and Commissioning Phases

During the initial project phases, this impact will be less relevant. As the drilling and installation phases are *medium* term activities only, the required specialized skills will likely be sourced from the international market, through the procurement of dedicated vessels with full crews and with not enough time to transfer

the needed skills to local labor. During this phase, this impact will be *positive* and *direct*, but of *local* extent (it is possible that some local unskilled labor will be contracted to support the drilling and installation activities), *low* importance and affecting a *low* number of workers, resulting in an impact of *low* positive significance.

Enhancement Measures

During the drilling, installation and commissioning phases, little enhancement is possible in what regards skill transfer, given the short duration of these activities. Nevertheless, it is still recommended the contractors implement training activities to any national worker employed during these phases, namely:

- Provide technical training programs for unskilled workers, with the objective of improving their jobs;
- Provide environmental, health and safety training to all workers.

Impact Assessment Summary

The proposed enhancement will increase the impact's importance, but not enough to increase the rating of the enhanced impact, which will remain *low.*

Impact: Transfer of work and technical skills to national labor - Drilling, Installation and Commissioning Phases					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- Provide technical training programs for unskilled workers, with the objective of improving their jobs; - Provide environmental, health and safety training to all workers.	Positive	
Type	Direct			Direct	
Duration	Medium	2		Medium	2
Extent	Local	1		Local	1
Importance	Low	1		Medium	2
No. of elements involved	Low	1		Low	1
Significance	**Low**	**5**		**Low**	**6**

2. Operational Phase

During the operational phase, this impact will be much more relevant. Given the duration of the FLNG operation, it is expected that skills and technical knowledge will be gradually transferred to the national workforce, increasing Mozambique capabilities in the LNG industry. During this phase, the impact will be *positive*, *direct*, of *critical (very long term)* duration (throughout the project's life cycle), *national* extent (as it is expected that technical and skilled national workers will be hired at a national level), of *medium importance* and affecting a *medium number* of workers, resulting in *high significance*.

Enhancement Measures

During the operational phase, it is recommended that EEA develop a Training and Skill Transfer Program, with a long term vision of skill trickledown effect. The goals of this program should be to:

- Train national workers to occupy positions at all levels of the FLNG operations, including technical, engineering and managerial;
- Gradually reduce the need for expatriate workers in the FLNG operations;
- Strengthen Mozambique's LNG industry, by training a specialized and skilled national workforce.

Impact Assessment Summary

The proposed mitigation will increase the impact's importance, although that does not change the significance of the enhanced positive, which remains *high*.

Impact: Transfer of work and technical skills to national labor - Operational Phase					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- Develop a Training and Skill Transfer Program, with a long term vision of skill trickledown effect.	Positive	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	National	3		National	3
Importance	Medium	2		High	3
No. of elements involved	Medium	2		Medium	2
Significance	**High**	**11**		**High**	**12**

Impact: Revenues at the Provincial and National level

Impact Assessment

The FLNG project will result in revenue to the Provincial and Central Government through the form of taxes (including income tax from workers), throughout the life of the project (with the exception of the decommissioning phase). The level of this revenue and the impact to state budget will depend on the taxation arrangements agreed with the Government. The exported gas sales will also significantly contribute to national revenue, given that the state is a partner in the project, throughout the operational phase. This impact can be considered to be *positive*, of *critical duration* (operational lifespan), of *national* extent and of medium importance, resulting in a high significance.

Enhancement Measures

No enhancement measures are applicable.

Impact Assessment Summary

Impact: Revenue to the provincial and central governments					
Criteria	**Pre-mitigation assessment**		**Key Enhancement**	**Post-mitigation assessment**	
Nature	Positive		- No enhancement is applicable.	Positive	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	National	3		National	3
Importance	Medium	2		Medium	2
No. of elements involved	Medium	2		Medium	2
Significance	**High**	**11**		**High**	**11**

7.4.2.3 Decommissioning Phase

Impact: Loss of employment opportunities, revenue to local businesses and Government due to decommissioning

Impact Assessment

Most of the impacts mentioned in the previous subsections above will occur during all phases of the project. However during the de-commissioning phase, activity will increase as the dismantling of the project takes place and the area will see an increase in a number of vessels active in the Concession Area 4. The main activities that could generate impacts on the social, cultural and economic aspects of the communities in the AII during the de-commissioning phases of the Project are related mainly to the loss of employment and some outflow of workers to other areas.

This will have a negative impact on the economy of the AII, as employment will be terminated and purchasing power of the communities will be diminished. Indirect impacts of this decrease of purchasing power and loss of customers could include a reduction of revenues. The loss of employment whilst resulting in a lower purchasing power for the employees will not have a high localized effect, as most employees will come from all around Mozambique and will likely return to their homes. In addition, these ex-employees will have received training of new skills (including the less specialized workers) which will allow them to be more competitive in the local/national job market.

The Government of Mozambique will also lose an important source of revenue which will potentially have implications to the allocation of the state budget.

Social and economic impacts in the decommissioning phase are dependent on the degree of dependency of the communities to the project with a high degree of dependency resulting in a highly significant negative impact and a low degree of dependency resulting in a low significant negative impact, as other industries and formal employment options absorb the impact of losing an industry and related employment.

Given the lack of knowledge of this dependency at this stage of this study, the assessment of the degree of dependency to the project resulting from the decommissioning will not be further elaborated and it is recommended that the project undertake an economic impact and dependency study two years prior to decommissioning that will provide more specific and focused recommendations to mitigate any potential impacts unforeseen in this study resulting from this phase.

The combination of loss of employment, loss of revenue to existing business and more importantly the loss of revenue to the Government, results in a significant negative impact of the project. While this direct impact is likely to be felt at the national level given impacts on government revenue and loss of employment opportunities, the number of elements involved is assessed as medium (given the average number of employment offered by the project during operation), with a medium resilience given that it is expected that with training, workers will have better future employment opportunities and therefore able to adapt to changes. Likewise it is expected that by the time the project is decommissioned, Government would have reinvested part of revenue as well as have other sources of similarly important revenues, thereby decreasing its dependency on the FLNG project.

Mitigation Measures

Given the significance of this impact is assessed as high prior to mitigation due to the permanence of the decommissioning, the following mitigation should be applied namely:

- Undertake an economic impact and dependency study two years prior to decommissioning with more specific recommendations for impact mitigation.

Impact Assessment Summary

Impact: Loss of employment opportunities, revenue to local businesses and Government due to decommissioning					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Undertake an economic impact and dependency study two years prior to decommissioning with more specific recommendations for impact mitigation.	Negative	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	National	3		National	3
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Low	1
Significance	**High**	**11**		**Medium**	**9**

7.4.2.4 Unplanned Events

Impact: Effects of potential gas blowouts on livelihoods of fishermen

Impact Assessment

The gas blowout is the uncontrolled release of natural gas from a gas well after pressure control systems have failed. This usually occurs during drilling but can also occur during production. The gas fluid may ignite from an engine spark or other source of flame. They can destroy rigs and kill nearby workers. Blowouts may take days to months to cap and control. During a blowout, the main gas is methane. Fortunately, significant improvements in technology with well control techniques, and personnel training have reduced the likelihood of blowouts and spills significantly and these are considered quite rare.

In the unlikely case of a blowout or a gas leak the short term increase in fish mortality might be expected around the well due to the increase of methane in the water. Researchers conducted detailed observations after accidental gas blowouts on drilling platforms during summer-autumn of 1982 and 1985 [GLABRYBVOD, 1983; AzNIIRKH, 1986] showed a cause-effect relationship between mass fish mortality and large amounts of natural gas input into the water after the accidents. There is however very little data on the environmental impacts of gas blowouts as the amount of gas leaked is difficult to estimate and the gases are quickly assimilated by the marine environment or lost to the atmosphere. Once Methane is dissolved, it is then eaten by bacteria. However and despite the lack of research, observations by Patin (1999) have shown that gas can rapidly penetrate organisms through their gills, disturbing their functional systems and leading to poisoning.

However, the impact of any accident of this nature tends to be localized to the vicinity of the accident. Given the FLNG is an offshore facility located at a significant distance from the coastline (50km) and the nearest island (~46km), combined with the highly adaptable nature of fishermen (as they can avoid the accident areas and fish in different areas); it is highly unlikely that any accidents from the FLNG and its subsea facilities will have any significant impact on the artisanal fishermen and their livelihoods.

The effects of gas blowouts on commercial and artisanal fishing, livelihoods of artisanal fishers or first order fish traders are assessed as a *negative* impact, *indirect*, *low* duration, *local* and of *low* importance, affecting little if any numbers of people, thus resulting in a *low* significance.

Mitigation Measures

- Train personnel in well-control programs so that they can spot the signs and react accordingly
- Conduct an appropriate risk assessment

Impact Assessment Summary

Impact: Effects of gas blowouts on livelihoods of fishermen					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Train personnel in well-control programs so that they can spot the signs and react accordingly - Conduct an appropriate risk assessment	Negative	
Type	Indirect			Indirect	
Duration	Low	1		Low	1
Extent	Local	1		Local	1
Importance	Low	1		Low	1
No. of elements involved	Low	1		Low	1
Significance	**Low**	**4**		**Low**	**4**

Impact: Effects of oil spills and leaks on livelihoods of fishermen and coastal communities

Impact Assessment

In addition to a potential gas blowout discussed above, offshore facilities could result in spills due to leaks, equipment failure, accidents, or human error. ERM (2014b) conducted oceanographic studies to model the effects of potential spills and leaks. Results of this modeling exercised showed that a diesel spill (due to a vessel collision) would travel along the Cabo Delgado and Nampula Provinces (if no efforts are done to contain it) and that the probability of the spill reaching Tanzania would be less than 10%. This would largely depend on the winds and currents at the time of the spill.

If it were to occurs, spills could potentially result in:

- Disruption of recreational activities (tourism) including not only swimming but recreational fishing, diving, snorkeling, sightseeing, cetacean watching, among others. While normal activities would resume once the area is cleaned up, long term economic impacts could prevail due to public perceptions of prolonged and wide scale pollution, with tourists choosing other destinations other than northern Mozambique. This would also affect the image of the Quirimbas Archipelago as a pristine environment.
- Damage to fisheries – damage to fisheries would depend on the characteristics of the spills and type of fishing activity affected. Local physical characteristics would also play a role in determining the range and extent of economic impacts but could potentially be felt by commercial all way to artisanal fishing (including collectors using intertidal areas).
- Effects on human health through direct inhaling and touching oil products and eating contaminated seafood and;
- Economic impacts would be associated with cleaning-up costs.

Mitigation Measures

- In case of spills, the company should ensure rapid detection and containment. As such, it is recommended that guidelines for release prevention, and control planning are provided in the company general's EHS guidelines including the requirement to develop a spill prevention and control plan. In addition, conduct a spill risk assessment for the offshore facility and support vessels.
- Implement all mitigation measures outlined in Section 7.2.4.4, namely for Impact: Risk of seawater quality degradation resulting from accidental diesel spills due to vessel collisions

Impact Assessment Summary

Impact: Effects of spills and leaks on livelihoods of fishermen and coastal communities					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- In case of spills, the company should ensure rapid detection and containment. As such, it is recommended that guidelines for release prevention, and control planning are provided in the company general's EHS guidelines including the requirement to develop a spill prevention and control plan. In addition, conduct a spill risk assessment for the offshore facility and support vessels. - Implement all mitigation measures outlined Section 7.2.4.4	Negative	
Type	Indirect			Indirect	
Duration	Medium	2		Low	1
Extent	International	4		Regional	2
Importance	High	3		Medium	2
No. of elements involved	High	3		Medium	2
Significance	**High**	**12**		**Medium**	**7**

7.4.3 Marine Navigation

7.4.3.1 General Considerations

Following the marine navigation baseline assessment (see Volume I), this section assesses the potential project impacts on marine navigation.

The main project impacts on marine navigation are associated with interference and risks of collision due to (i) increased maritime traffic and (ii) reduction in the navigation space. While the same impacts are expected to occur during all project phases, impact assessment has been grouped in the following two stages: (1) drilling and installation, commissioning and decommissioning; and (2) operational phase. The latter has been assessed separately mainly due to its duration.

As stated in the baseline assessment, the Mozambique Channel - where Area 4 is located - is an important navigation route for various types of shipping. It is estimated that approximately 1500 vessels per year move through or near Area 4, which can be potentially affected by project implementation.

7.4.3.2 Potentially Impact Generating Project Activities

The main project activities likely to result in impacts on existing navigation in the area include:

- Movement and presence of drilling rig, vessels, tankers and the FLNG facility in Concession Area 4 - which will be a source of maritime risks (e.g. collision) to the normal maritime traffic in the area; and
- Promulgation of safety zones around the drilling, installation and support vessels and FLNG facility – which will lead to densification of maritime traffic in the remaining navigation zones and a consequent increase in the probability of maritime accidents.

7.4.3.3 Drilling, Installation, Commissioning and Decommissioning phases

Impact: Interference and collision risks due to increased maritime traffic and reduction in navigation space

Impact Assessment

The slow movement and presence of drilling, pipe-laying, supply and construction vessels in Concession Area 4 will interfere with and be a source of maritime risks to the normal maritime traffic in the area.

The navigation speed of vessels passing through this area would normally be between 10 knots and 15 knots. Maritime vessels are reasonably sluggish with respect to course correction, the more so with vessels of larger mass such as laden Very Large Crude Carriers (VLCCs). The presence of slow-moving or stationary Project vessels in the navigation lane would lead to a higher probability of collision between vessels than would be the case for vessels moving in the same or opposite directions, such as in navigation channels. Vessel collisions may lead to human casualties or injuries, material damage, cargo losses and fire, and environmental pollution (the latter especially when tankers are involved).

During drilling and installation phase of the Project, about 1 500 maritime vessels per year will move through the Rovuma Basin (Section 6.7.4, Volume I). This means on average about 4 vessels passing per day or one vessel passing every six hours. Although this is a very low intensity of shipping, there will still be a (small) probability of vessel collision. This probability will be influenced by the applied maritime warning systems and measures on the Project vessels.

Although the probability of occurrence of vessel collisions is generally very small, the consequences of such an event can be very serious. Such consequences can be ship damage and disability, cargo losses, loss of life or personal injury, gas or oil pollution with environmental damage and a fire or and loss of production. This not only relates to the Project vessels but also to third party vessels and therefore the impacts that can lead to such consequences should be assessed as part of the EIS. Most maritime accidents, where besides the own ship often a third party ship is involved, can be ascribed to human error and therefore a high level of training of maritime project staff is required to obtain maximum safety from the side of the project operator.

The promulgation of safety zones of 2 nm radius around the stationary drilling and installation vessels in Concession Area 4 is an appropriate safety measure against collisions. However, it will have the impact of reducing the navigation area for remaining vessels, requiring a course correction for those passing vessels that are on a course through the safety zone. They will now have to pass on either side of a safety zone.

Baseline conditions indicate that the maneuvering width for vessels sailing through the Rovuma Basin is about 40 nm. If the 4 passing vessels per day during the drilling and installation phase would be equally distributed over this available navigation width, the density of the maritime traffic would be one vessel navigating per 10 nm width per day. If a safety zone of 2 nm radius or 4 nm diameter would be promulgated, this area will then not be available for navigation. The safety zone around the Project vessels will, therefore, reduce the navigation lane width in the Rovuma Basin from about 40 nm to 36 nm, i.e. by 10%.

This implies that the shipping intensity in the remaining navigation lanes would on average increase by also 10%, which in turn could lead to a higher risk of collision. It can be expected that the maximum effect will be an increase in shipping intensity of 40% just outside the safety zone (one vessel passing per 10 nm per day to one vessel passing per 6 nm per day), since vessels on a course through the safety zone will aim to deviate as little as possible from their original course. It will be clear that this impact on maritime shipping of the baseline intensity will be very limited.

The interference and collision risk due to increased maritime traffic and reduction in navigation space, during the drilling, installation, commissioning and decommissioning phases, is thus assessed as a *negative* and *direct* impact, of *medium* duration (restricted to the duration of these phases), of *low* extent (restricted to the safety zones around the stationary drilling and installation vessels), and of *medium* importance and number of affected vessels, resulting in a *medium* significance.

Mitigation Measures

Concerning continuous safe maritime navigation in the Rovuma Basin, the following standard maritime measures should be applied:

- Stay up to date on the latest safety guidelines and regulations of maritime organizations like IMO and IALA and apply these. Liaise regularly with the relevant Mozambican authorities (especially INAHINA and INAMAR) about safety standards for the Project vessels and their operations;
- Ascertain that the Aids to Navigation on the Project vessels are modern, adequate and adhere to the most recent guidelines of IMO (including SOLAS) and IALA, in close cooperation with INAHINA. Install proper maritime warning systems on all (semi-)stationary Project vessels, including radar reflectors, lights and fog horns;
- Maintain all maritime equipment on board the Project vessels in excellent working condition;
- Follow the proposed project measure to promulgate a safety zone of 2 nm radius around all (semi-) stationary Project vessels and, in addition, indicate a relevant warning on the nautical charts of the area (through INAHINA and the UK Hydrographic Office);
- Issue a *Notice to Mariners* through INAHINA about the drilling and installation activities;
- Ascertain that the maritime staff on the Project vessels is well trained and skilled in carrying out their responsibilities. Training must encompass both routine ship handling as well as emergency procedures such as detection and responses to spills or fires;
- Perform continuous watch keeping on the bridge of the Project vessels, monitor approaching vessel traffic and issue radio warnings if such a vessel would be on a (near-)collision course or on a course through the promulgated safety zone; and
- Keep a log book on critical maritime situations, evaluate these regularly and recommend ways to reduce maritime risks. Provide regular feed back to the Mozambican authorities about the maritime conditions around the Project vessels.

For additional safety, the following measures should also be considered.

- Deploy radio beacons at 5 nm north and south of the area of operation to provide additional warning to approaching vessels;
- Install an automated collision warning system on the Project vessels which issues a strong horn signal in case an approaching vessel is with a distance of 3 nm and on a (near-)collision course; and
- Support the Mozambican maritime authorities in their efforts of implementing maritime traffic separation or regulation for the Rovuma Basin, as this will be beneficial to the safety of the FLNG vessel and other vessels navigating in and through the area.

In addition, piracy threats should be monitored by liaising with the naval vessels in the area and providing armed response staff on the vessels to ward off hijackings. This will have a calming effect on the maritime traffic in the area as vessels will not have to sail in a “high alert” state with nervous crew and in this way indirectly mitigate maritime risks.

Impact Assessment Summary

The impact assessment summary is provided in the following table. The proposed mitigation will reduce the risk of vessel interference and collision, thus lowering the importance to low, resulting in a low significance residual impact.

Impact: Interference and risk of collision due to increased maritime traffic (drilling and construction vessels) and a reduction in the navigation space (due to safety zones)					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement all standard maritime measures; - Promulgate a safety zone of 2 nm radius around the stationary Project vessels; - Deploy radio beacons at 5 nm north and south of the area of operation; - Install an automated collision warning system on the Project vessels.	Negative	
Type	Direct			Direct	
Duration	Medium	2		Medium	2
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Medium	2
Significance	**Medium**	**7**		**Low**	**6**

7.4.3.4 Operational Phase

Impact: Interference and collision risk due to the presence and operations of the FLNG vessel, tankers and support vessels and reduced areas for navigation

Impact Assessment

The presence and operations of FLNG vessel will be a hindrance and source of maritime risks to the normal maritime traffic in the project area. The navigation speed of vessels passing through this area would normally be between 10 knots and 15 knots. Maritime vessels are reasonably sluggish with respect to course correction, the more so with vessels of larger mass such as laden VLCCs. The presence of a turret-moored FLNG vessel in the navigation lane would lead to a risk of collision with these passing vessels. Vessel collisions may lead to human casualties or injuries, material damage and fire, and environmental pollution (the latter especially when tankers are involved).

During the operational phase of the Project, up to about 4000 maritime vessels per year (in 2040) will move through the Rovuma Basin (see Section 6.7.4, Volume I). This means that at the end of the project lifetime on average about 11 such vessels will be passing per day or one vessel passing every two hours. Although this is a relatively low shipping intensity, there will still be a (small) probability of vessel collision, estimated to be once per 50 years (2% probability per year). This probability will be influenced by the applied maritime measures on the FLNG vessel.

The probability of vessel collision provided above is derived from a number of sources on shipping accidents, but in particular from a report done for Southampton Solent University entitled '15 years of shipping accidents: a review for WWF' (Butt *et al.*, 2013). Based on the analysis of data from Lloyd's Fairplay, IMO and others, it was concluded that about 150 maritime vessels are lost worldwide each year (fairly constant over the period between 1997 to 2011). Of these, 44 vessel were lost due to collisions over these 14 years, which means about 3 vessels per year lost worldwide due to a collision. Regional analysis reveals that along the East African Coast, 61 vessels were lost over these 14 years, which is 3.3% of the worldwide losses of vessels. If this same regional percentage (3.3%) is applied to the number of collisions,

this would mean that statistically, 0.1 vessel per year or one vessel per 10 years is lost due to a collision along the East African Coast. If it is assumed that about 20% of these accidents along the East African Coast occur in the Northern Mozambique Channel, this means that statistically one vessel per 50 years is lost due to a collision in or near the Rovuma Basin[17]. .

The impact of space reduction due to the presence of a stationary FLNG vessel in the navigation area and the required safety zone around it is an unavoidable consequence of the Project. The impact of space could be reduced by proclaiming a smaller safety zone, but this would have consequences on an increased probability of a collision, with loss of life, gas and oil spills, etc. A wide safety zone would lead to a lower probability of collision but a larger impact of space on navigation. A safety zone of 2 nm radius appears to be also in this case a good compromise between a reduction of navigation space (by about 10%) and safety. Without the safety zone, the probability of a collision between a navigating vessel and a project vessel may be once in ten years, but with the proposed safety zone this may reduce to a probability of once per 100 years. The support vessels used during operations (tugs, pilot boat and other mooring support vessels) will operate within this 2 nm safety zone.

It has been derived in Section 6.7.4 (Volume I) that the maneuvering width for vessels sailing through the Rovuma Basin in a north-south direction is about 40 nm. If the initially 4 passing vessels per day would be equally distributed over this available navigation width, the density of the maritime traffic would be one vessel navigating per 10 nm width per day. In 2040, this will have increased to 11 vessels passing per day and a shipping density of one vessel navigating per 3.6 nm width per day.

After a safety zone of 2 nm radius or 4 nm diameter has been promulgated, this area will not be available for navigation anymore. The safety zone around the FLNG vessel will, therefore, reduce the navigation lane width in the Rovuma Basin from about 40 nm to 36 nm, i.e. by 10%. This implies that the shipping intensity in the remaining navigation lanes would on average increase by also 10%. It can be expected that the maximum effect will be an increase in shipping intensity of 40% just outside the safety zone, since vessels on a course through the safety zone will aim to deviate as little as possible from their original course. These impacts on maritime shipping on the baseline of 11 vessels passing per day will be very limited.

It can be expected that the efforts to proclaim a *Marine Highway* in the Mozambique Channel (as discussed in Section 6.7.4 – Volume I) will continue and are likely to be realized during the lifetime of the project. These efforts would be stimulated by the gas exploitation developments in the Rovuma Basin. The realization of such a *Marine Highway* would structure the maritime traffic in a more orderly manner. Although directional traffic lanes would add further constraints to the navigation space, this would be beneficial for the safety aspects around the FLNG vessel.

The arrival of LNG tankers in ballast at the FLNG site and the merging of laden LNG tankers at departure from the FLNG location would be in a direction in line with the baseline traffic in the area (mainly north - south). Considering the low intensity of maritime traffic, even at the end of the project lifetime, and the fact that the tanker would be at low speed only in and near the safety zone around the FLNG vessel, this should not form a major source of additional maritime risk to passing vessels, if standard maritime operations are followed.

The interference and collision risk due to due to the presence and operations of the FLNG vessel, tankers and support vessels and reduced areas for navigation, during the operational phase, is thus assessed as a

[17] Please, note that this relates to one vessel lost after a collision. It is expected that more collisions with minor damage (i.e. no ship lost) would also occur.

negative and *direct* impact, of *critical* duration (during the operational phase, over 10 years), but of *low* extent (restricted to the safety zones around FLNG vessel), and of *medium* importance and number of affected vessels, resulting in a *medium* significance.

Mitigation Measures

Concerning continuous safe maritime navigation in the Rovuma Basin, the following actions should be taken by the Maritime Manager of the Project, as standard maritime measures (which are fairly similar to those listed in Section 7.4.3.3 above):

- Stay up to date on the latest safety guidelines and regulations of maritime organizations like IMO, OCIMF, SIGGTO, ISGOTT and IALA and apply these. Liaise regularly with the relevant Mozambican authorities (especially INAHINA and INAMAR) about safety standards for the FLNG and support vessels and their operations;
- Ascertain that the Aids to Navigation on the FLNG vessels are modern, adequate and adhere to the most recent guidelines of IMO (including SOLAS) and IALA, in close cooperation with INAHINA. Install proper maritime warning systems on the FLNG vessel, including radar reflectors, lights and fog horns;
- Install maritime warning systems on the FLNG vessel, including radar reflectors, lights and fog horns. Maintain all maritime equipment on board the FLNG vessel in excellent working condition;
- Promulgate a safety zone of 2 nm radius around the moored FLNG vessel and indicate a relevant warning on the nautical charts of the area (through INAHINA and the UK Hydrographic Office);
- Issue a *Notice to Mariners* through INAHINA about the presence of the FLNG vessel;
- Ascertain that the maritime staff on the FLNG vessel is well trained and skilled in carrying out their responsibilities. Training must encompass both routine ship handling as well as emergency procedures such as detection and responses to spills or fires; and
- Perform continuous watch keeping on the bridge of the FLNG vessel, monitor approaching vessel traffic and issue radio warnings if such a vessel would be on a (near-)collision course or on a course through the promulgated safety zone;
- Reduce the maritime activities around the FLNG vessel, or carry them out with more care, during the passing of a tropical storm or cyclone.

The maritime actions listed above should be minimum measures to ascertain safe navigation in the Project area. For additional safety, the following measures should be considered.

- Keep a log book on critical maritime situations, evaluate these regularly and recommend ways to reduce maritime risks. Provide regular feed back to the Mozambican authorities about the maritime conditions around the FLNG vessel;
- Stop shipping activities during the passing of a tropical storm or cyclone;
- Ascertain good communication between the pilot of vessels maneuvering to / from the FLNG vessel and the vessels sailing in the area;
- Deploy radio beacons at 5 nm north and south of the area of FLNG exploitation site to provide additional warning to approaching vessels;
- Install an automated collision warning system on the FLNG vessel which issues a strong horn signal in case an approaching vessel is with a distance of 3 nm and on a (near-)collision course;
- Monitor piracy threats, liaise with the naval vessels in the area and provide armed response staff on the FLNG vessel to ward off hijackings;

- Support the Mozambican maritime authorities in their efforts of implementing maritime traffic separation or regulation for the Rovuma Basin, as this will be beneficial to the safety of the FLNG vessel, LNG export tankers and other vessels navigating in and through the area; and
- Monitor vessel movements on board the FLNG vessel using the maritime Automatic Information System (AuIS). Install a shore-based Vessel Traffic Service (VTS) and operator office near Pemba to monitor and guide maritime traffic in the northern sector of the Mozambique Channel.

Impact Assessment Summary

The impact assessment summary is provided in the following table. The proposed mitigation will reduce the risk of vessel interference and collision, thus lowering the importance to low. This, however, does not lower the overall significance rating of the residual impact, which remains as medium (this is mainly due to the fact that the impact is of very high duration, which influences the significance score).

Impact: Interference and risk of collision due to the presence and operations of the FLNG vessel, tankers and support vessels and reduced areas for navigation in the Rovuma Basin due to the promulgation of a safety zone around the FLNG vessel					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Implement all standard maritime measures; - Deploy radio beacons at 5 nm north and south of the area of operation; - Install an automated collision warning system on the Project vessels; - Monitor piracy threats and liaise with the naval vessels in the area.	Negative	
Type	Direct			Direct	
Duration	Critical	4		Critical	4
Extent	Low	1		Low	1
Importance	Medium	2		Low	1
No. of elements involved	Medium	2		Medium	2
Significance	**Medium**	**9**		**Medium**	**8**

7.4.4 Health Environment

7.4.4.1 General Considerations

Following the health baseline assessment (see Volume I), this section assesses the potential project impacts on the health environment.

Although the FLNG facility will be located offshore, a few potential health impacts have been identified which are related to will be associated with an increased pressure on local health infrastructure and increased incidence of Sexually Transmitted Infections and HIV/Aids. These impacts will be felt in the AII of the project and are associated with increased employment opportunities in the region and associated expectations

As stated in the baseline assessment, health infrastructure in Mozambique in general and the study area in particular still present some deficiencies, in terms of infrastructure and resources.

7.4.4.2 Potentially Impact Generating Project Activities

The main project activities likely to result in health impacts are related to the expected Influx of people and their families into the region, with a resulting increased influx of users of health services and potential increase in the incidence of certain diseases.

7.4.4.3 Drilling, Installation, Commissioning and Operational phases

Impact: Increased pressure on existing health facilities

Impact Assessment

The presence of workers and their families in the region will result in a potentially higher influx of users to health services, in particular in Pemba City. An increase between 820-1350 people is expected in the area throughout project implementation, excluding family members of works and people who may be eventually attracted to the area looking for employment and other opportunities. In case of illness or accidents, EEA's staff will initially be conducted and assisted in the available public health services. Besides the lack of facilities, these health units have a reduced number of equipment and means of diagnosing, a small number of doctors, and have already shown to be inadequate to local population numbers.

The influx of people to the area may have impacts on health facilities, human resources and national health programs, and will contribute to the additional pressure on public health services. This pressure can bring worse medical care for local communities, as well as a deficient assistance to EEA's workers and their families.

It is expected that this negative impact will have a *regional* extension, *long* duration and affecting *critical* resources and a *high* number of elements, thus resulting in a *high* significance.

Mitigation Measures

The following measures are proposed, to be implemented by EEA:

- Provide an adequate health post with capacity for the diagnosis and treatment of common diseases (malaria, diarrhea, respiratory diseases) for its workers;
- Coordinate the use of existing health facilities with relevant authorities, and have means of transport to ensure the rapid transport of seriously ill patients to a hospital.

It is further recommended that, in straight collaboration with the Provincial Directorate of Health, identify potential areas for the improvement of health services at the Provincial, District or Municipal levels.

Impact Assessment Summary

Impact: Increased pressure on existing health facilities					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Provide an adequate health post with capacity for the diagnosis and treatment of common diseases (malaria, diarrhea, respiratory diseases) for its workers; - Coordinate the use of existing health facilities with relevant authorities, and have means of transport to ensure the rapid transport of seriously ill patients to a hospital.	Negative	
Type	Direct			Direct	
Duration	High	3		High	3
Extent	Regional	2		Regional	2
Importance	Critical	4		Low	1
No. of elements involved	High	3		Low	1
Significance	**High**	**12**		**Medium**	**7**

Impact: Increased incidence of Sexually Transmitted Infections (STI) and HIV/Aids

Impact Assessment

STI and HIV/AIDS are generally a concern in Mozambique: institutional capacity to prevent and treat these infections is still insufficient. High levels of stigma around the disease affect people's willingness to get tested, and therefore treatment and transmission rates.

While the FLNG Project will be located offshore, there will be a support office in Pemba where most workers will be located, while people may also migrate to Palma Town looking for employment and other opportunities given EEA's presence there.

As such, an increase in the number of workers in the region, including people who may be eventually attracted to the area looking for employment and other opportunities as well as family members of workers, may potentially involve close contact with local people in the form of high risk sexual activities with commercial sex workers, which in turn would lead to increasing prevalence rates.

Any increase in the prevalence rates of STIs and HIV/AIDS in the region is a risk to the community given current poor treatment options and lack of health services. This in turn could result in additional pressures on existing health facilities. This negative impact is expected to have a regional extension, critical duration as transmission could occur throughout project's life cycle and potentially affecting a high number of individuals of high sensitivity (given the lack of services and stigma of the disease). The impact is therefore assessed as of high significance.

Mitigation Measures

It is recommended that EEA develops a policy and management plan to reduce the transmission of STIs, including HIV/AIDS, including:

- Provision for access to voluntary awareness, counseling and testing for Project personnel for STIs and HIV/AIDS.
- Provide support to workers to access treatment for STIs and in particular HIV/AIDS through existing health facilities or NGO campaigns or programs.
- Ensure there is access to free condoms at all worker sites and accommodation.
- Ensure that all Project personnel are given specific HIV and STI prevention training.

Impact Assessment Summary

Impact: Increased incidence of STI and HIV/Aids					
Criteria	**Pre-mitigation assessment**		**Key Mitigation**	**Post-mitigation assessment**	
Nature	Negative		- Develop a policy and management plan to reduce the transmission of STIs, including HIV/AIDS	Negative	
Type	Indirect			Indirect	
Duration	Critical	4		Critical	4
Extent	Regional	2		Regional	2
Importance	High	3		Low	1
No. of elements involved	High	3		Low	1
Significance	**High**	**12**		**Medium**	**8**

7.5 Impact Assessment Summary

This section presents a summary of all impacts assessed for the FLNG Project, including pre and post-mitigation. It further presents the proposed key mitigation in order to facilitate a global perception of the Project's impacts. The impact assessment summary is presented in tabulated form, separated by environmental component and per project phase, as follows:

- **Table 7.18** – impacts associated with the drilling, installation, commissioning and decommissioning phases;
- **Table 7.19** – impacts associated with operational phase;
- **Table 7.20** – impacts associated with unplanned events.

Table 7.18 – Project Impacts associated with the drilling, installation, commissioning and decommissioning phases

#	Impact Description –Impacts during the drilling, installation, commissioning and decommissioning phases	Significance Rating		Nature of the Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
Air quality					
1.	Increase in atmospheric concentrations resulting in potential adverse effects on air quality	**LOW**	**LOW**	(-)	- Prepare and implement an Air Quality Management Plan
2.	Increase in atmospheric concentrations due to vessel activity during decommissioning phase resulting in potential adverse effects on air quality	**LOW**	**LOW**	(-)	- Prepare and implement an Air Quality Management Plan.
Greenhouse Gas					
3.	Increase in GHG emissions to the atmosphere	**MEDIUM**	**MEDIUM**	(-)	- Implementation of the best available technique for energy efficiency; - Installation of waste heat recovery units on the gas turbine exhaust stacks; - Preventative maintenance and operational efficiencies to reduce flaring; - Development and implementation of a GHG management plan to monitor and assess GHG emissions from the FLNG operation; - Project design to minimize fugitive emissions. Implement a LDAR.
Illumination					
4.	Disruption of natural seascape during the drilling, installation, commissioning and decommissioning phases	**LOW**	**LOW**	(-)	- Illumination will be designed on permanent facilities with the objective to reduce light glow, while meeting workplace health and safety, and navigational requirements.
Oceanography					
5.	Potential seawater quality degradation due to the discharge of drill cuttings during the drilling phase	**LOW**	**LOW**	(-)	- All safety protocols must be strictly followed during drilling activities; - Select drilling fluids and additives in accordance with their toxicity rating, using a globally accepted hazard assessment tool; - During use of LTOBM, monitoring must be performed onboard the rig to ensure that less than 1% oil remains adhered to the cuttings prior to disposal; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.
Marine Ecology					
6.	Effects of vessel liquid effluents on marine ecology due to changes in water quality	**LOW**	**LOW**	(-)	- Discharge of deck drainage, bilge water and sewage shall comply with MARPOL 73/78 requirements; - Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills as soon as they occur.

#	Impact Description –Impacts during the drilling, installation, commissioning and decommissioning phases	Significance Rating		Nature of the Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
7.	Effects of solid waste disposal on marine ecology due to changes in water quality	**LOW**	**LOW**	(-)	- Apply adequate treatment and disposal of solid waste in order to avoid pollution of marine waters; - Apply all solid waste management measures according to national regulations and international standards and best practices; - Food solid waste will be treated in accordance with MARPOL (73/78) regulations; - All other solid waste must be segregated and temporarily stored and contained on the vessel, for appropriate treatment and/or disposal onshore in compliance with Annex V of MARPOL - Train crew members on waste management procedures.
8.	Effects of the discharge of drilling muds and cuttings on marine ecology due to changes in water quality	**LOW**	**LOW**	(-)	- Use lox toxicity WBMs only, for the drilling of the initial well sections; - When LTOBM are used, mud recovery systems are recommended; - Monitor and record the use of all drilling fluid components and other chemicals; - During use of LTOBM, monitoring must be performed onboard the rig to ensure that the oils are removed from the cuttings such that less than 1% oil remains adhered to the cuttings prior to disposal; - Manage and discharge WBM mud and cuttings and LTOBM cuttings in compliance with international best practices; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.
9.	Effects of discharge of drilling muds and cuts on deepwater benthic macrofauna	**MEDIUM**	**LOW**	(-)	- Undertake ROV analysis of the drilling sites prior to start of drilling. Adjust the exact drilling location, as much as possible, in order to avoid impacting on any sensitive benthic community or habitat that may be identified; - Use lox toxicity WBMs only, for the drilling of the initial well sections; - When LTOBM are used, mud recovery systems are recommended; - Monitor and record the use of all drilling fluid components and other chemicals; - Manage and discharge WBM mud and cuttings and LTOBM cuttings in compliance with international best practices.
10.	Effects of noise on marine fauna	**MEDIUM**	**LOW**	(-)	- The DP systems are likely to be the major source of noise. Therefore, selection of the drill ship (MODU) and support vessels should be carried out taking into account the noise emissions, and where possible selecting quieter DP systems; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - If technically feasible, investigate the possibly of using mooring/anchoring to keep the drill ship on station rather than using DP systems; - .Avoidance of noise generating anchoring techniques such as impact piling; - Should piling option be used, mitigation measures such as soft starts, provision of dedicated MMOs and establishment of a 500 m mitigation zone throughout piling operations should be adhered to (JNCC, 2010); - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).

#	Impact Description –Impacts during the drilling, installation, commissioning and decommissioning phases	Significance Rating		Nature of the Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
11.	Impacts related to artificial lighting on marine fauna	LOW	LOW	(-)	- Light emissions should be kept as low as possible, in accordance with best practice environmental management.
12.	Risk of collisions and entanglement on the marine fauna	MEDIUM	LOW	(-)	- Ensure constant bridge watch is kept on all vessels to look out for cetaceans in danger of collision.
13.	Risk of introduction of alien species due to discharge of ballast water during the drilling, installation, commissioning and decommissioning phases	MEDIUM	LOW	(-)	- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010). - All vessels should have a documented Biofoul Management Plan (as per IPIECA, 2010 and IMO, 2011)
14.	Effects of increased vessel and helicopter movement on seabirds and migratory birds	LOW	LOW	(-)	- Instruct helicopters to maintain a minimum height of 500m over bird foraging areas unless essential for safety or emergency purposes. - Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme. - Prohibit all crew members from killing or causing injury to seabirds (any crew members found to have deliberately killed or caused injury to marine fauna shall be dismissed immediately and removed to shore).
15.	Effects of illumination on seabirds	LOW	LOW	(-)	- Minimize non-essential lighting on vessels, and shield and/or reduce the number of lights shining directly onto the water as far as possible. - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights. - Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme. - Prohibit all crew members from killing or causing injury to seabirds (any crew members found to have deliberately killed or caused injury to marine fauna shall be dismissed immediately and removed to shore).
16.	Effects of vessel discharges on seabirds	MEDIUM	LOW	(-)	- Prior to the establishment of the Project (i.e. during the construction phase) vessels associated with the contractor will comply with MARPOL 73/78 and utilize MARPOL compliant waste facilities elsewhere for offloading wastes. - All Project vessels will comply with MARPOL 73/78. This will, among other things, necessitate the provision of Port Reception Facilities for vessels based at the facility (i.e. support vessels and tugs), as well as effective waste disposal.
Fisheries					
17.	Loss of access to fishing grounds by commercial fisheries	LOW	LOW	(-)	- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from fishing operators regarding FLNG operations; - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.
18.	Loss of access to fishing grounds by sports and recreational fisheries	LOW	LOW	(-)	- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from tourism operators and organizations

#	Impact Description –Impacts during the drilling, installation, commissioning and decommissioning phases	Significance Rating		Nature of the Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
19.	Increased fishing competition in remaining fishing grounds due to project installation	**MEDIUM**	**LOW**	(-)	- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from artisanal fishermen - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.
20.	Decreased catch rates due to noise emissions	**LOW**	**LOW**	(-)	- The DP systems are likely to be the major source of noise. Therefore, selection of the drill ship (MODU) and support vessels should be carried out taking into account the noise emissions, and where possible selecting quieter DP systems; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - If technically feasible, investigate the possibly of using mooring/anchoring to keep the drill ship on station rather than using DP systems; - Avoidance of noise generating anchoring techniques such as impact piling; - Should piling option be used, mitigation measures such as soft starts, provision of dedicated MMOs and establishment of a 500 m mitigation zone throughout piling operations should be adhered to (JNCC, 2010); - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).
21.	Decreased catch rates due to light emissions	**LOW**	**LOW**	(-)	- Light emissions should be kept as low as possible, in accordance with best practice environmental management.
22.	Effects of discharge and loading of ballast water on fisheries	**MEDIUM**	**LOW**	(-)	- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010).
23.	Decreased catch rates due to changes in water quality from general waste, drill cuttings and mud	**LOW**	**LOW**	(-)	- Implement all mitigation measures outlined in Section 7.2.4.2 for impact: Potential seawater quality degradation due to the discharge of drill cuttings - Implement a Waste Management Plan and train crew members on waste management procedures; - Food waste will be treated in accordance with MARPOL (73/78) regulations.
Socio-Economy					
24.	Effects on recreational diving and sports fishing; effects on cetacean (whales and dolphins) sightseeing excursions	**LOW**	**LOW**	(-)	- Draft and implement a Communication Plan and Grievance Mechanism
25.	Effects on the image of the Quirimbas Archipelago as a medium to high-end tourism destination; Visual/aesthetic effects on tourists, especially on the islands	**MEDIUM**	**MEDIUM**	(-)	- Illumination will be designed on permanent facilities with the objective to reduce light glow while meeting workplace health and safety, and navigational requirements; - The use of non-reflective surface treatments.
26.	Halting effects on planned and future tourism developments in the Quirimbas Archipelago	**MEDIUM**	**LOW**	(-)	- Include tourism operators in project's stakeholder mapping, with direct lines of frequent and informative communication of project activities that are sea based and that can influence tourism.
27.	Stimulation of business tourism	**MEDIUM**	**MEDIUM**	(+)	- No enhancement measures required.

#	Impact Description –Impacts during the drilling, installation, commissioning and decommissioning phases	Significance Rating		Nature of the Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
28.	Economic stimulation effect on local and regional services	MEDIUM	HIGH	(+)	- The procurement of goods and services should give priority to sourcing from the local and provincial markets, whenever possible; - Small and medium sized local businesses should get involved in empowerment, training and providing of quality services so as to take advantage of the commercial opportunities being created by the project.
29.	Economic impacts on commercial fisheries	LOW	LOW	(-)	- Establishment of appropriate communication channels with relevant fishing associations and institutions, providing information on the Project spatial usage. - Implementation of a detailed communication plan with fishing operators and vessels, in partnership with the National and Provincial Fisheries Administrations.
30.	Influx of workers into the Area of Indirect Influence (Pemba and Palma)	MEDIUM	LOW	(-)	- Communication plan with key relevant social structures (Education, health) on current obstacles and increases in pressures. - Community development plan
31.	Increased community expectations	HIGH	LOW	(-)	- Stakeholder engagement plan and communications plan; - Community grievance mechanism; - Training plan on recruitment message and procedures to contractors; - Elaborate a local recruitment plan adapted to the local context.
32.	Employment during the installation, drilling and commissioning phase	MEDIUM	MEDIUM	(+)	- Recruitment policy and plan with a long term vision of skill trickledown effect.
33.	Transfer of work and technical skills to national labor	LOW	LOW	(+)	- Provide technical training programs for unskilled workers, with the objective of improving their jobs; - Provide environmental, health and safety training to all workers.
34.	Revenue to the provincial and central governments	HIGH	HIGH	(+)	- N/a
35.	Loss of employment opportunities, revenue to local businesses and government due to decommissioning.	HIGH	MEDIUM	(-)	- Undertake an economic impact and dependency study two years prior to decommissioning with more specific recommendations for impact mitigation.
Marine navigation					
36.	Interference and risk of collision due to increased maritime traffic (drilling and construction vessels) and a reduction in the navigation space (due to safety zones)	MEDIUM	LOW	(-)	- Implement all standard maritime measures; - Promulgate a safety zone of 2 nm radius around the stationary Project vessels; - Deploy radio beacons at 5 nm north and south of the area of operation; - Install an automated collision warning system on the Project vessels.
Health					
37.	Increased pressure on existing health facilities	HIGH	LOW	(-)	- Provide an adequate health post with capacity for the diagnosis and treatment of common diseases (malaria, diarrhea, respiratory diseases) for its workers - Coordinate the use of existing health facilities with relevant authorities, and have means of transport to ensure the rapid transport of seriously ill patients to a hospital;
38.	Increased incidence of STI and HIV/Aids	HIGH	LOW	(-)	- Develop a policy and management plan to reduce the transmission of STIs, including HIV/AIDS

Table 7.19 – Project Impacts associated with the operational phase

#	Impact Description – Impacts during the operational phase	Significance Rating		Nature of Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
Air quality					
39.	Increase in atmospheric concentrations resulting in potential adverse effects on air quality	**LOW**	**LOW**	(-)	- Implement a Stack Emission Monitoring System; - Implement a Leak Detection and Repair (LDAR) System.
Greenhouse Gas					
40.	Increase in GHG emissions to the atmosphere	**MEDIUM**	**MEDIUM**	(-)	- Implementation of the best available technique for energy efficiency; - Installation of waste heat recovery units on the gas turbine exhaust stacks; - Preventative maintenance and operational efficiencies to reduce flaring; - Development and implementation of a GHG management plan to monitor and assess GHG emissions from the FLNG operation; - Project design to minimize fugitive emissions. Implement a LDAR.
Illumination					
41.	Disruption of natural seascape during the operational phase	**LOW**	**LOW**	(-)	- Illumination will be designed on permanent facilities with the objective to reduce light glow, while meeting workplace health and safety, and navigational requirements; - The use of non-reflective surface treatments should be preferred, to minimize reflective emissions.
Oceanography					
42.	Potential increase of marine water temperature due to the discharge of the FLNG's cooling water	**LOW**	**LOW**	(-)	- Maintain proper operation of the cooling system, to maintain designed discharge temperatures; - Ensure that the pumping of cooling water through the system is turned off when cooling is not required; - Continuous monitoring of the discharge temperature; - Periodic monitoring of the receiving seawater temperature, to ensure compliance with the end of mixing zone standard.
43.	Potential increase of marine water temperature due to the discharge of the FLNG's cooling water in the operational phase	**LOW**	**LOW**	(-)	- Maintain proper operation of the treatment system, to maintain designed discharge concentrations; - Periodic monitoring of the produced water effluent, to verify compliance with the emission limits; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.
Marine Ecology					
44.	Effects of liquid effluents on marine ecology due to changes in water quality	**LOW**	**LOW**	(-)	- Discharge of deck drainage, bilge water and sewage shall comply with MARPOL 73/78 requirements; - Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills as soon as they occur.

#	Impact Description – Impacts during the operational phase	Significance Rating		Nature of Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
45.	Effects of solid waste disposal on marine ecology due to changes in water quality, during the operational phase	LOW	LOW	(-)	- Develop and implement a Waste Management Plan for the operational phase of the FLNG, in order to ensure that all solid waste generated in the facility is adequately collected, sorted, temporarily stored and sent to final treatment or disposal; - Provide training to all workers, in what regards the need to reduce production of solid waste and the adequate procedures of waste management.
46.	Effects of noise on marine fauna	MEDIUM	MEDIUM	(-)	- The design of the FLNG and offloading vessels should be investigated in order to minimize noise, particularly during use of dynamic positioning thrusters; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).
47.	Impacts related to artificial lighting during the operational phase	MEDIUM	MEDIUM	(-)	- Placement and direction of lighting used, in accordance with relevant standards; - Shading to direct light inward and downward; - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights; - Flat black paint may reduce whale response to brightly reflective objects such as oceanographic cables.
48.	Risk of collisions and entanglement for marine fauna	HIGH	MEDIUM	(-)	- Ensure constant bridge watch is kept on all vessels and at the FLNG to look out for cetaceans in danger of collision; - Periodically check risers to detect any entanglement with marine fauna, in particular with turtles. If entanglement is frequently detected, more detailed studies should be developed in order to devise additional mitigation measures.
49.	Risk of introduction of alien species due to discharge of ballast water during the operational phase	HIGH	MEDIUM	(-)	- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010).
50.	Effects of cooling water discharges on marine ecology	LOW	LOW	(-)	- Maintain proper operation of the cooling system, to maintain designed discharge temperatures; - Ensure that the pumping of cooling water through the system is turned off when cooling is not required; - Continuous monitoring of the discharge temperature; - Periodic monitoring of the receiving seawater temperature, to ensure compliance with the end of mixing zone standard.
51.	Effects of produced water discharges on marine ecology, due to potential degradation of seawater quality	LOW	LOW	(-)	- Maintain proper operation of the treatment system, to maintain designed discharge concentrations; - Periodic monitoring of the produced water effluent, to verify compliance with the emission limits; - Periodic monitoring of the receiving seawater quality, to verify compliance with the ambient quality standards.

#	Impact Description – Impacts during the operational phase	Significance Rating		Nature of Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
52.	Effects of lighting from the FLNG structure on seabirds	**MEDIUM**	**LOW**	(-)	- Minimize non-essential lighting on vessels, and shield and/or reduce the number of lights shining directly onto the water as far as possible. - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights. - Keep any disoriented but otherwise unharmed seabirds found on vessels at night in dark containers and release them during daylight. Any ringed/banded birds found on vessels should be reported to the appropriate ringing/banding scheme. - Prohibit all crew members from killing or causing injury to seabirds (any crew members found to have deliberately killed or caused injury to marine fauna shall be dismissed immediately and removed to shore).
Fisheries					
53.	Loss of access to fishing grounds by commercial fisheries	**MEDIUM**	**MEDIUM**	(-)	- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from fishing operators regarding FLNG operations; - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.
54.	Loss of access to fishing grounds by sports and recreational fisheries	**MEDIUM**	**MEDIUM**	(-)	- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from tourism operators and organizations
55.	Increased fishing competition in remaining fishing grounds due to project installation	**MEDIUM**	**MEDIUM**	(-)	- Implement a Communication Plan and appropriate Grievance Mechanism to report any complaints from artisanal fishermen - The Communication Plan should be implemented in partnership with ADNAP and IDPPE.
56.	Decreased catch rates due to noise emissions	**LOW**	**LOW**	(-)	- The design of the FLNG and offloading vessels should be investigated in order to minimize noise, particularly during use of dynamic positioning thrusters; - Vessels used in the project to incorporate measures to reduce cavitation as far as reasonably practicable; - Avoidance of sensitive marine areas and receptors during transit (e.g. maintain 500 m exclusion zone from any marine mammals encountered during transit).
57.	Decreased catch rates due to light emissions	**LOW**	**LOW**	(-)	- Placement and direction of lighting used, in accordance with relevant standards; - Shading to direct light inward and downward; - Avoid the use of orange, red and white lights where possible in favor of primarily green and blue lights; - Flat black paint may reduce whale response to brightly reflective objects such as oceanographic cables.
58.	Effect of discharge and loading of ballast waters on fishing catch rates	**MEDIUM**	**LOW**	(-)	- Discharge and loading of ballast water must comply with international, national and local legislation. Best international practices have to be followed (see IPIECA, 2010).
59.	Decreased catch rates due to changes in water quality from general waste, thermal and cooling water discharges	**MEDIUM**	**LOW**	(-)	- Adequate management of waste and effluents

#	Impact Description – Impacts during the operational phase	Significance Rating		Nature of Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
Socio-Economy					
60.	Effects on recreational diving and sports fishing; effects on cetacean (whales and dolphins) sightseeing excursions	**LOW**	**LOW**	(-)	- Draft and implement a Communication Plan and Grievance Mechanism.
61.	Effects on the image of the Quirimbas Archipelago as a medium- to high-end tourism destination; Visual/aesthetic effects on tourists, especially on the islands	**MEDIUM**	**MEDIUM**	(-)	- Illumination will be designed on permanent facilities with the objective to reduce light glow while meeting workplace health and safety, and navigational requirements; - The use of non-reflective surface treatments.
62.	Halting effects on planned and future tourism developments in the Quirimbas Archipelago	**MEDIUM**	**LOW**	(-)	- Include tourism operators in project's stakeholder mapping, with direct lines of frequent and informative communication of project activities that are sea based and that can influence tourism.
63.	Stimulation of business tourism	**HIGH**	**HIGH**	(+)	- No enhancement measures required.
64.	Economic stimulation effect on local and regional services	**HIGH**	**HIGH**	(+)	- The procurement of goods and services should give priority to sourcing from the local and provincial markets, whenever possible; - Small and medium sized local businesses should get involved in empowerment, training and providing of quality services so as to take advantage of the commercial opportunities being created by the project.
65.	Economic impacts on commercial fisheries	**MEDIUM**	**MEDIUM**	(-)	- Establishment of appropriate communication channels with relevant fishing associations and institutions, providing information on the Project spatial usage. - Implementation of a detailed communication plan with fishing operators and vessels, in partnership with the National and Provincial Fisheries Administrations.
66.	Influx of workers into the AII	**MEDIUM**	**LOW**	(-)	- Communication plan with key relevant social structures (Education, health) on current obstacles and increases in pressures. - Community development plan
67.	Increased community expectations	**HIGH**	**LOW**	(-)	- Stakeholder engagement plan and communications plan; - Community grievance mechanism; - Training plan on recruitment message and procedures to contractors; - Elaborate a local recruitment plan adapted to the local context.
68.	Employment during the operational phase	**MEDIUM**	**MEDIUM**	(+)	- Recruitment policy and plan with a long term vision of skill trickledown effect.
69.	Transfer of work and technical skills to national labor	**HIGH**	**HIGH**	(+)	- Develop a Training and Skill Transfer Program, with a long term vision of skill trickledown effect.
70.	Revenue to the provincial and central governments	**HIGH**	**HIGH**	(+)	- N/a

#	Impact Description – Impacts during the operational phase	Significance Rating		Nature of Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
Marine Navigation					
71.	Interference and risk of collision due to the presence and operations of the FLNG vessel, tankers and support vessels and reduced areas for navigation in the Rovuma Basin due to the promulgation of a safety zone around the FLNG vessel	**MEDIUM**	**MEDIUM**	(-)	- Implement all standard maritime measures; - Deploy radio beacons at 5 nm north and south of the area of operation; - Install an automated collision warning system on the Project vessels; - Monitor piracy threats and liaise with the naval vessels in the area.
Health					
72.	Increased pressure on existing health facilities	**HIGH**	**MEDIUM**	(-)	- Provide an adequate health post with capacity for the diagnosis and treatment of common diseases (malaria, diarrhea, respiratory diseases) for its workers - Coordinate the use of existing health facilities with relevant authorities, and have means of transport to ensure the rapid transport of seriously ill patients to a hospital;
73.	Increased incidence of STI and HIV/Aids	**HIGH**	**MEDIUM**	(-)	- Develop a policy and management plan to reduce the transmission of STIs, including HIV/AIDS

Table 7.20 – Project Impacts associated with unplanned events

#	Impact Description – Impacts linked to unplanned events	Significance Rating		Nature of Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
Air quality					
74.	Increase in atmospheric concentrations due to accidental releases to the atmosphere resulting in potential adverse effects on air quality	**LOW**	**LOW**	(-)	- Implement good industry practice, operational plans and procedures aimed at reducing the probability of occurrence of unplanned events.
Oceanography					
75.	Risk of seawater quality degradation resulting from accidental diesel spills due to vessel collisions (unplanned event)	**HIGH**	**LOW**	(-)	- EEA will develop and implement a comprehensive oil spill response plan (OSRP); - EEA will train personnel to effectively respond in the event of a hydrocarbon spill, including undertaking safety drills; - Enforcement of all policies and procedures. Tier 1 oil spill response equipment will be staged on support vessels and/or at shore; - Readiness of EEA response crew and third-party responders in the event of an unplanned oil spill.
76.	Risk of seawater quality degradation resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase (unplanned event)	**MEDIUM**	**LOW**	(-)	
Marine Ecology					
77.	Effects on marine fauna resulting from accidental diesel spills due to vessel collisions	**HIGH**	**LOW**	(-)	- Ensure the FLNG vessel and supply vessels comply with international certificates in terms of prevention, planning and response; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.
78.	Effects on coastal habitats resulting from accidental diesel spills due to vessel collisions (unplanned event)	**HIGH**	**LOW**	(-)	- Ensure the FLNG vessel and supply vessels comply with international certificates in terms of prevention, planning and response; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.
79.	Effects on marine fauna resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase	**MEDIUM**	**LOW**	(-)	- Ensure the FLNG vessel and supply vessels comply with international certificates in terms of prevention, planning and response; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.
80.	Effects on deepwater benthic habitats and macrobenthic communities resulting from accidental LTOBM releases due to disconnection of the riser during the drilling phase	**LOW**	**LOW**	(-)	- Ensure the FLNG vessel and supply vessels comply with international certificates in terms of prevention, planning and response; - Develop and have in place site-specific Oil Spill Contingency and Emergency Response Plans.
Fisheries					
81.	Decreased catch rates due to changes in water quality from hydrocarbon releases	**MEDIUM**	**LOW**	(-)	- Implement all mitigation measures outlined Section 7.2.4.4 and 7.3.4.2.
82.	Decreased catch rates due to effects of potential LNG and natural gas releases	**LOW**	**LOW**	(-)	- Train personnel in well-control programs so that they can spot the signs and react accordingly; - Conduct an appropriate risk assessment; - Establish exclusion zone for tankers travelling in shipping lanes thereby reducing the potential for collision and spills.

#	Impact Description – Impacts linked to unplanned events	Significance Rating		Nature of Impact	Key Mitigation
		Pre-mitigation	Post-mitigation		
Socio-economy					
83.	Effects of gas blowouts on livelihoods of fishermen	**LOW**	**LOW**	(-)	- Train personnel in well-control programs so that they can spot the signs and react accordingly; - Conduct an appropriate risk assessment.
84.	Effects of spills and leaks on livelihoods of fishermen and coastal communities	**HIGH**	**MEDIUM**	(-)	- In case of spills, the company should ensure rapid detection and containment. As such, it is recommended that guidelines for release prevention, and control planning are provided in the company general's EHS guidelines including the requirement to develop a spill prevention and control plan. In addition, conduct a spill risk assessment for the offshore facility and support vessels.

8 Public Participation Process

8.1 Introduction

Public participation[18] is a key component of an EIA process. It involves those interested in or affected by the proposed development in highlighting opportunities, risks and issues of concern. Public participation thereby assists the project team to take account of locally relevant conditions rather than imposing designs that are potentially insensitive, socially and environmentally, onto an environment. Fulfilling the basic requirements of public participation is a legal requirement, and failure to address this aspect can create significant risks to project development.

The Public Participation Process (PPP) undertaken in this EIA process was developed according to Mozambican EIA Regulations and international best practice. The relevant documents that guided the PPP were the following (see Chapter 3, Volume I for more information on how these documents were taken into account in the EIA process, in general, and in the PPP, in particular):

- General Guidelines for Public Participation Process in the EIA process, Ministerial Diploma No 130/2006: this diploma provides the guidelines to be followed in any PPP undertaken as part of an EIA process, as regulated by Decree No 45/2004 (as amended by Decree No 42/2008);
- Equator Principles (EP): EP 5 (Consultation and Disclosure) states that public consultation with the project affected communities must be undertaken in a structured and culturally appropriate manner;
- IFC Performance Standards: Performance Standard 1 (Assessment and Management of Social and Environmental Risks and Impacts) states that adequate engagement with affected communities, throughout the project cycle, on issues that could potentially affect them must be provided and that grievances from affected communities and external communications from other stakeholders must be responded to and managed appropriately.

In accordance with Ministerial Diploma No 130/2006, the PPP for this EIA included consultation in two phases: early in the EIA process (EPDA Phase) and again in the Impact Assessment (Environmental Impact Study-EIS) Phase. This is also in accordance with EP 5, which states that disclosure should occur early in the assessment process and on an ongoing basis.

The overall PPP strategy included:

- The disclosure and availability of documentation for a 30 day period (15 days prior to and post public meetings);
- Public meetings and other stakeholder engagement activities; and
- inclusion of issues raised in the public meetings on the reports drafted as part of the EIA process.

The following sections present a brief overview of the consultation undertaken throughout the EIA process, including both the EPDA and EIS Phase. A more detailed description and documentation of the PPP activities is provided in the Public Participation Process Report (please see **Volume V**).

[18] The terms 'stakeholder engagement' and 'public participation' are used interchangeably throughout the report, as are the terms Interested and Affected Parties (I&APs) and stakeholders.

8.2 Objectives of the Public Consultation Process

Much has been written about the value of different levels of stakeholder engagement in development related processes, and EIAs are no exception. What is clear is that the greater the level of public participation, particularly amongst those groups and individuals most directly affected by planned projects, the more thorough the identification of potential impacts, the more appropriate the project design and the better the relationship between stakeholders and the project developers. This is not to say that conflicts do not arise. However, enough trust should have been established between parties through a participatory process to allow for open and constructive engagement aimed at satisfactory resolution.

Thus the main objective of the consultation process is to inform all I&APs of the activities to be carried out, and of the predicted impacts of such activities, and to grant them an opportunity to voice their opinions, concerns and expectations regarding the project.

The PPP is based on the following principles:

- Understanding the social and environmental context of the overall project area is key to a successful impact assessment. The I&APs are a valuable source of information on this;
- The development and promotion of confidence in the PPP are fundamental to a positive and effective involvement of I&APs and to ensure a successful impact assessment process. The key element to establish such trust is to provide an open and transparent EIA process;
- The involvement of I&APs allows a defensible and more comprehensive EIA process, through the comments received and views expressed;
- The I&APs have the right to express their views and to obtain feedback to their concerns; and
- Information disclosure and availability is key to a participative EIA process.

Based on such principles, and in accordance to the guidelines referred to above, **Table 8.1** summarizes the aims and objectives of the stakeholder engagement process undertaken in this EIA.

Table 8.1 – Aim of stakeholder engagement undertaken

Objective	Motivation
Identify all I&APs for the project.	Involving as many I&APs as possible would facilitate good communication and capture a wide range of issues and concerns.
Distribute accurate project information.	Ensuring that I&APs, particularly those directly affected by the proposed development, have information at their disposal with which to make informed comments and which would enable them to plan for the future, thereby reducing levels of uncertainty and anxiety. Information should allow affected parties to develop an understanding of potential impacts, risks and benefits.
Gather information that will contribute to the environmental and technical investigations.	Identifying issues through people familiar with the local environment and incorporating these into the ToR for specialist investigations meets legislative requirements and ensures that specialists focus on all relevant issues. It is also critical in ensuring the most appropriate project design and management possible.
Form partnerships to promote constructive interaction amongst all parties.	Developing relationships of trust between the developer and I&APs will contribute to proactive interactions and avoid, where possible, unnecessary conflicts based on rumor and misinformation. Identifying structures and processes through

Objective	Motivation
	which to deal with conflicts and grievances, in contrast to attempting to squash any disputes, would allow the project a better understanding of stakeholder concerns and expectations, thereby increasing the opportunities to enhance the project's value to local stakeholders.
Record and address public concerns, issues and suggestions.	Documenting I&AP issues allows project decisions to be traced and motivated and allows stakeholders to see where their input has been incorporated into planning and design. This approach addresses potential concerns that public participation may be a token gesture by the developer in order to meet legislative requirements,.
Manage I&APs expectations.	Expectations, both positive and negative, are often out of proportion to the realities of a project. This is particularly so in areas of extreme poverty and limited development and service provision. Ensuring that expectations are kept at realistic levels (e.g. around job opportunities, provision of local infrastructure, social development, disruption) limits the disappointment and frustration of directly affected parties at later stages of project implementation. Frustration and unfulfilled expectations are key triggers of conflict and require mitigation and management that might otherwise be avoided.
Fulfill national and international requirements consultation.	Ensuring regulatory compliance can avoid potential project delays based on procedural issues rather than substantive ones.

8.3 Summary of Public Consultation Activities

8.3.1 PPP in the EPDA Phase

As part of the scoping exercise (EPDA Phase), a PPP was developed[19]. A database of I&APs was compiled, information regarding the project and the EIA process was disclosed and three consultation meetings were held in Cabo Delgado and Maputo provinces, as shown in **Table 8.2** below.

While two of these were formal public meetings, i.e. the Maputo and Pemba ones, the third meeting was directed at the Palma Administration only. According to analysis carried out and given the area of influence of the project and its location (deep sea, more than 50 km from the coast), the project is unlikely to have a direct influence at the level of Palma Town and communities. Therefore, a formal public consultation at the district level was deemed unnecessary, thereby avoiding unreasonable expectations regarding the project and its impacts on local communities and the environment. The information meeting was aimed at keeping the district government informed about EEA's FLNG development.

Table 8.2 – Consultation meetings held in the EPDA PPP

Palma	Pemba City	Maputo City
Type of Meeting: Information Meeting	**Type of Meeting:** Public Meeting	**Type of Meeting:** Public Meeting
Date: 20/05/14	**Date:** 21/05/14	**Date:** 23/05/14
Place: Palma Club	**Place:** Pemba Beach Hotel	**Place:** Radisson Blue Hotel

[19] The EPDA Phase was conducted by a different Environmental Consultant (Impacto), however the results of this phase's consultation are provided in this report.

The results of the EPDA PPP were documented in the EPDA Report, which was submitted to MITADER for approval. **Table 8.3** presents a summary of the PPP activities undertaken in the EPDA Phase, which are also described in the PPP Report (see **Volume V**). The results of the EPDA PPP were documented in the PPP Report of the EPDA, which was integrated into the final EPDA report and submitted to MITADER's approval.

Table 8.3 – Summary of Public Consultation in the EPDA Phase

Activity	Purpose	Date of activity
Compilation of stakeholder database.	Identify stakeholders to be included in the consultation process.	February and March 2014
Distribution of invitations to public meetings (letters and faxes).	To invite stakeholders to public meetings.	April 2014
Release EPDA Report for public review.	Allow authorities and the public to comment on the project and draft Report.	6 May – 6 June 2014
Press and radio advertisements for public meetings	To invite stakeholders to public meetings.	6 – 15 May 2014
Public Meetings	To present the proposed EIA process and project to the public and to allow the public to identify issues of concern	21 – 23 May 2014
Written comments received	Written comments received during the scoping process	Until 6 June 2014
Submission of Final EPDA Report and ToR	For MITADER review, commenting and decision	12 July 2014

8.3.2 PPP in the EIS Phase

During the EIS phase, the PPP process initiated during the EPDA phase was given continuity. The I&AP database was updated, considering the more detailed information regarding the environmental and socio-economic context, the project potential impacts that were identified, the results of the EPDA phase PPP and a few direct requests by stakeholders to be included in the database, and several different types of stakeholder engagement activities were undertaken.

Considering the main findings of the impact assessment, as well as the concerns raised by I&AP's during the EPDA PPP and MITADER's review of the EPDA report, the public consultation strategy adopted for the EIS PPP included the following consultation activities:

- Consultation meetings – including open public meetings in Pemba and Maputo and an information meeting with the Palma District Administration and Consulting Council. These meetings gave continuity to the public consultation activities undertaken in the EPDA PPP;
- Discussions with key stakeholders – a number of additional meetings with key stakeholders were held, to source information and their concerns regarding the Project;
- Focus group discussions with fishing communities in the Project's Area of Indirect Influence (AII), i.e., the coastal strip of Palma District.

These activities were preceded by disclosure of a Draft EIS Report, which was made available at several strategic locations and in Consultec's website.

As noted above, three consultation meetings were held in Cabo Delgado and Maputo provinces, as shown in **Table 8.4** below, following the same strategy adopted in the EPDA phase: two of these meetings were formal public meetings, i.e. Maputo and Pemba, while the third meeting was directed at the Palma Administration, to keep the district government informed about EEA's FLNG development.

Table 8.4 – Consultation meetings held in the EIS PPP

Palma	Pemba City	Maputo City
Type of Meeting: Information Meeting	**Type of Meeting:** Public Meeting	**Type of Meeting:** Public Meeting
Date: 10/02/15	**Date:** 09/02/15	**Date:** 12/02/15
Number of participants: 53	**Number of participants:** 64	**Number of participants:** 124
Place: District Administration Meeting Room	**Place:** Pemba Beach Hotel	**Place:** Avenida Hotel

Additionally, focus groups discussions were held in fishing communities along the coast of Palma District, given the concerns raised during the EPDA phase by I&AP's regarding potential impacts on artisanal fisheries and coastal communities, and the need to engage with these stakeholders. The details of these meetings are summarized in **Table 8.5**.

Table 8.5 – Focus group discussions with coastal communities in Palma District meetings held during the EIS PPP

Community	Date	Number of Participants
Olumbi Sede	09/02/2015	16
Mondlane	09/02/2015	28
Namanengo	10/02/2015	20
Lalane	10/02/2015	30
Milamba	11/02/2015	27
Nsangue Ponta A	11/02/2015	37
Quirinde Sede	12/02/2015	24
Farol do Cabo	12/02/2015	49
Mbuize	13/02/2015	20
Quiwia	13/02/2015	24
Maganja	16/02/2015	22
Milamba 1 e 2	16/02/2015	15
Palma	17/02/2015	75

The stakeholder engagement methodology and the results of the EIS PPP are documented in greater detail in the PPP Report (see **Volume V**). **Table 8.6** presents a summary of the PPP activities undertaken in the EIS Phase. The issues raised during the EIS Phase, and the way in which they were considered either in the Project or the EIA process, are described in **Table 8.7** (see section 8.4 below).

Table 8.6 – Summary of Public Consultation in the EIS Phase

Activity	Purpose	Date of activity
Updating of the stakeholder database.	Identify stakeholders to be included in the consultation process.	December 2014 and January 2015
Release Draft EIS Report for public review.	Allow authorities and the public to comment on the project and draft Report.	26 January - 27 February 2015
Distribution of invitations to public meetings (letters and faxes).	To invite stakeholders to public meetings.	26 January - 6 February 2015
Press and radio advertisements for public meetings	To invite stakeholders to public meetings.	26 January - 6 February 2015
Consultation Meetings	To present the proposed EIA process and Project to the public and to allow the public to identify issues of concern	9 – 12 February 2015
Focus group meetings with coastal communities of Palma District	To present the Project, EIA process and main potential impacts with relevance to the coastal communities of the Project's Area of Indirect Influence	9 – 17 February 2015
Written comments received	Written comments received during the EIS PPP	Until 27 February 2015
Submission of Final EIS Report	For MITADER review and decision	March 2015

8.4 Comments and Responses Register

Table 8.7 presents a summary of the main comments of I&APs on the project and the EIA process, received during the EIS PPP process. **Table 8.7** also indicates the way these comments and recommendations were considered, either in the project design or in the EIA process.

Table 8.8 – MITADER's comments on the EPDA Report

presents a summary of comments from MITADER on the EPDA Report, also indicating the way these recommendations were considered in the EIS.

Table 8.7 – Main comments received throughout the Public Participation Process of the Environmental Impact Study

Issues / Comments		Meeting	Stakeholder	Answers / Comments
Project Layout/Project Description				
1.	Reasons for developing an FLNG, instead of an onshore development.	Pemba and Maputo meetings	Representative of the National Petroleum Institute (INP); Representative of Companhia Moçambicana de Hidrocarbonetos	The Coral Reservoir is located at a considerable distance from the coast (around 90km from Palma) and the sea bottom profile shows the existence of several canyons of more than 400m elevation and geohazard subsea areas to be crossed with pipeline to pursue an onshore development. These two main factors would make an onshore development risky, complicated especially in relation to the pipeline installation. Another issue is related to the flow assurance: in order to guarantee the delivery pressure of 70/80 bar at the LNG plant inlet onshore from Coral, a Floating Production Unit (FPU) should be installed from the beginning of the FLNG operation. All these aspects make the Coral development viable only through a FLNG.
2.	What are the benefits to the onshore communities if the project is developed offshore?	Pemba and Palma meetings	Representative from Cabo Delgados's Provincial Directorate of Planning and Finance (DPFF); Member of Palma District Consulting Council (CC)	The FLNG project will require skilled and unskilled labor, some of which will be directly hired by the FLNG and part of it by the Service Contractors that will provide all support services necessary to the FLNG operation. Training opportunities also targeting potential candidates in the area will be available. The project will also create a stimulation effect on the regional economy, which will result in the indirect creation of jobs. The development of this gas project will also contribute to the increase of revenue to central and provincial governments, which will indirectly benefit the communities, due to the greater capacity of the state to invest in social infrastructure. These benefits or potential positive impacts were assessed in the socio-economic specialist study and are discussed in greater detail in Section 7.4.2.2 of Volume II.
3.	Government control mechanisms on resource quantities withdrawn and exported	Pemba meeting	Representative of DPFF	EEA has signed an EPCC contract with the Government of Mozambique (GoM) and will comply with all laws established by the Mozambican government. A communication protocol will be established with the Government to ensure compliance to authority. ENH is a partner of this development and will be involved in all activities, including the export of gas.

Issues / Comments		Meeting	Stakeholder	Answers / Comments
4.	How will the 800 jobs be divided in terms of foreigners and Mozambicans	Palma meeting	Member of Palma's CC	The initial estimate foresees a peak of 1350 jobs during the Commissioning phase and around 820 jobs during the operation phase, including Company personnel and Contractors personnel. For company direct personnel (in the range of 320), at the initial phase is foreseen 30% of Mozambican Personnel, number that is expected to increase in subsequent years of operations based on the training program put in place by the operator as well as the training on the job during the normal operations of the FLNG unit. For the Service Contractors personnel, it is expected a higher percentage of Mozambican labor. All awarded contracts will be in full respect of the Mozambican Law regarding Local Content, and a Local Content Plan will be a mandatory requirements for all EEA's contractors to comply with.. Additional information on the amount of employment opportunities is provided in Section 4.9 (Volume I).
5.	Clarify if FLNG structure will be designed to outstand severe cyclones.	Maputo meeting	Representative of INP	This has been clarified in Section 4.5 (Volume I). The facility is being designed to withstand cyclones and storms without the need to disconnections.
6.	Submission of data on manpower to be allocated to the production phase, specifying the number of men, women, permanent and seasonal workers, levels of qualification and worker origins, including local/national staff.	Maputo meeting	Representative of Ministry of Mineral Resources and Energy (MIREM)	Please refer to the answer provided to comment No. 4, above, and to Section 4.9 (Volume I).
7.	Indication of the total expected investment amount for the development of the Project.	Maputo meeting	Individual Citizen	This is provided in Section 4.1 (Volume I).
8.	Clarification on the gas export process: will it be exported directly from the FLNG or will it pass through a Mozambican port.	Pemba meeting	Representative of Ports and Railroads of Mozambique (CFM)	The gas offloading procedures are described in Section 4.7.4.7 (Volume I). Gas will be offloaded from the FLNG to LNG carriers and exported directly, with no need to call on a Mozambican port.
9.	Final destination of the solid waste generated in the FLNG vessel during the operational phase.	Pemba meeting	Representative of Anadarko	EEA is currently undertaken a feasibility study to determine the final destination of all solid wastes generated in the FLNG. This study will indicate which onshore facility will be used or if there is a need to build a dedicated waste management facility.
10.	Project and EEA's social responsibility initiatives.	Pemba and Maputo meetings	Representative of DPFF; Representative of the European Union (EU); Representative of Technical University of Mozambique (UDM); Representative of National Cultural Heritage Archive (ARPAC)	The FLNG project does not specifically includes social responsibility developments. However, EEA has a Social Responsibility Program in place, which coordinates and integrates all of EEA's social developments. EEA has already implemented several community development initiatives, in Pemba and Palma, including projects in the education, water supply and energy components. EEA is committed to continue to develop social initiatives, in an integrated way, and not specifically linked to any one project.

Issues / Comments		Meeting	Stakeholder	Answers / Comments
11.	Decommissioning activities, including environmental restoration.	Pemba and Maputo meetings	Representative of National Institute for Fisheries Research (IIP); Representative of the Assembly of the Republic (AR)	Decommissioning activities are described in Section 4.7.5 (Volume I). Prior to decommissioning, a specific plan will be developed in accordance with the Area 4 EPCC, eni internal standards and International Codes and Standards relevant to offshore petroleum activities. Final aim of this activity is to assure the restoration of environment to a reasonable condition.
12.	Relationship between the Coral FLNG and the onshore Afungi LNG plant.	Palma meeting	Members of Palma CC	The proposed FLNG development aims to explore the gas reserves of the Coral reservoir, which is fully contained within EEA's Area 4 concession. The onshore Afungi LNG project aims to explore the gas reserves of the Mamba reservoir, which straddles the areas of concessions Area 4 (EEA) and Area 1 (Anadarko), and is thus being developed by an EEA / Anadarko joint venture, in compliance with applicable regulations. The two projects are independent. The scope of this EIA is solely the Coral FLNG.
13.	Potential involvement of Mozambique's metallurgic-mechanical industry on the construction of the FLNG	Maputo meeting	Representative of the Ministry of Industry and Commerce (MIC)	There are very few shipyards in the world with the capacity to build a FLNG vessel. As described in Section 4.7.2 (Volume I), the FLNG vessel unit will be built at an overseas technically qualified shipyard (Far East) and towed to the gas field where it will be moored to the seabed over the field.
14.	Include the development plan in the project's schedule.	Maputo meeting	Representative of INP	The project's overall schedule is presented in Figure 4.7 (Section 4.5; Volume I), indicating the development phase, which includes the development plan.
15.	Procedures for gas offloading.	Maputo meeting	Representative of INP	The gas offloading procedures are described in Section 4.7.4.7 (Volume I).
16.	What are the impacts of the Pemba onshore logistic base on communities? Will it require resettlement?	Maputo meeting	Representative of World Wide Fund for Nature (WWF)	The Pemba logistic base is outside of the scope of this EIA (see Section 4.8; Volume I), as it is a project under coordination of Portos de Cabo Delgado – PDC (Concessionaire as per Decree Law 87/2013) which will serve several oil and gas projects in Cabo Delgado. This EIS recommends that a specific EIA process is developed for the Pemba logistic base.
17.	Work-hours regime in the FLNG vessel.	Maputo meeting	Representative of AR	Work-hour regimes will be in full compliance to all applicable national labor regulations.
Legal framework				
18.	Include in the EIS the National Oil Spill Plan, approved in February 2014.	Maputo meeting	Representative of the Ministry of the Sea, Continental Waters and Fisheries (MMAIP)	The National Contingency Plan for the Combat of Marine Pollution from Hydrocarbons was included as one of the requirements to be considered for the development of the Project's Oil Spill Response Plan (see Section 7.3.4.1 – Volume II).

Issues / Comments		Meeting	Stakeholder	Answers / Comments
Baseline assessment				
19.	The information on Palma's health units in the EIS is outdated. Palma District now has of those 6 health units, of which 1 is of Type III, 4 are of Type II and 1 is of Type I.	Palma meeting	Director of Palma's District Services of Health, Women and Social Action (SDSMAS)	The information on Palma's health units was updated in Section 6.7.2 (Volume I).
20.	The NTS states that more common diseases in Palma include malaria, diarrhea, dysentery and cholera. Palma hasn't had reported cholera cases in the last 5 years, and Cabo Delgado hasn't had reported cases in the last 2 years.	Palma meeting	Director of Palma's SDSMAS	The provided information has been used to update the health profile baseline of Cabo Delgado and Palma (see Section 6.7.3 – Volume I).
21.	The NTS states that Palma has 2 secondary schools. This information is incorrect; Palma has secondary schooling, which is taught in 1 EPC only.	Palma meeting	Chief of Pundanhar Administrative Post	The information regarding education facilities has been updated in Section 6.5.7 (Volume I).
Impact assessment and mitigation (general)				
22.	Did the EIS assess the impacts of the decommissioning phase?	Maputo meeting	Representative of AR	Relevant impacts resulting from the decommissioning phase are assessed for every environmental component. Please refer to Chapter 7 (Volume II).
Impacts on water quality				
23.	Impacts on water quality associated with the management of solid wastes from drilling vessels and waste management procedures.	09.02.2015	Representative of DPCA-CD	This impact is assessed in section 7.3.2.2 (Volume II). Drilling vessels will adhere to the requirements of MARPOL, in what regards solid waste management. No significant impact on water quality is expected.
24.	Impacts on water quality during the drilling phase.	12.02.2015	Representative of LAH Associados	Potential impacts on water quality during the drilling phase were assessed through modeling (see Appendixes X – Volume IV) and are discussed in Section 7.2.4 (Volume II).
Impacts on marine ecology				
25.	Need for a detailed study on marine mammals due to impacts from noise and presence of deep sea whales which are sensitive to noise.	Pemba meeting	Administrator of the Quirimbas National Park (QNP)	The EIS undertook two relevant specialist studies, namely underwater noise and marine ecology. Both provided a baseline assessment and assessed impacts on marine mammals from noise, based on noise modeling results. Baseline results are presented in Section 6.2.3 (Volume I) for noise and Section 6.4 (Volume I) for marine ecology, while impacts are assessed in Section 7.3 (Volume II).

Issues / Comments		Meeting	Stakeholder	Answers / Comments
26.	Potential impacts on marine species resulting from increased sea temperature, due to the FLNG's thermal discharges	Pemba meeting	QNP Administrator	The EIS undertook two specialist studies, namely oceanography (assessing discharges into the ocean) and marine ecology. Both assessed impacts on marine mammals from discharges, based on discharge modeling results. The results are presented in Section 7 (Volume II). The modeling estimates that the maximum increase at the edge of the mixing zone (100 m from the discharge) will be 0.2ºC, well below the admissible limit. No significant impacts on marine ecology were identified resulting from the FLNG thermal discharge.
Impacts on air quality				
27.	Contribution of the FLNG in terms of carbon dioxide to the atmosphere	Pemba meeting	QNP Administrator	The EIS undertook an Air Quality Specialist Study which assesses the contribution of the FLNG project in terms of emissions to the atmosphere. Adequate modeling was carried out, the results of which are found in Section 7.2.1 (Volume II) and model results presented in Appendix XIII (Volume IV). No significant impacts on air quality were identified.
28.	Impacts on air quality, resulting from the power generation unit.	Maputo meeting	Representative of EU; Representative of INP	An Air Quality Specialist Study was developed for the EIS. Impacts on air quality were estimated based on modeling, which took into account the FLNG emissions, including the emissions of the power generation unit. The results are provided in Section **7.2.1** (Volume II). Appendix XIII (Volume IV) provides more information on the modeling process.
Impacts on tourism				
29.	Impacts of the project on sport fishing, particularly in Vamizi Island, due to the visibility of the FLNG vessel	Pemba meeting	Lúrio University Representative	This impact has been assessed both in the Fisheries and Socio-economic Specialist Studies. The results are provided in sections 7.4.1.3 and 7.4.2.2 (Volume II).
30.	Impacts on tourism, development and boom in tourism.	Pemba and Maputo meetings	Representative of Cabo Delgado's Provincial Directorate of Tourism (DPT); Representative of WWF	This impact has been assessed in the Socio-economic Specialist Study and is discussed in Section 7.4.2.2 (Volume II).
31.	Engagement with tourist operators during the EIA.	Pemba meeting	Representative of PDT	Tourist operators were engaged throughout the EIA process, including during the EIS PPP. Please refer to the PPP Report (Volume IV) for more details.
Socio-economic impacts				
32.	Include in the EIS measures directed at promoting the acquisition of services and goods to Mozambican companies during the operational phase.	Maputo meeting	Representative of MIC	The impact of indirect economic stimulation due to the Project's expenditure in the operational phase is assessed in Section 7.4.2 (Volume II). Recommendations to promote, whenever possible, contracting Mozambican companies to supply products and services have been included as enhancement proposals.

Issues / Comments		Meeting	Stakeholder	Answers / Comments
33.	Transfer of technical and professional skills for national workers.	Maputo meeting	Representative of INP	The positive impact related to skill transfer to national personnel is assed in Section 7.4.2 (Volume II). It is recommended that a Training and Skill Transfer program is developed by EEA, focusing on ensuring transfer of skills to national workers, in all operational areas.
Impacts on fisheries				
34.	Impacts on artisanal fishermen due to the fishing restrictions on the FLNG security zone, if they are enabled with motorized boats.	Pemba meeting	Representative of the Institute for the Development of Small Scale Fishery (IDPPE)	The impacts on fisheries resulting from the implementation of the FLNG security zone are assessed in Section 7.4.1 (Volume II). The security zone is a radius of 3.7 km surrounding the FLNG vessel. This is a tiny fraction of the available area for offshore fisheries and thus the impact was not considered to be significant.
35.	Compensation measures for industrial and semi-industrial fishermen, due to the fishing restrictions on the FLNG security zone.	Pemba and Maputo meetings	Representative of IDPPE; Representative of MMAIP	The impacts on industrial and semi-industrial fisheries resulting from the implementation of the FLNG security zone are assessed in Section 7.4.1 (Volume II). The security zone is a radius of 3.7 km surrounding the FLNG vessel. This is a tiny fraction of the available area for offshore fisheries and thus the impact was not considered to be significant. As such, no compensation measures are proposed.
36.	Impacts on artisanal fishermen during the operational phase due to increased risks and scarcer fish stocks.	Maputo meeting	Representative of LAH Associados	The impacts on fisheries resulting during the operational phase are assessed in Section 7.4.1.4 (Volume II). No relevant risks were identified nor any relevant impacts in terms of reduction of fisheries stocks.
Health and Safety				
37.	Responses and time required in case of hydrocarbon spills and safety mechanisms. Effectiveness of the spill response procedures.	Meetings of Pemba, Palma and Maputo	QNP Administrator; Member of Palma CC; Representative of MIREM	The EIS assessed potential impacts resulting from accidental spills of hydrocarbons (see Sections 7.2.4.4 and 7.3.4 – Volume II) and defines the required mitigation, including the need for the proponent to develop specific Oil Spill Response Plan. This will include training of personnel, maintaining Tier 1 oil spill response equipment on support vessels and/or onshore and ensuring arrangements with relevant entities for the deployment of Tier 2 and Tier 3 response equipment and personnel.
Risk assessment				
38.	Why was a diesel spill accident scenario modeled and not an LNG spill?	Maputo meeting	Representative of INP	The accidental scenarios assessed in the EIS were the worst-case scenarios, in terms of environmental impacts. LNG has low toxicity and is soluble and volatile. A LNG spill would result in lower environmental impacts (namely in terms of spill extension and impacts on water quality and marine ecology) than that of a diesel spill.
Environmental performance and management systems				
39.	Communication procedures with stakeholders, including coastal communities, fishermen (artisanal, industrial and semi-industrial) and tourist operators on the Project's activities and presence.	Meetings of Pemba, Palma and Maputo	Representative of Pemba's PDT; Member of Palma CC; Representative of ADNAP	Engagement with communities and fisheries stakeholders was developed during the EIS, as described in the PPP Report. A Communication Framework Plan has been included in the EMP (Volume III), defining the procedures to be undertaken by EEA to disclose information to all stakeholders, including fishing communities and fisheries stakeholders, throughout the project's life cycle.

Issues / Comments		Meeting	Stakeholder	Answers / Comments
40.	The Emergency Response Plan should include response procedures for all relevant risk scenarios, including fires, explosions and piracy attacks.	Maputo meeting	Representative of INP	An Emergency Response Strategy is provided in the EMP (please see Volume III; Annex I) describing the strategic guidelines for emergency response to various accidental scenarios. More detailed emergency responses procedures will be drafted in the detailed engineering phase, when more detailed information regarding the project design are known, and submitted to the relevant authorities, including INP and MITADER.

Table 8.8 – MITADER's comments on the EPDA Report

Issues / Comments		Date	Stakeholder	Commentary
Project Layout/Project Description				
41.	FLNG present some economic and environmental advantages. However, there are significant technical challenges involved in the building of enormous sea structures, able to outstand strong storms as the northern part of the Mozambique Channel is often hit by cyclones.	30.10.2014	MITADER's Review Report of the EPDA	The project does not include any offshore construction activities, except the installation of subsea infrastructure – i.e. SURF system. As stated in Chapter 4 (Volume I) , the FLNG will be assembled at an overseas shipyard and towed to Area 4 and moored to the seabed over the field. The facility is designed to withstand the most severe cyclones (10,000 year return period) and is expected to be on site for at least 25 years without dry-docking
42.	The terms for the duration of each project phase are not listed.	30.10.2014	MITADER's Review Report of the EPDA	The duration of each project phase has been included in Section 4.5 (Volume I).
43.	Along the description of activity no mention is made of manpower and the overall EPDA at no point covers the issue of hiring manpower, whether local or expatriate.	30.10.2014	MITADER's Review Report of the EPDA	The initial estimate foresees a peak of 1350 jobs during the Commissioning phase and around 820 jobs during the operation phase, including Company personnel and Contractors personnel. For company direct personnel (in the range of 320), at the initial phase is foreseen 30% of Mozambican Personnel, number that is expected to increase in subsequent years of operations based on the training program put in place by the operator as well as the training on the job during the normal operations of the FLNG unit. For the Service Contractors personnel, it is expected an higher % of Mozambican labor. Moreover all the contract we will place will be in full respect of the Mozambican Law regarding Local Content and Local Content Plan will be a mandatory requirements for all our contractors to comply with.. Additional information on the amount of employment opportunities is provided in Section 4.9 (Volume I).
44.	The report mentions that land-based infrastructure will be required to support logistic operations offshore and such infrastructure shall be assessed in a different EIA. It is however unclear whether it refers to structures for vessels.	30.10.2014	MITADER's Review Report of the EPDA	The land-based infrastructure will include a logistic base in Pemba that will include a Marine terminal, Helicopter base, Remote monitoring centre, Maintenance workshop, Capital and operations spares warehouse, Administration offices, Training centre, Logistics facilities, Medical centre and Fire fighting (see Section 4.8, Volume I).
45.	It would be objective if every productive component was accompanied by a detailed description of the types and forms of treatment of resulting by-products. For instance, "The drilling rig will be equipped to properly process and handle onboard the drilling fluids".	30.10.2014	MITADER's Review Report of the EPDA	The description of the treatment of drill cuttings aboard the drilling vessels has been provided in Section 4.7.1.1 (Volume I).

Issues / Comments		Date	Stakeholder	Commentary
46.	There is an estimate of 1.5 nautical mile maneuvering safety area around the floating structure. However, to ensure that navigation is done safely we recommend presentation of the respective geographic coordinates.	30.10.2014	MITADER's Review Report of the EPDA	A map clearly illustrating the positioning of the FLNG and the safety zone is presented in Figure 4.10, (Volume I). The coordinates of the FLNG are also provided in Table 4.1 (Volume I).
47.	The identification and assessment of likely effects should not be directed only at tourist resorts and fisheries. The impact assessment exercise should focus on Government Plans and Programs for the region.	30.10.2014	MITADER's Review Report of the EPDA	The EIS identifies all plans and programs relevant to the project, indicating overall compliance to the strategic goals – this is provided in Section 2.2 (Volume I).
48.	The report seems to suggest that there is a possibility of conducting some activities on the coast. However, the description of potential impacts only assesses impacts on the aquatic environment. Failure to provide this information will be deemed as an omission of the matter and should wait for additional assessments.	30.10.2014	MITADER's Review Report of the EPDA	The scope of this EIA covers the FLNG facility which is located offshore. All support infrastructure based onshore will be subject to separate EIA processes and is not assessed in this EIS.
49.	There are contradictions regarding flaring of hydrocarbons, and the flaring of residual gases will not take place in normal operation, save in the event of emergencies. Certain amounts of gas will be released to the atmosphere (venting) during maintenance procedures.	30.10.2014	MITADER's Review Report of the EPDA	Flaring will only occur in case of emergency – this has been clarified in Section 4.7.4.5 (Volume I).
50.	Clarify if FLNG structure will be designed to outstand severe cyclones.	30.10.2014 12.02.2015	MITADER's Review Report of the EPDA; Representative of INP	This has been clarified in Section 4.5 (Volume I). The facility is being designed to withstand cyclones and storms without the need to disconnections.
51.	Submission of layouts and diagrams in appropriate size and format, to facilitate reading and understanding.	30.10.2014	MITADER's Review Report of the EPDA	All layouts and figures have appropriate size and format, as requested.

Issues / Comments		Date	Stakeholder	Commentary
52.	Submission of data on manpower to be allocated to the production phase, specifying the number of men, women, permanent and seasonal workers, levels of qualification and worker origins, including local/national staff.	30.10.2014 12.02.2015	MITADER's Review Report of the EPDA; Representative of Ministry of Mineral Resources and Energy	The initial estimate foresees a peak of 1350 jobs during the Commissioning phase and around 820 jobs during the operation phase, including Company personnel and Contractors personnel. For company direct personnel (in the range of 320), at the initial phase is foreseen 30% of Mozambican Personnel, number that is expected to increase in subsequent years of operations based on the training program put in place by the operator as well as the training on the job during the normal operations of the FLNG unit. For the Service Contractors personnel, it is expected an higher % of Mozambican labor. Moreover all the contract we will place will be in full respect of the Mozambican Law regarding Local Content and Local Content Plan will be a mandatory requirements for all our contractors to comply with.. Additional information on the amount of employment opportunities is provided in Section 4.9 (Volume I).
53.	Indication of the treatment technology and quantities of by-products resulting from drilling activities.	30.10.2014	MITADER's Review Report of the EPDA	This description in provided in Section 4.7.1.1 (Volume I).
54.	Detailed presentation of safety issues related to the movement of waves and cyclones occurrence, during loading and transport of LNG at sea.	30.10.2014	MITADER's Review Report of the EPDA	The FLNG facility was designed to withstand the most severe cyclones (10,000 year return period) without the need to disconnect and is expected to be on site for at least 25 years without dry-docking. This is provided in Section 4.7.2.2 (Volume I).
55.	Clarification on the removal of natural components in gas extracted from the drilling wells.	30.10.2014	MITADER's Review Report of the EPDA	This information has been provided in Section 4.7.4.1 (Volume I).
56.	The list of emissions resulting from burning residual gases in the respective section.	30.10.2014	MITADER's Review Report of the EPDA	This information is provided in Table 4.8, Section 4.7.4.11 (Volume I).
57.	Indication of the total expected investment amount for the development of the Project.	30.10.2014 12.02.2015	MITADER's Review Report of the EPDA; Individual Citizen	This is provided in Section 4.1 (Volume I)and corresponds to between 7-9 billion USD.
EIA Process and Public Consultation				
58.	Ensure proximity between the proponent and the directly affected stakeholders during the Public Participation Process to allow them to negotiate their interests in order to find feasible and efficient solutions and agree to a set of environmental and social issues.	30.10.2014	MITADER's Review Report of the EPDA	The PPP activities undertaken during the EIS are described in the PPP Report. These were developed in compliance with Ministerial Diploma No. 130/2006 which sets General Guidelines for Public Participation Process in the EIA process, and included public meetings in Pemba and Maputo, an information meeting with the Palma District Administration, focus group discussions with the fishing communities of Palma and other stakeholder engagement activities.
Legal framework				
59.	Recommend compliance with the complementary legal provisions, e.g. Ministerial Diploma no. 129/2009 from 19 July.	30.10.2014	MITADER's Review Report of the EPDA	This has been included in the legal framework, Chapter 2 (Volume I).

Issues / Comments		Date	Stakeholder	Commentary
60.	Compliance with the Regulation on the Environmental Assessment Process passed by Decree no. 45/2004 on 29 September, from the Environmental Regulation on Oil Operations, passed by Decree 56/2010 on 22 November, and General Guidelines for the Development of Environmental Impact Assessments and Public Participation Process, passed by Ministerial Diplomas 126/2006 and 130/2006 both on 19 July.	30.10.2014	MITADER's Review Report of the EPDA	The EIS was fully compliant with these Decrees and Regulations. These are referred to in Section 2 as well as Section 3 (Volume I).
61.	The inclusion in the legal framework: a) The International Maritime Code for Hazardous Goods applicable to Maritime transportation, as well as IBC and IGC.	30.10.2014	MITADER's Review Report of the EPDA	This has been included in Chapter 2 (Volume I) of the EIS.
62.	The inclusion in the legal framework: b) Sector-based Programs for later characterization/identification of possible conflicts between the developer/project proponent and the Mozambican Government's Action Plans in relation to sector-based management of natural resources occurring in the direct and indirect areas of influence. Thus the importance of identifying opinion makers within the study areas, to enable MICOA to understand the level of acceptability of the project by those who reserve the right to establish norms and rules for the management natural resources.	30.10.2014	MITADER's Review Report of the EPDA	Relevant national Programs and Plans have been identified in Section 2.2 (Volume I).Eventual conflicts between these programs and the project have also been assessed in the same section.
63.	The inclusion in the legal framework: c) Labor legislation.	30.10.2014	MITADER's Review Report of the EPDA	Included in Section 2.4 (Volume I).

Issues / Comments		Date	Stakeholder	Commentary
Areas of Influence				
64.	Art. 1 (2) of Decree 45/2004 on 29 September states that the extent of the area of influence should be established based on the impacts resulting from the activity. The EPDA's area of direct influence basically covers a maximum security area with 2 miles radius around the FLNG, firm on the surface corresponding to the maximum security area provided for the project. From this definition it is unclear whether the ADI definition considered the legal provisions applicable to the sector or complementary legal tools with important guidance. The Area of Direct Influence is defined as the actual geographic area covering 2 miles, but the criteria for this definition is unclear. Is ADI the geographic area on the surface of the sea on which the direct environmental impacts of the project are effective? Should this be the case, kindly take into consideration that the nature of the impact varies greatly, from biotic and abiotic factors, in summary for the EPDA submitted. Some direct impacts are distant from the FLNG on the surface, some may damage sensitive the deep-sea areas. We recommend in the scope of definition of the AoI to take into consideration that the FLNG will be located offshore with a depth of about (2,000 m), therefore the AoI should also include the underwater area;	30.10.2014	MITADER's Review Report of the EPDA	Chapter 5 (Volume I) reassesses the preliminary areas of direct and indirect influence defined in the EPDA, based on all specialist studies and input, i.e., air quality, underwater noise, oceanography (including a series of models to assess impacts associated with thermal discharge, produced water discharge, drill cuttings discharge and oil spills), socio-economic and tourism, fisheries and maritime navigation. These recommendations have been duly taken into account in the definition of the areas of influence.
Baseline assessment				
65.	The expected location of the FLNG is located in a complex area. I.e. according to the overall data available, it is an area of concentration of underwater epicenters. Source: Paulo Jorge Acurcio das Merces e Sousa, "Avaliação de Perigosidade Sismica e Segurança Estrutural em Moçambique 2006". We deem pertinent to include this descriptor in the analysis of environmental issues.	30.10.2014	MITADER's Review Report of the EPDA	This issue and reference to Sousa 2006 has been included in Section 6.1.6 (Volume I).

Issues / Comments		Date	Stakeholder	Commentary
66.	The EPDA states that current noise levels close to the Project are low and no baseline noise assessment will be conducted. We cannot understand what led the consulting team do decide not to include the assessment of primary data, when the aim is to reduce acoustic effects of the development on the adjacent environment.	30.10.2014	MITADER's Review Report of the EPDA	The baseline assessment provides quantitative estimates for underwater noise based on literature review (see Section 6.1.3; Volume I). Given that the area if largely undeveloped, it was reasonable to make assumptions on local underwater noise conditions.
67.	Conducting and submitting studies related to protection against piracy attacks at the Channel of Mozambique, taking into consideration that maritime movement will increase in the area.	30.10.2014	MITADER's Review Report of the EPDA	This aspect has been considered in the Maritime Navigation Specialist Study and is presented in Section 6.6.3.6 (Volume I).
Impact assessment and mitigation (general)				
68.	Separate analysis of expected impacts from the construction phase, operation phase and project decommissioning.	30.10.2014	MITADER's review report of the EPDA	Impact assessment on each environmental component was grouped according to project phases and types of impacts.
Impacts on water quality				
69.	The EPDA does not mention the characteristics, physical features and daily quantities of water discharged to the sea (temperature limits for the discharged effluents, chlorine concentration in parts per million after treatment), as well as the likely impacts that may arise for the marine ecosystem.	30.10.2014	MITADER's Review Report of the EPDA	This information has been provided in Section 4.7.4.2 (Volume I)and the impacts assessed in Sections 7.2.4 (water quality) and 7.3.3 (marine ecology) of Volume II. Results of modeling are also presented in Appendixes VIII and IX (Volume IV).
70.	The quality of seawater may change due to discharge of drilling cuttings, increased turbidity, and contaminant load. However a great movement of support ships is expected from the implementation process to operation, as well as support to FLNG operation. In addition to the above mentioned sources of pollution, it is important to include the issue of oils and lubricants spills from these additional vessels.	30.10.2014	MITADER's Review Report of the EPDA	Potential impacts on water quality due to drilling cuttings and potential accidental spills were assessed through modeling (see Appendixes X and XI – Volume IV) and are discussed in Section 7.2.4 (Volume II). Associated impacts on marine ecology and the socioeconomic environment are discussed in Sections 7.3 and 7.4 (Volume II), respectively.
71.	According to the structural complexity of the FLNG, it is clearly visible that acoustic effects are likely both for the underwater environment and the air environment, and its assessment should be included.	30.10.2014	MITADER's Review Report of the EPDA	No noise sensitive receptors have been identified around the FLNG facility other than marine organisms. As such, the noise assessment was limited to the underwater environment. An Underwater Noise Specialist Study was undertaken, and the potential noise impacts on marine ecology are described in Section 7.3 (Volume II).

Issues / Comments		Date	Stakeholder	Commentary
72.	There is a reference to the proximity of Area 4 with proposed conservation areas. There will be no direct influence of FLNG on areas of specific interest, but there is a clear link between "land-sea" activities that may influence the conservation units and/or specific management. Thus, we recommend that these impacts are included on this list, the issue regarding the interference of this development on the conservation units.	30.10.2014	MITADER's Review Report of the EPDA	Land-based activities will be located in Pemba and subject to a separate EIA process. As such, they have not been included in this EIS. No project impacts on conservation areas is expected.
73.	The impact of colonization of subsea structures with increased biodiversity has been identified as positive impact on the subsea structure. This statement is not clear as increased organisms in a certain area, depending on the species, may create an ecological imbalance.	30.10.2014	MITADER's Review Report of the EPDA	This impact was not identified during the EIS.
74.	The use of seawater as cooling medium may result in loss or gain of species, depending on adaptations from each species. This is ambiguous and makes it a judgment call for the reader which is not correct. Requires further details. Increasing temperature will depend on the season, however the length and size of the cooling system circuit, 150 m deep, is not taken into account. Thus the doubt on whether the identification of impact lies on the planktonic, nektonic or benthonic community.	30.10.2014	MITADER's Review Report of the EPDA	Modeling of the FLNG's thermal discharges was undertaken as part of the Oceanographic Specialist Study (see Appendix VIII – Volume IV) and the potential impacts on marine ecology are discussed in section 7.3.3.2 (Volume II). The national and international limits for increased water temperature are complied to, and no significant impacts on marine ecology due to the FLNG's thermal discharge were identified.
Impacts on air quality				
75.	Any atmospheric emissions (whether continuous or not) include sources of combustion for generation of energy and heat. The resulting emissions from flaring and venting, as well as leaks comprise the main gases NOx, CO2, CO and others. For FNGL plants with major combustion sources, the impacts on air quality should be estimated from baseline assessments to the quality of air and assessment and atmospheric dispersion models to establish their air concentrations during all project phases, from operation to decommissioning.	30.10.2014	MITADER's Review Report of the EPDA	An Air Quality Specialist Study was developed for the EIS. Impacts on air quality were estimated based on modeling, the results of which are provided in Section 7.2.1 (Volume II). Appendix XIII (Volume IV) provides more information on the modeling process.

Issues / Comments		Date	Stakeholder	Commentary
Impacts on navigation				
Socio-economic impacts				
76.	Regarding socioeconomic gains for the local population, state that the implementation of this type of project will not contribute to employment of local manpower since all operations will be conducted offshore with specific technology.	30.10.2014	MITADER's review report of the EPDA	While the FLNG facility will be located offshore, it will be supported by home office and support base located onshore in Pemba. While these structures will be subject to a specific EIA process, they will employ about 500 people, some of which will be Mozambican. This potential positive impact was assessed in the socio-economic specialist study and is presented in Section 7.4.2.2 (Volume II).
77.	Vessels and FLNG activities may interfere with tourism activities and commercial fishing ships. The list should include any impacts found and the economic consequences for the affected sectors.	30.10.2014	MITADER's review report of the EPDA	Impacts on maritime navigation were subject to a specific specialist study and are presented in Section 7.4.3 (Volume II). Impacts on fisheries were also subject to a specific specialist study and are presented in Section 7.4.1 (Volume II).
78.	Include in the assessment of impacts the issue related to management of local manpower.	30.10.2014	MITADER's review report of the EPDA	This issue has been assessed under the socio-economic specialist study and is discussed in Section 7.4.2 (Volume II).
Impacts on fisheries				
79.	The EPDA states that no health-related assessment will be conducted failing to provide a detailed explanation of the reasons for this decision. Regarding this issues we would like to state the importance of submitting a health assessment since chemicals will be stored and handled during operations, from which there may be gas emission and taking into consideration working in confined spaces, there are health risks for the workers that should be addressed.	30.10.2014	MITADER's review report of the EPDA	Potential health impacts on non-project people were duly identified and assessed in Section 7.4.4 (Volume II). Work health and safety issues have not been included in this EIS, as these issues are outside the scope of an EIA process. However, EEA has a specific EHS Policy which is included in Section 2.7.4 (Volume I).
Risk assessment				
80.	Assessment such as Hazard Identification (HAZID), Operational Hazards (HAZOP) were conducted for identification of hazards pertinent to this phase. To confront impacts described on the EPDA to the findings of the HAZID/HAZOP we recommend that the results of such assessments are included as appendices to the EIS report.	30.10.2014	MITADER's review report of the EPDA	These studies will be carried out during the Front End Engineering Design (FEED) phase and developed in details during the EPCIC phase

Issues / Comments		Date	Stakeholder	Commentary
81.	Conducting a more detailed risk assessment to ensure that they are the lowest possible, since the health and safety risks for the crew on the platform will be relatively higher than on an onshore LNG plant. Given that the potential consequences of an explosion and fire event on sea are higher than on land, it is paramount to ensure that the loss of contention at the FLNG platform is not significant.	30.10.2014	MITADER's review report of the EPDA	These studies will be carried out during the Front End Engineering Design (FEED) phase and developed in details during the EPCIC phase.
Environmental performance and management systems				
82.	From review to the Environmental Management Plan and considering the complexity of the process to reduce impacts to an acceptable level it is pertinent to know beforehand the specific control/minimization/monitoring programs that the consultant will propose in the EIS. We expectation to find in the respective subchapter the list of specific programs in support of environmental management.	30.10.2014	MITADER's review report of the EPDA	The EMP is provided in Volume III with a set of Management Plans.
83.	Submission of a comprehensive plan for Greenhouse Gas management and energy management, that includes emission minimization measures for such gases as well as measures to improve energy efficiency.	30.10.2014	MITADER's review report of the EPDA	A specific Air Quality Management Plan has been drafted as part of the EMP (Volume III).
84.	Submission of detailed spillage prevention measures during the process of offloading of condensed.	30.10.2014	MITADER's review report of the EPDA	EEA will develop and implement a comprehensive oil spill response plan (OSRP) for the FLNG project which will take into account all spillage prevention measures. Tier 1 oil spill response equipment will also be staged on support vessels and/or at shore.
85.	Include in the Environmental Management Plan: a) The Communication and Social Responsibility Programs.	30.10.2014	MITADER's review report of the EPDA	A Communication Framework Plan has been included in the EMP (Volume III). EEA is responsible for drafting a Social Responsibility Program, which is outside the scope of this EIA process.
86.	Include in the Environmental Management Plan: b) Monitoring Program of Possible Interference on Fishery Activities.	30.10.2014	MITADER's review report of the EPDA	A specific Socio-economic and Fisheries Management Plan has been drafted as part of the EMP (Volume III).
87.	Include in the Environmental Management Plan: c) Environmental Education Program for Workers.	30.10.2014	MITADER's review report of the EPDA	En Environmental Training Program was included in the EMP (Section 4.8; Volume III).
88.	Include in the Environmental Management Plan: d) Monitoring and Control Program for Seabed Preparation Activities for Drilling Activities.	30.10.2014	MITADER's review report of the EPDA	No specific Plan has been prepared for seabed preparation activities, however all relevant measures to avoid or reduce negative impacts associated with these activities have been included in the different management programs provided in the EMP (please see Volume III - sections 4.2 to 4.9).

Issues / Comments		Date	Stakeholder	Commentary
89.	Include in the Environmental Management Plan: f) Monitoring and Control Program for Gas Exploration Activities.	30.10.2014	MITADER's review report of the EPDA	No specific Plan has been prepared for gas exploration activities, however all relevant measures to avoid or reduce negative impacts associated with these activities have been included in the different management programs provided in the EMP (please see Volume III - sections 4.2 to 4.9).
90.	Include in the Environmental Management Plan: g) Monitoring and Control Program for Gas Processing Activities.	30.10.2014	MITADER's review report of the EPDA	No specific Plan has been prepared for gas processing activities, however all relevant measures to avoid or reduce negative impacts associated with these activities have been included in the different management programs provided in the EMP (please see Volume III - sections 4.2 to 4.9).
91.	Include in the Environmental Management Plan: h) Monitoring and Control Program of LNG Offloading Activities.	30.10.2014	MITADER's review report of the EPDA	No specific Plan has been prepared for LNG offloading activities, however all relevant measures to avoid or reduce negative impacts associated with these activities have been included in the different management programs provided in the EMP (please see Volume III - sections 4.2 to 4.9).
92.	Include in the Environmental Management Plan: i) Biota Control and Monitoring Program.	30.10.2014	MITADER's review report of the EPDA	Two Management Plans have been included in the EMP which specifically deal with biota namely a Marine Ecology Management Plan and an Effluent and Marine Discharges Management Plan (please refer to Volume III - sections 4.4 and 4.2 respectively).
93.	Include in the Environmental Management Plan: j) Noise and Vibration Management Program.	30.10.2014	MITADER's review report of the EPDA	A Noise and Vibration Management Program was not considered relevant by the noise specialist study, However, relevant mitigation and control management measures have been included in the EMP, in particular in the Marine Ecology Management Plan (see Volume III; Section 4.4).
94.	Include in the Environmental Management Plan: k) Emergency Action Plan;	30.10.2014	MITADER's review report of the EPDA	An Emergency Action Plan has been included in the EMP (Volume III).

9 Conclusions and Recommendations

EEA proposes to install and operate a FLNG in Area 4, located offshore the District of Palma. This report presents the findings of the impact assessment of the proposed project, developed in compliance with the Terms of Reference for the EIS, defined in the EPDA phase. All potential negative and positive impacts on the receiving biophysical and socioeconomic environment were identified and evaluated both in the pre-mitigation scenario and following the implementation of the recommended mitigation and enhancement measures (the residual impacts).

The drilling, installation, commissioning, operational and decommissioning phases of the FLNG project imply a wide range of different impacts on the receiving environment. Impacts associated with the drilling, installation, commissioning, and decommissioning phases are mostly related, directly or indirectly, to increases in vessel traffic with consequent noise and illumination effects on people (including tourism) and marine fauna, exclusion zones around the drilling and FLNG vessel with effects on reduced areas for fishing and marine navigation, increased air and greenhouse gas emissions, potential seawater degradation due to discharge of drill cuttings and effects on the marine ecology due to effluents, waste, potential entanglement of marine fauna, introduction of alien species, among others. In the operational phase, impacts are likely to be similar, however with a critical duration given that the FLNG is expected to operate for 25 years. In addition, operational impacts will also include operational discharges including thermal and produced water. Impacts associated with unplanned events are mainly related to oil spills, vessel collisions and well blowouts.

The results of the impact assessment exercise conducted in this EIS are summarized in the form of a table in Section 7.5. The vast majority of the FLNG's impacts were rated as low or medium significance following mitigation, i.e. assuming the implementation of the proposed mitigation. While no critical significance residual impacts were identified, a few positive impacts were rated as high significance post mitigation, namely those related to the stimulation of the local and regional economy, the transfer of technical and specialized skills to national labor throughout the FLNG lifespan and the increased revenue to the provincial and national government resulting both from the sale of LNG and increased tax collection. Negative impacts rated as high significance prior to mitigation were mainly related to unplanned events, including effects of accidental spills on marine fauna and coastal habitats. In addition, community expectations, risks of entanglement for marine fauna and risk of introduction of alien species were also identified as high significance prior to mitigation.

The FLNG Project is thus likely to result in both negative and positive residual impacts on the receiving environment. No residual negative impacts of critical significance were identified and a few high significance positive impacts were identified, especially during the operational phase. As such, the FLNG Project is considered environmentally feasible if all mitigation and enhancement measures outlined in the EIS are implemented by EEA.

The Project's EMP (Volume III) summarizes and structures all management, mitigation and monitoring requirements defined in this EIS. It is recommended that the EMP is strictly complied to and updated across the Project's life cycle. This will require action by several entities, namely the Project's Proponent (EEA) the contractors, and several other governmental agencies.

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