

**EIA FOR SHALLOW WATER EXPLORATION SEISMIC SURVEY &
EXPLORATION DRILLING ROVUMA AREA 1**



ENVIRONMENTAL IMPACT STUDY REPORT

Volume 1

NON-TECHNICAL SUMMARY

Prepared by:



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LIST OF ABBREVIATIONS AND ACRONYMS

2-D	Two-dimensional
3-D	Three-dimensional
AMA1	Anadarko Moçambique Área 1, Lda
AOO	Accommodation Only Operators
APC	Anadarko Petroleum Corporation
BID	Background Information Document
BOD	Biochemical Oxygen Demand
BOP	Blowout Preventer
CE	Critically Endangered
CSA	CSA International, Inc.
DD	Data Deficient
DGPS	Differentiated Global Position System
DMAC	Diving Medical Advisory Committee
DNAC	National Directorate for Conservation Areas
DNAIA	<i>Direcção Nacional de Avaliação de Impacto Ambiental</i> (National Directorate for Environment Impact Assessment)
EC	Environmental Component
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EHS	Environmental, Health, and Safety
EIR	Environmental Impact Report
EMP	Environmental Management Plan
ENH	Empresa Nacional de Hidrocarbonetos, EP
EPC	Exploration and Production Concession
EPDA	<i>Estudo de Pré-viabilidade Ambiental e Definição de Âmbito</i> (Environmental Pre-feasibility and Scoping Study)
ERP	Emergency Response Plan
GOM	Government of Mozambique
IIP	<i>Instituto de Investigação Pesqueira</i> (Fisheries Research Institute)
INAMAR	National Institute of Maritime Authority
IPIECA	International Petroleum Industry Environmental Conservation Association
IUCN	International Union for the Conservation of Nature
L&AO	Leisure and Accommodation Operators
MBREMP	Mnazi Bay-Ruvuma Estuary Marine Park
MICOA	Ministry for Coordination of Environmental Affairs Mozambique
MITUR	Ministry of Tourism
MP	Ministry of Fisheries (<i>Ministério das Pescas</i>)
NADF	Non-Aqueous Drilling Fluid
NEMP	National Environmental Management Program
NO _x	Nitrogen Monoxide
NOSCP	National Oil Spill Contingency Plan
NTPIS	National Tourism Policy and Implementation Strategy
QNP	Quirimbas National Park
ToR	Terms of Reference

1.0 INTRODUCTION

Anadarko Moçambique Área 1, Lda (AMA1) signed an Exploration and Production Concession (EPC) contract with the Government of the Republic of Mozambique for the exploration of Offshore Area 1 in the Rovuma Basin. The EPC contract gives AMA1 exclusive rights to explore for and produce commercial quantities of hydrocarbons in the block. As part of the agreement, AMA1 will undertake 2D and 3D seismic surveys and exploration drilling in Area 1. AMA1 has committed to drill a minimum of seven wells. Four of the exploration wells will be drilled in water depths greater than 200m and the remainder in shallower waters, less than 200m depth.

The main objective of the project is to determine if the prospects, identified after the seismic surveys and exploration drilling, have hydrocarbons in commercial quantities. The seismic survey will allow the identification of prospects for exploration drilling, using acoustic energy to map the structure of the earth's crust below the seafloor. Exploration drilling is a temporary activity aimed to determine the presence of hydrocarbons.

The Ministry for the Coordination of Environmental Affairs (MICOA) has classified the project as a Category A project (Appendix 1) in accordance with the Environmental Impact Assessment Decree (Decree 45/2004). Therefore, an Environmental Impact Assessment (EIA) must be prepared for the project.

This Non-technical Summary is part of the Environmental Impact Assessment Report (EIAR) for the shallow water seismic and drilling (SWSD) operations proposed by AMA1 in the Rovuma Offshore Area 1, which consists of four volumes:

- Volume I – Non -Technical Summary;
- Volume II – Part A: EIS Report and Part B: Environmental Management Plan (EMP);
- Volume III – Specialist Studies
- Volume IV – Public Participation Report.

AMA1 have commissioned Projectos e Estudos de Impacto Ambiental, Limitada to prepare the Environmental Impact Assessment. CSA international. a company based in the USA provided selected technical contributions for the preparation of this document. .

The EIA was prepared by a multidisciplinary team which comprised the following specialists:

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- Carlota Quilambo – Project Manager
- John Hatton – Technical Coordinator

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2.0 PURPOSE

The purpose of the EIA is to evaluate potential impacts to the physical, biological and social environments arising from the shallow water seismic surveys and exploration drilling and to identify appropriate mitigating measures to reduce/eliminate potential negative impacts as well as measures to enhance any potential positive impacts.

3.0 PROPOSED PROJECT

This project refers to seismic surveys and exploration drilling of a minimum of three wells in shallow waters - mainly less than 200m in depth in Offshore Area 1. The Project area is limited by the northern and southern borders of the block, while the western border is defined by the coastline and the eastern border is defined by the line that joins the most eastern points of the 200 m bathymetry line. The western border of the Project area also encompasses those offshore areas contained within the Rovuma Onshore Area (**Figure 1**).



Figure 1. Area of proposed seismic surveys and exploration drilling in the AMA1 Concession Area in the Rovuma Basin

AMA1 intends to conduct the proposed 2-D seismic survey in the second quarter of 2009. It is planned that the seismic program will be conducted in 90 days. The 2-D lines will serve as a reconnaissance tool to determine the location of any 3-D surveys required in the area. The schedule for the 3 D surveys has not been determined and will be controlled by the interpretation of the 2D data and equipment availability. Drilling may proceed with out acquisition of a 3D seismic survey.

The exploratory drilling phase is expected to commence in the first quarter of 2010. The duration of individual wells is expected to be less than 90 days. Three obligatory wells will be drilled before February 2012.

4.0 ALTERNATIVES CONSIDERED

According to the Mozambican EIA legislation, an analysis of alternatives is required. This report assesses two types of alternatives: a) The No Action Alternative and b) Project Alternatives, including the project location (adjustments to the location of the seismic survey configuration and location of the rigs), adjustments to project scheduling (timing of seismic surveys) and project technologies (seismic methods and rig and drilling fluids alternatives).

The “No Action” alternative

The “No Action” alternative is not recommended as:

1. AMA1 has signed an Exploration and Production Concession (EPC) contract with the Government of the Republic of Mozambique for Offshore Area 1 and has a contractual obligation to carry out exploratory drilling in the Concession Area. The “No Action” alternative would represent a failure to meet the requirements of the EPC contract between AMA1 and the Government of Mozambique.
2. Opportunities to find hydrocarbons in the project area would be eliminated and would thus prevent Mozambique from accruing potentially significant economic benefits.

Spatial alternatives

The analysis of project spatial alternatives for the seismic program within the Project area took into account several criteria for development of an alternative seismic configuration. These criteria include:

1. Seismic lines occurring within, or near to, sensitive habitats identified in the habitat mapping exercise.
2. Seismic lines occurring near to islands with tourism complexes
3. Seismic lines occurring with, or near to, the buffer zone of the Quirimbas National Park.

Based on these criteria alternatives to the initial seismic configuration were made *viz.*:

1. Seismic lines passing through certain sensitive habitats and associated buffer zones were excluded.
2. Seismic lines passing adjacent to islands with tourist complexes (Vamizi and Medjumbe islands) were moved or excluded
3. Seismic lines within the Concession Area 1 but falling within the Quirimbas National Park buffer zone were excluded.

The initial seismic program comprised 2503 km of seismic lines whereas the revised seismic program comprises 1180 km of seismic lines (i.e., a reduction of 53%).

Alternative Scheduling

Seismic surveys will be scheduled to avoid the humpback whale migration season which takes place from July through to December.

Alternative technologies

The types of rig and drilling fluid system alternatives to be used were considered. For both the most environmentally friendly alternatives were chose

5.0 KEY ISSUES FOR INVESTIGATION

Critical factors in the Category A activity classification related to this project are described below:

The main potential bio-physical and socio-economic impacts associated with the seismic survey and identified in the EPDA and TOR are the following:

- Impacts of underwater noise arising from the seismic sound sources on marine resources, especially marine mammals, sea turtles and fish;
- Operation of streamers in shallow water with sensitive habitats could pose potential impacts due to direct contact;
- Interruption of artisanal fishing due to the safety zone around the seismic vessels, support vessels, and the recording cables;
- Impacts on artisanal divers due to the underwater noise coming from seismic sound sources;
- Interference with local shipping due to the safety zone around the seismic vessels, support vessels, and the recording cables;
- Impacts on tourist activities (scuba diving), due to the underwater noise arising from seismic sound sources, or to the safety exclusion zones around the seismic vessels (affecting sports fishing);
- The project will have a positive impact insofar that it will stimulate the local economy through the provision of services and goods. This will be limited during the exploration phase, but will be very significant for the national and local economy if economically viable reserves of hydrocarbons are discovered.

The main potential bio-physical and socio-economic impacts associated with exploration drilling are the following:

- Localized increase in water turbidity;
- Water contamination by potential hydrocarbon spills and subsequent impacts on marine fauna and socio-economic activities;
- Localized, physical impacts on habitats associated with locating the drilling rig on the substrate (sea grasses, corals, benthic fauna etc.);
- Localized, behavioral and physical impacts to marine mammals and sea turtles from drilling operations and vessel traffic associated with drilling operations;
- Interruption of artisanal fisheries due to the safety zone around the drilling rig;
- Interference with the tourism activities in the area (safety zone and aesthetic impacts).

These issues emerged from the initial stakeholder engagement and the EIA team's preliminary assessments.

The affected environment for this impact assessment encompasses the following three elements:

- Physical-chemical environment: climate, tides, currents oceanography and bathymetry;
- Biological environment – Corals, sea grasses, mangroves, fish, marine mammals (whales, dolphins and dugongs) and sea turtles; and
- Socio-economic environment – fishing and tourism.

The EIS comprised a combination of desktop studies (based on existing data) and field studies (for collection of primary data).

The following specialist studies were undertaken during the Environmental Impact Study:

1. Legal and institutional review
2. A description of the biophysical environment
3. A review of marine mammals and sea turtles that occur in the Project area that are sensitive to noise, and the potential impacts that affect these species
4. A review fish biology and impacts coral reef fish (either behavioral or physiological)
5. Underwater Noise Modeling for Shallow Water Seismic Surveys and Exploration Drilling
6. Assessments of potential impacts arising from oil spills on the marine and socio-economic environments
7. A socio-economic survey of artisanal fisheries activity to assess potential impacts
8. A study of tourism the Project area
9. Sensitivity analysis and sensitivity mapping of coastal and marine habitats and socio-economic features

Mapping of coastal and marine habitats using detailed satellite imagery was carried out a separate exercise. The results of this study were used to prepare a detailed description of the coastal, island and shallow water habitats including sandy beaches, seagrass

beds, mangroves and coral reefs. Sensitivity mapping of coastal and marine habitats and socio-economic features was performed based on the habitat map

Additional biological data was obtained from two field studies that were commissioned by the AMA1 specifically for the project area *viz.*:

- An Aerial Census Survey of Marine Mammals and Sea Turtles in the Shallow Waters within the Offshore Area 1 Concession Block;
- A Representative Marine Habitat Survey of the northern Quirimbas Archipelago.

6.0 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

The overall Project comprises five separate “sub-Projects” as described in Chapter 2. For the purposes of the Environmental Impact Assessment two of the sub-Projects have identical impacts (*viz.*, 2D and 3D seismic surveys using ocean bottom cables) and these are discussed together in Chapter 6. Impacts are evaluated for the following sub-Projects:

1. Two dimensional (2D) seismic surveys using shallow water streamers, which send sound waves directed downwards from a seismic vessel;
2. 2D and 3D seismic surveys using ocean bottom cables;
3. 3D seismic surveys using individual (autonomous) receivers that are placed on the sea floor; and
4. Drilling

The impact assessment process, in the first instance, identifies the activities associated with each of the sub-projects above that could interact with the environment.

In parallel, the key biological, physical and human components of the project area described in Chapter 5 (Biophysical and Socioeconomic Description of the Study Area) that could be affected by the activities of each sub-project are identified. The potential positive and negative impacts resulting from each of the sub-project activities were predicted. These predicted impacts were then evaluated using a significance ranking process.

An outline of the impact assessment procedure is as follows:

- Identification of the key project activities;
- Identification of the environmental components;
- Impact identification;
- Impact evaluation; and
- Significance ranking

7.0 SUMMARY OF THE POTENTIAL IMPACTS AND MITIGATION MEASURES

The potential impacts and mitigating measures associated with routine and non-routine events for seismic surveys and exploratory drilling are presented in Tables 1, 2, 3 and 4 respectively.

Table 1. Mitigation Measures for routine events (seismic survey)

No.	EC	EC sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
PHYSICAL AND CHEMICAL ENVIRONMENT							
1	AIR	MEDIUM	Mobilization/ demobilization and seismic operations	Reduction in air quality due to project emissions	INSIGNIFICANT	<p>Regularly maintain seismic vessel motors and engines.</p> <p>Operate and maintain exhaust systems and engines in accordance with the manufacturer's specifications.</p> <p>Use preventative maintenance, leak detection and repair programs.</p> <p>Compliance to Annex VI MARPOL emission standards:</p> <ul style="list-style-type: none"> • Diesel engine NO_x emissions should be limited to between 9.8 and 17 g/kWh, depending on maximum operating speed. • Substances harmful to the ozone layer (including halon and CFCs), cannot be deliberately released. New facilities can contain HCFCs until 1Jan 2020, but cannot contain other substances that harm the ozone layer. 	INSIGNIFICANT
2	WATER	HIGH	Mobilization/ demobilization and seismic operations	Water contamination around the seismic vessel and accommodation barge due to deck drainage and bilge water	INSIGNIFICANT	<p>Any bilge water from the two seismic vessels will be transferred to the accommodation barge each night.</p> <p>At appropriate intervals stored bilge water should be disposed of and or in accordance with MARPOL.</p>	INSIGNIFICANT

No.	EC	EC sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
PHYSICAL AND CHEMICAL ENVIRONMENT							
3				Water contamination around the seismic vessel and accommodation barge from the discharge of sanitary sewage	MINOR	<p>The disposal of liquid wastes will be conducted in accordance with MARPOL 73/78 (Annexes 1-4):</p> <ul style="list-style-type: none"> • Sewage must be treated and disinfected (on-board treatment plant) prior to discharge. <ul style="list-style-type: none"> • Treated effluents shall achieve a BOD < 40 ppm, suspended solids < 50 ppm and a coliform count < 200 cells per 100 ml of effluent. 	INSIGNIFICANT
4				Reduced water quality due to the discharge of solid wastes	MINOR	<ul style="list-style-type: none"> • Solid waste (kitchen waste) can be macerated to 25mm and then discharged to the sea (3nm at least from the coast). Untreated kitchen waste will be discharged farther than 12 nautical miles from the nearest shore. • All other solid waste must be segregated and contained for appropriate treatment and disposal according to the Waste Management Plan. • Hazardous wastes will not, under any circumstances, be discharged to the sea. 	INSIGNIFICANT

BIOLOGICAL ENVIRONMENT							
5	MANGROVES	HIGH	Seismic survey	Impacts of sound pressure waves on mangroves	MINOR	<p>It is recommended that <i>soft start and ramp up</i> procedures are implemented to minimize the risk of fishes and invertebrates inhabiting mangroves being trapped in an area of high impact near the vessel. <i>Soft starts and ramping</i> involves the gradual increase in the intensity of sound from the acoustic sources in order to provide affected species with sufficient time to move out of the injury zone.</p> <p>Respect the 200m buffer zone for the sound sources.</p>	INSIGNIFICANT
6			Seismic survey	Impacts of retrieval and deployment of bottom cables/autonomous receivers on mangroves	MODERATE	<p>Streamers with passive receivers should not be dragged in water less than 1m at any tidal cycle.</p> <p>Autonomous receivers and bottom cables must be deployed by carefully laying the equipment among the sensitive root systems to avoid abrasion.</p> <p>When retrieving the equipment, the cables must not be dragged across the roots.</p> <p>No boat traffic should be allowed in water depths less than 1m to avoid damage to root systems (even during deployment and recovery)</p>	INSIGNIFICANT

7	SEAGRASS BEDS	HIGH	Seismic survey	Impacts of sound pressure waves on seagrass beds and macroalgae	MINOR	<p>It is recommended that <i>soft start and ramp up</i> procedures are implemented to minimize the risk of fishes and invertebrates inhabiting seagrass being trapped in an area of high impact near the vessel.</p> <p>Seismic sources must not be used at water depths less than 2 meters.</p>	
8			Seismic survey	Impacts of retrieval and deployment of bottom cables/autonomous receivers on seagrass beds and macroalgae	MINOR	<p>The bottom cables and autonomous receivers must not be dragged over the bottom such that swaths of seagrass beds are uprooted.</p> <p>The cables must be laid directly from the deck of the shallow draft boats to prevent these from scouring several meters on each side of their length.</p> <p>A qualified observer must ensure, by visual confirmation, the vertical deployment and recovery techniques as these habitats are found in relatively shallow and clear water areas.</p>	INSIGNIFICANT

9	CORAL REEFS	HIGH	Seismic survey	Impacts of sound pressure waves on coral reefs	MODERATE	<p>It is recommended that <i>soft start</i> procedures are implemented to minimize the risk of organisms including reef fish inhabiting coral reefs being trapped in an area of high impact near the vessel. While it is thought that soft starts will encourage behavioral avoidance before the organisms can be exposed to possibly injurious levels of sound, there is no evidence in the literature concerning the effectiveness of this mitigation in respect of pelagic and neritic invertebrates inhabiting coral reefs.</p> <p>A buffer zone for acoustic sources must be maintained: 75m – if coral reefs are 0 to 20 m deep 50m – if coral reefs are 21 to 70m deep 0m – if coral reefs are > 70m deep</p>	INSIGNIFICANT
10			Seismic survey	Impacts of retrieval and deployment of bottom cables/autonomous receivers on coral reefs	MODERATE	<p>All cables and autonomous receivers must be deployed by visually assuring that they are not in contact with corals as they are put into place.</p> <p>When retrieving them, assure they are not dragged across coral tissues but lifted directly from the seafloor.</p>	INSIGNIFICANT

11	MARINE MAMMALS	HIGH	Seismic survey	Impacts of sound pressure waves on marine mammals	MODERATE	<p>The surveys must be planned to avoid the humpback whale season (July to December). To the extent that other mysticetes exhibit similar seasonal migration patterns, their exposure to seismic survey noise would also be avoided.</p> <p>It is recommended the use of soft starts to allow time for marine mammals to move away before the array reaches full power. The process should begin with the smallest source in an array and build up slowly over 20 to 40 minutes.</p> <p>At least 30 minutes before startup during daylight hours, visual observers should monitor a safety (exclusion) zone of a 1km radius around the source vessel. Startup of the array cannot begin until the safety zone is clear of marine mammals for at least 20 minutes.</p> <p>Visual monitoring of the sea surface should continue while the seismic array is operating during daylight hours, and the array should be shut down if a whale enters the 1km safety zone during visual monitoring. A whale is defined as a cetacean other than Family Delphinidae (i.e., including any baleen, sperm, or beaked whale species).</p>	MINOR
12			Seismic survey	Impacts of retrieval and deployment of bottom cables/autonomous receivers on marine mammals	INSIGNIFICANT	No mitigation measure is applicable	INSIGNIFICANT

13	MARINE TURTLES	HIGH	Seismic survey	Impacts of sound pressure waves on marine turtles	MODERATE	<p>It is recommended the use of Soft starts to allow time for turtles to move away before the array reaches full power. The process should begin with the smallest source in an array and build up slowly over 20 to 40 minutes.</p> <p>At least 30 minutes before startup during daylight hours, visual observers should monitor a safety (exclusion) zone of a 500m radius around the source vessel. Startup of the array cannot begin until the safety zone is clear of turtles for at least 20 minutes.</p> <p>Visual monitoring of the sea surface should continue while the seismic array is operating during daylight hours, and the array should be shut down if a sea turtle enters the 500m safety zone during visual monitoring.</p> <p>Maintain a 500m buffer zone from the vessel with the sound source from sandy beaches</p>	MINOR
14			Seismic survey	Impacts of retrieval and deployment of bottom cables/autonomous receivers on marine turtles	INSIGNIFICANT	No mitigation measure is required.	INSIGNIFICANT
15	FISHES	HIGH	Seismic survey	Impacts of sound pressure waves on fishes	MODERATE	<p>It is recommended the use of Soft starts to allow time for fish to move away before the array reaches full power. The process should begin with the smallest source in an array and build up slowly over 20 to 40 minutes.</p>	MINOR

16			Seismic survey	Impacts of retrieval and deployment of bottom cables/autonomous receivers on fishes	INSIGNIFICANT	No mitigation measure is required.	INSIGNIFICANT
SOCIOECONOMIC ENVIRONMENT							
17	POPULATION AND LOCAL ECONOMY	HIGH	Seismic survey	Social conflicts due to the presence of foreign workers	MINOR	<p>Personnel should be informed of social conduct codes based on cultural characteristics of the resident population, of local culture and customs and of the importance of respectful social relationships with the local community.</p> <p>Personnel should be provided with information about avoidance of sexually transmitted diseases through hygienic practices and low risk behavior.</p>	INSIGNIFICANT
18			Seismic survey	Increased revenue due to the presence of the crew in Pemba	POSITIVE	Local goods and service providers in Pemba should be used whenever possible.	POSITIVE

19	ARTISANAL FISHERIES	VERY HIGH	Seismic survey	Temporary loss of access to fishing grounds and associated loss of catch – off-shore commercial artisanal fishers	MINOR	<p>Establish a communication structure to liaise with the artisanal fishing industry. Daily notifications should be sent via SMS (where cell phone service is available) or radio stations, mobile brigades as well as the use of pamphlets and brochures to inform fishers of the planned events, as well as the location of the seismic vessel on any particular day, as well as the following day</p> <p>A Grievance Procedure through which valid grievances regarding the project could be raised should be implemented.</p> <p>Investigate the possibility of surveying the transects furthest west, thus, closest to the islands and fishing areas, at night, thereby decreasing the effect on artisanal fishers.</p> <p>At least one of the crew members on the chase boat should be fluent in local languages, and have knowledge of local fishing practices.</p> <p>A Compensation Plan will be prepared.</p>	
20			Seismic survey	Temporary loss of access to fishing grounds and associated loss of catch – subsistence and commercial artisanal fishers operating from the shoreline	MODERATE	<p>Coordination and communication with fishers – See above.</p> <p>Establish a Grievance Procedure – See above.</p> <p>Surveying at night – See above.</p> <p>Ensure appropriate chase boat crew members – See above.</p> <p>Prepare a Compensation Plan – See above.</p>	
21			Seismic survey	Temporary decreased catch volumes in certain areas - off-shore commercial artisanal fishers	MODERATE	Same action as above (#20)	MINOR

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22			Seismic survey	Temporary decreased catch volumes in certain areas - subsistence and commercial artisanal fishers operating from the shoreline	MODERATE	Same action as above (#20)	MINOR
23			Seismic survey	Effects on physical safety and health of divers due to sound source pulses	MAJOR	<p>Coordination and communication with fishers – See above. Establish a grievance procedure – See above. Surveying at night – See above. Ensure appropriate chase boat crew members – See above. Compile and implement a Compensation Plan – See above.</p> <p>Ensure no diving in 2.4 km safety zone around the seismic vessel.</p> <p>An additional safety vessel should be used in conjunction with the chase vessel, in order to scout reefs and known dive sites and warn off any divers, prior to the seismic vessel entering the 2.4 km safety zone. If divers are found in the water, the seismic vessel should lay-off until they have surfaced and are safely onboard their own vessels.</p>	MINOR
24			Seismic survey	Temporary loss of income and effects on food security	MINOR	Same action as above (#20)	INSIGNIFICANT
25			Seismic survey	Temporary reduction in fish volumes available for purchase and resale	MINOR	If all the relevant mitigation measures with regard to artisanal fishers are implemented, there should be a minimal effect on first order traders.	INSIGNIFICANT

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26	TOURISM	HIGH	Seismic survey	Temporary loss of access to dive sites due to safety zone around the seismic vessel	MINOR	<p>Establish a Provincial Stakeholder Forum, well before the advent of the actual seismic acquisition.</p> <p>Establish a grievance procedure through which valid grievances regarding the project could be raised.</p> <p>Investigate the possibility of surveying the transects closest to the islands and dive sites at night, thereby eliminating effects on divers.</p> <p>A media fact sheet should be prepared which can be used to assist the L&A Operators in briefing members of staff as to how to convey information relating to the seismic survey, where this is necessary.</p>	INSIGNIFICANT
27			Seismic survey	Physical safety and health of divers due to seismic sound source pulses	MAJOR	<p>Retaining a 2.4 km buffer – see #23 above.</p> <p>Additional safety vessel – see #23 above.</p> <p>Coordination and communication with tourism operators – See #23 above.</p> <p>Establish an Exploration Tourism Forum – See #23 above.</p> <p>Establish a grievance procedure – See #23 above.</p> <p>Surveying at night – See #23 above.</p>	MINOR
28			Seismic survey	Discomfort of divers due to sound pulses generated by the seismic sound source	MODERATE	<p>Coordination and communication with dive operators – above.</p> <p>Establish a Provincial Stakeholder Forum – See above.</p> <p>Establish a grievance procedure – See above.</p> <p>Survey at night – See above.</p> <p>Compilation of a Compensation Plan – Compile and implement a Compensation Plan. Compensate any proven losses by tourism operators due to effects of the seismic exploration.</p>	MINOR

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29			Seismic survey	Temporary loss / delayed access to recreational off-shore fishing grounds due to movements of the seismic vessel	MINOR	Prepare a Compensation Plan together with Grievance Procedures to address the fishing operators that may have had to significantly delay or reroute their fishing trips due to the seismic survey. Surveying at night.	INSIGNIFICANT
30			Seismic survey	Reduced off-shore sports fishing experience due to changes in fish behavior and movement, potentially leading to decreased catches	MINOR	Prepare a Compensation Plan together with Grievance Procedures to address the fishing operators that may have had to significantly delay or reroute their fishing trips due to the seismic survey. Surveying at night.	MINOR
31			Seismic survey	Reduced quality of sightseeing, due to mammal movement away from the area of exploration activities	MINOR	Limit the seismic survey window to the months between January and June, out of the Whale migration season. Prepare a Communications Plan to inform tourists and ecotourism operators of the drilling locations and the time that the rig will be on location,	
32			Seismic survey	Visual disturbance caused by the seismic vessel	MINOR	Limit distances of stoppages – any stoppages for weather or any other reason which do not require an immediate halt, should be undertaken at least at 4km from the closest island.	MINOR

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33			Seismic survey	Potential loss of revenue to the tourism operators	MODERATE	<p>Prepare a media fact sheet to assist the L&A Operators in briefing members of staff as to how to convey information relating to the seismic program, where this is necessary.</p> <p>Prepare a Compensation Plan along with Grievance Procedures that outlines strategies for, and means of, compensation to tourism operators that may have lost business due to the seismic survey.</p>	MINOR
34			Seismic survey	Potential loss of income (in terms of wages and purchases)	MINOR	Same action as above (# 34)	MINOR
35			Seismic survey	Effects on the sale of island plots to private investors	MINOR	<p>Prepare a media fact sheet to assist the L&A Operators in briefing members of staff as to how to convey information relating to the seismic program, where this is necessary.</p> <p>Strategic assessment – The GOM should consider strategic environmental assessment as a tool to evaluate the potential conflicts and synergies between the tourism, oil and gas, and other industries in the Quirimbas Archipelago.</p>	MINOR
36			Seismic survey	Effects on the 'island paradise' image	MODERATE	Same action as above (# 35)	MODERATE
37			Seismic survey	Suspension of planned and future investment	MODERATE	Same action as above (# 35)	MODERATE

Table 2. Mitigation Measures for routine events (seismic survey)

No.	EC	EC sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
1	AIR	MEDIUM	Seismic survey and support operations	Reduction in air quality due to evaporation of VOCs from a diesel spill	INSIGNIFICANT	The aim should be in preventing the occurrence of a diesel spill by undertaking the correct procedures during bunkering and transferring of diesel.	INSIGNIFICANT
2				Reduction in air quality due to a fire/ explosion	MINOR	All personnel to be fully trained on the onboard health and safety procedures. Prepare and comply with the OSCP/ERP	INSIGNIFICANT

3	WATER	HIGH	Seismic survey and support operations	Reduced water quality due to accidental diesel spills	MINOR	<ul style="list-style-type: none"> • Conduct transfer operations during calm weather conditions • Ensure that transfer hoses are of sufficient length and strength to maneuver vessels as sea conditions require • Only conduct transfer operations during the day, if possible, and hoist the “bravo” flag. • 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 seismic vessel and monitor the transfer • Use oil collector trays or drip pans under equipment • Ensure that pipes and hoses are properly connected, closed and in good condition • Monitor tank levels throughout the program • Make available absorbent pads near the area where spills may occur • In the event of a diesel spill the incident will be promptly reported through the contractor chain-of-command to AMA1. 	INSIGNIFICANT
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4	MANGROVES	HIGH	Seismic survey and support operations	Effects on coastal mangroves due to diesel spills	MINOR	The implementation of the proposed mitigation measures for reduced water quality due to a diesel spill will ensure the minimization of such impacts on mangroves (Action #3).	INSIGNIFICANT
5	SEAGRASS BEDS AND MACROALGAE	HIGH	Seismic survey and support operations	Effects on seagrass beds and macroalgae due to diesel spills	MINOR	The implementation of the proposed mitigation measures for reduced water quality due to a diesel spill will ensure the minimization of such impacts on seagrass beds and macroalgae (Action # 3).	INSIGNIFICANT
6	CORAL REEFS	HIGH	Seismic survey and support operations	Effects on coral reefs due to diesel spills	MINOR	The implementation of the proposed mitigation measures for reduced water quality due to a diesel spill will ensure the minimization of such impacts on coral reefs (Action # 3).	INSIGNIFICANT
7	MARINE MAMMALS	HIGH	Seismic survey and support operations	Effects on marine mammals due to diesel spills	MINOR	The implementation of the proposed mitigation measures for reduced water quality due to a diesel spill will ensure the minimization of such impacts on marine mammals (Action # 3).	INSIGNIFICANT
8	MARINE TURTLES	HIGH	Seismic survey and support operations	Effects on marine turtles due to diesel spills	MINOR	The implementation of the proposed mitigation measures for reduced water quality due to a diesel spill will ensure the minimization of such impacts on marine turtles (Action # 3).	INSIGNIFICANT
9	FISH	HIGH	Seismic survey and support operations	Effects on fish due to diesel spills	MINOR	The implementation of the proposed mitigation measures for reduced water quality due to a diesel spill will ensure the minimization of such impacts on fish (Action # 3).	INSIGNIFICANT

10	POPULATION	HIGH	Seismic survey and support operations	Effects on population due to diesel spills	MINOR	The implementation of the proposed mitigation measures for reduced air quality and reduced water quality due to a diesel spill will ensure the minimization of such impacts on population (Action # 1 and 3).	INSIGNIFICANT
11			Seismic survey and support operations	Effects on population due to fire/explosion	MODERATE TO MAJOR	The implementation of the proposed mitigation measures for reduced air quality due to fire explosions will ensure the minimization of such impacts on population (Action # 2).	MINOR
12	ARTISANAL FISHERIES	VERY HIGH	Seismic survey and support operations	Effects on artisanal fisheries due to diesel spill	MINOR	The implementation of the proposed mitigation measures for reduced water quality due to a diesel spill will ensure the minimization of such impacts on fish (Action # 3) and therefore minimize impacts on artisanal fisheries.	INSIGNIFICANT
13	TOURISM	HIGH	Seismic survey and support operations	Effects on tourism due to diesel spill	MINOR	The implementation of the proposed mitigation measures for reduced air quality and reduced water quality due to a diesel spill will ensure the minimization of such impacts on tourism (Action # 1, 2 and 3).	INSIGNIFICANT

Table 3. Mitigation measures for routine events (drilling)

No.	EC	EC sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
1	AIR	MEDIUM	Mobilization/ demobilization and drilling operations	Reduction in air quality due to use of fuel for routine operations	MINOR	<p>Regularly maintain drilling rig motors and engines. Operate and maintain exhaust systems and engines in accordance with the manufacturer's specifications. Use preventative maintenance, leak detection and repair programs. Compliance to Annex VI MARPOL emission standards:</p> <ul style="list-style-type: none"> • Diesel engine NO_x emissions should be limited to between 9.8 and 17 g/kWh, depending on maximum operating speed. • Substances harmful to the ozone layer (including halon and CFCs), cannot be deliberately released. New facilities can contain HCFCs until 1Jan 2020, but cannot contain other substances that harm the ozone layer. 	INSIGNIFICANT
2				Reduction in air quality due to test flaring of wells ¹	MINOR	<p>Maintain and effectively control well test burners for high efficiency. Consider the use of an alternative "green burner" test flare to improve the quality of flare emissions and to minimize incomplete combustion and black smoke and to prevent hydrocarbon fallout to the sea. Limit periods of hydrocarbon burning to the operationally required minimum.</p>	INSIGNIFICANT

¹ Test flaring will not be carried out during drilling. However, in the event of a successful well being discovered test flaring will be carried out after drilling.

3	WATER	MEDIUM	Drilling operations (waste management)	Reduced water quality due to discharges of solid wastes (excluding drilling muds and cuttings)	MODERATE	<p>All waste materials produced onboard the vessel will be transported back to mainland Mozambique for disposal via resources available in country or will remain onboard the vessel until suitable recycling opportunities are made available in near future anticipated ports.</p> <p>Disposal of solid wastes must also comply with the Waste Management Plan.</p> <p>Hazardous wastes will not, under any circumstances, be discharged to the sea.</p>	INSIGNIFICANT
4				Reduction in water quality due to the discharge of drilling muds and cuttings	MINOR (shallow water²)	<p>Discharge in shallow waters: No mitigation is available.</p>	MINOR
					MINOR (deep water)	<p>Discharge in deep waters: Mud recovery systems must be used, whenever possible, and the rig should have an efficient solid control and mud recirculation system with the following main components:</p> <ul style="list-style-type: none"> • Shale shakers to remove large-sized cuttings • De-gasser to remove entrained gas • De-sanders to remove sand-sized cuttings; • De-silters to remove silt-sized cuttings • Centrifuge to recover fine solids and weighting materials such as barite. <p>WBM and low toxicity additives should be used whenever possible. For SBM, use the Group III NADFs – Non Aqueous Drilling Fluids (most environmentally acceptable with low to negligible aromatic content). Synthetic fluids that are low in toxicity, biodegradable and non-accumulative should be used. All chemicals used should conform to internationally accepted standards and submitted to MICOA and INP for approval when necessary before the drilling activities begin.</p>	INSIGNIFICANT

² Potential impacts related to drilling of the initial hole section before marine riser is in place.

						<p>The use of all drilling fluid components and other chemicals should be monitored and recorded.</p> <p>Ensure careful transfer of drilling muds and cuttings from the rig to the barge, proper storage of the cuttings in the barge and careful transfer of cuttings to deeper waters for discharge (at least 12 nautical miles from the coast).</p> <p>Once in disposal area spread the cuttings over a large surface area to reduce concentrations in the water column and minimize impacts. Cuttings to dispersed overboard via either an auger or sluice system while the vessel is underway at a constant speed. Discharge directly into the prop wash to further aid in dispersion.</p> <p>As with most oil and gas companies in their worldwide offshore operations, AMA1 will comply with the following requirements for discharge of drilling cuttings and muds (EPA, 2007):</p> <ul style="list-style-type: none"> • Metal concentrations in the barite added to mud must not exceed: 1mg/kg for mercury and 3mg/kg for cadmium. • No discharge of drilling wastes allowed within 3 miles from shore. • Discharge rate not to exceed 1,000 bbls/hour. • Cuttings coated up with 6.9%SBMs may be Discharged <p>Ester SBMs can have up to 9.4% SBM on cuttings</p>	
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5			Mobilization/ demobilization and drilling operations	Reduction in water quality due to deck drainage, bilge water and sewage discharge	MODERATE	<p>All vessels must be certified for seaworthiness through an appropriate internationally recognized marine certification body. The rig must have adequate safety systems (alarms and automated shut-down devices), that meet regulatory and industry standards. Adequate maintenance and testing programs must be in place.</p> <p>The disposal of liquid wastes will be conducted in accordance with MARPOL 73/78 (Annexes 1-4):</p> <ul style="list-style-type: none"> • Sewage must be treated and disinfected (on-board treatment plant) prior to discharge. <ul style="list-style-type: none"> • Treated effluents shall achieve a BOD < 40 ppm, suspended solids < 50 ppm and a coliform count < 200 cells per 100 ml of effluent. • Treated deck drainage will be discharged at the rig location. The concentration of oil in the water after treatment in an IMO approved oil/water separator shall not exceed 15 ppm • Oil/water separators must be regularly maintained. • Water from machinery spaces (ballast and bilge water) shall be routed to the closed drainage system, or contained and treated before discharge. • Secondary containment shall be provided for storage areas with oil and chemicals as well as equipment (deck, mud tanks and pumps) • Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills on the deck as soon as they occur. • Ensure that oil separators are in place and that spills are cleaned up immediately. Equip oil and water separators with sensors and an alarm to avoid exceeding the discharge limit. • Oil derived from the oil/water separator shall be stored in tanks on board and be disposed at an accredited hazardous waste site according to the waste management plan. 	INSIGNIFICANT
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6			Drilling operations (waste management)	Reduction in water quality due to disposal of kitchen wastes	MINOR	<p>As established by MARPOL 73/78 no solid waste will be discharged.</p> <ul style="list-style-type: none"> • Solid waste (kitchen waste) will be macerated to 25mm and then discharged to the sea (3nm at least from the coast). Untreated kitchen waste will be discharged farther than 12 nautical miles from the nearest shore. • All other solid waste must be segregated and contained for appropriate treatment and disposal according to the Waste Management Plan. 	INSIGNIFICANT
7			Drilling operations (waste management)	Reduction in water quality due to the disposal of produced water ³	MINOR	<ul style="list-style-type: none"> • Comply with the MARPOL 73/78 requirements. • Ensure that 3-phase separators are in place and provide tankage to store produced water if MARPOL standards not met. • The concentration of oil in the water after treatment in an IMO approved oil/water separator shall not exceed 15 ppm. 	INSIGNIFICANT

³ Related to test flaring. Test flaring will not be carried out during drilling. However, in the event of a successful well being discovered test flaring will be carried out after drilling.

⁵ Small spill: That can be dealt locally with all spilled materials contained at this spill site.

8	MANGROVE	HIGH	Drilling operations (waste management)	Impacts of waste disposal (including muds and cuttings) on the coastal mangroves*	MINOR TO MODERATE*	<ul style="list-style-type: none"> Regarding the 40m³ of cuttings, produced during the drilling of the first hole section, that may be discharged in shallow water respect the 100m buffer zone from coastal mangroves. See mitigation Measure No. 5 for other wastes. 	INSIGNIFICANT
9	SEAGRASS AND CORAL COMMUNITIES	VERY HIGH	Drilling operations	Effects of positioning a jack-up rig on seagrass and coral community	MAJOR	<ul style="list-style-type: none"> Prepare an environmental survey of the seafloor prior to the mobilization of the rig. A 100 m buffer zone will be maintained to avoid physical impact to coral reefs and seagrasses. 	INSIGNIFICANT
10			Drilling operations (waste management)	Effects of disposal of drilling muds and cuttings on coral reefs and seagrass beds.*	MINOR TO MODERATE*	<ul style="list-style-type: none"> Regarding the 40m³ of cuttings, produced during the drilling of the first hole section, that may be discharged in shallow water maintain a 100 m buffer zone to avoid impacts to coral reefs and seagrasses. See mitigation Measure No. 5 for other wastes. 	INSIGNIFICANT

*Potential impacts related to drilling of the initial hole section before marine riser is in place

11	MACROBENTHOS		Drilling operations (waste management)	Effects on benthic macrofauna due to the discharge of drilling muds and cuttings	MINOR*	No mitigation for the 40m ³ of cuttings from drilling the initial hole section.	MINOR
12	DEEP WATER MACROBENTHOS	LOW	Drilling operations (waste management)	Effects on deep water benthic macrofauna due to discharge of drilling muds and cuttings	MINOR	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of drilling muds and cuttings (Action # 4) ensures the mitigation of the impact on deep water macrobenthos.	INSIGNIFICANT
13	FAUNA (FISH, MARINE MAMMALS, MARINE TURTELS)	HIGH	Mobilization/demobilization and drilling operations	Impacts due to the disposal of muds and cuttings on fauna through increased turbidity and contaminant load	INSIGNIFICANT (shallow water)	No mitigation is applicable for the 40m ³ of cuttings from drilling the initial hole section.	INSIGNIFICANT
					MINOR (deep water)	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of drilling muds and cuttings (Action # 4) ensures the mitigation of the impact on fauna.	INSIGNIFICANT
14			Mobilization/demobilization and drilling operations	Impacts on marine fauna due to deck drainage, bilge water disposal and sewage discharge	MODERATE	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of deck drainage, bilge water and sewage (Action # 5) ensures the mitigation of the impact on marine fauna.	INSIGNIFICANT

15			Drilling operations (waste management)	Impacts on marine fauna due to disposal of kitchen wastes	MINOR	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to solid food waste discharge (Action # 6) ensures the mitigation of the impact on marine fauna.	INSIGNIFICANT
16			Drilling operations	Impacts of noise on marine mammals, turtles and fish	MINOR	Periodically maintain equipment to minimize noise. Use a top drive motor on the drill string to limit drill noise	INSIGNIFICANT

- Potential impacts related to drilling of the initial hole section before marine riser is in place

17	POPULATION AND LOCAL ECONOMY	MEDIUM	Drilling operations and support operations	Social conflicts due to the presence of foreign workers	MINOR TO MODERATE	<p>Personnel should be informed of social conduct codes based on cultural characteristics of the resident population, of local culture and costumes and of the importance of respectful social relationships with the local community.</p> <p>Personnel should be provided with information about avoidance of sexually transmitted diseases through hygienic practices and low risk behaviour.</p>	INSIGNIFICANT
18			Drilling operations and support operations	Increased revenue due to the presence of the crew in Pemba and possibly in the islands	POSITIVE	Local goods and service providers in Pemba should be used whenever possible.	POSITIVE
19	ARTISANAL FISHERIES	HIGH	Drilling operations	Temporary loss of access to fishing grounds and associated loss of catch due to exclusion zones	MINOR	<p>Prepare a Communication Plan for the drilling program. Inform artisanal fishers prior to the start of the drilling, of well locations, safety exclusion zones, and vessel locations, and of planned events through established means of communication as identified in the Plan.</p> <p>Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled</p>	INSIGNIFICANT
20			Drilling operations	Temporary catch decrease due to fish displacement and restrictions on fishing	MINOR	The same mitigations measures for the impact above apply for this impact.	MINOR

21			Drilling operations	Effects on physical safety and health of divers due to sound generated by drilling activities	INSIGNIFICANT	<p>A support vessel around the rig will ensure that no diving operators or tourists are diving within 500 m of the rig to protect their health. Prepare a Communications Plan to inform divers of the drilling locations and the time that the rig will be on location, so they can relocate their diving ground and schedule the dives.</p> <p>Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled</p>	INSIGNIFICANT
22			Drilling operations	Temporary loss of income and effects on food security	MINOR	Implementation of mitigation measures for Action #19 apply.	MINOR

23	TOURISM	HIGH	Drilling operations	Temporary loss of access to dive sites due to the presence of the rig and safety zone around the rig	MINOR TO MAJOR (depending on location of the drilling rig)	<p>Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled. A 500m safety zone must be created around the rig in which vessel movement and diving is prohibited. Respect the 100m buffer zone away from any coral reef.</p> <p>Provide a media fact sheet for use by L&A Operators in the vicinity of the drilling location to brief staff and inform clients regarding the temporary nature of the drilling program and the measures taken to mitigate environmental impacts. Prepare a Compensation Plan along with Grievance Procedures that outlines strategies for, and means of, compensation to diving operator that may have lost business due to the location of the rig.</p>	MINOR
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24			Drilling operations	Physical safety and health discomfort of divers due to sound generated by the drilling operations	INSIGNIFICANT	A support vessel around the rig will ensure that no diving operators or tourists are diving within 500 m to protect their health. Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled. Prepare a Communications Plan to inform tourists and diving operators of the drilling locations and the time that the rig will be on location, so they can relocate their diving ground and schedule the dives.	INSIGNIFICANT
25			Drilling operations	Temporary loss/delayed access to recreational offshore fishing grounds due to the presence of the safety zone around the rig	MINOR	Provide a media fact sheet for use by L&A Operators to brief staff and inform clients regarding the temporary nature of the drilling program and the measures taken to mitigate environmental impacts. Prepare a Compensation Plan together with Grievance Procedures to address the fishing operators that may have to significantly delay or reroute their fishing trips due to the presence of the rig. Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled.	INSIGNIFICANT

26			Drilling operations	Reduced offshore sports fishing experiences due to changes in catch.	MINOR	Prepare a Communications Plan to inform tourists and ecotourism operators of the drilling locations and the time that the rig will be on location.	INSIGNIFICANT
27			Drilling operations	Reduced quality of sightseeing due to mammal movement away from the area of exploration activities	INSIGNIFICANT	Prepare a Communications Plan to inform tourists and ecotourism operators of the drilling locations and the time that the rig will be on location	INSIGNIFICANT
28			Drilling operations	Visual disturbance caused by the drilling activities	MINOR TO MAJOR (depending on location of the drilling rig)	Site specific addendum - Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled	MINOR TO MAJOR
29			Drilling operations	Potential loss of revenue to tourism operators	MINOR TO MAJOR (depending on location of the drilling rig)	Site specific addendum - Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled Preparation of a Compensation Plan	MINOR
30			Drilling operations	Potential loss of income (in terms of wages and purchases)	MINOR	Site specific addendum - Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled Preparation of a Compensation Plan	MINOR

31			Drilling operations	Effects on the sale of island plots to private investors	MINOR	Site specific addendum - Once exact drill sites are determined, a site-specific addendum to the SIA and EIS should be compiled	MINOR
32			Drilling operations	Effects on the "island paradise" image	MINOR	Media fact sheet – Prepare a media fact sheet to assist the L&A Operators in briefing members of staff as to how to convey information relating to the drilling program, where this is necessary. Strategic assessment – The GOM should consider strategic environmental assessment as a tool to evaluate the potential conflicts and synergies between the tourism, oil and gas, and other industries in the Quirimbas Archipelago.	MINOR
33			Drilling operations	Suspension of planned future investment	MINOR	Same action as above (#32)	MINOR

34	NAVIGATION	VERY LOW	Mobilization/ demobilization and drilling operations	Interference with maritime traffic	INSIGNIFICANT	<p>Apply for authorization to conduct oil exploration drilling activities at sea from the Maritime Authority (INAMAR).</p> <p>Inform maritime authorities prior to rig mobilization regarding detailed routes, rig locations, exclusion zones and scheduling plans through established means of communication:</p> <ul style="list-style-type: none"> • National Maritime Authority (INAMAR), with details about vessel entry, duration of stay and exact area(s) and duration of exclusion. INAMAR should make a formal Notice to Mariners for international dissemination • Notice to Mariners through maritime communications networks and GMDSS / Inmarsat • Provide advance notice to the Direcçao Nacional de Administraçao Pesqueira, within Ministry of Fishery. 	INSIGNIFICANT
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Table 4. Mitigation measures for non-routine events (drilling)

No.	EC	EC sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
1	AIR	Medium	Mobilization/ demobilization and drilling operations	Reduced air quality due to hydrocarbon release	MINOR TO MODERATE	Compliance to the Emergency Response Plan and Oil Spill Contingency Plan is mandatory.	INSIGNIFICANT
2			Mobilization/ demobilization and drilling operations	Reduced air quality due to a fire/explosion	MINOR TO MAJOR	All personnel to be fully trained on the onboard Health and Safety procedures. Compliance to the Emergency Response Plan and Oil Spill Contingency Plan is mandatory. Regular maintenance and verification of the Blowout Preventer (BOP).	MINOR

3	WATER	Very High	Drilling operations and support operations	Reduced water quality due to hydrocarbon spills	MINOR TO MAJOR	<p><u>Planning</u></p> <ul style="list-style-type: none"> • General Oil trajectories and an Oil Spill Contingency Plan (OSCP/ERP)/Emergency Response Plan (ERP) prepared for this project are presented as Annexes to the EMP. • Prepare & submit site-specific Oil Trajectory Models and OSCP/ERP to the MICOA & the INP before drilling activities <ul style="list-style-type: none"> ○ 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 <u>not</u> commence until the OSCP/ERP has been updated and addresses local environments. • Compliance to the OSCP/ERP is mandatory • The OSCP/ERP will detail how to mobilize services (Southern Africa region) for rapid response to accidental oil spills if local resources are unable to deal with spills. 	MINOR
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						<p><u>Prevention</u></p> <p>Ensure that the rig and the supply vessel comply with the following:</p> <ul style="list-style-type: none"> • International certification and approval by the Mozambican Authorities • Good operational conditions and serviced according to a service maintenance plan • Have OSCP/ERP and for (i) oil and chemical spills; (ii) fire and explosions, (iii) diesel or bunker fuel spills • Crews trained for emergency response relative to the cargo they transport and operations they perform • Maintain contact with the Port Authorities • Have updated information regarding the weather conditions in the area • Safety measures such as BOPs are in place • Fuel tanks or drums capped, not overfilled, marked with contents, and valves closed between connected fuel tanks • Store petroleum products & hazardous substances in adequately labeled approved containers • Store petroleum products & hazardous substances in bunded areas where spills can be contained & collected • Use oil collector trays or drip pans under equipment • Ensure that pipes and hoses are properly 	
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						<p>connected, closed and in good condition</p> <ul style="list-style-type: none"> • Monitor tank levels throughout the program • Make available absorbent pads near the area where spills may occur • Conduct transfer operations during calm weather conditions • Ensure that transfer hoses are of sufficient length and strength to maneuver vessels as sea conditions require • Only conduct transfer operations during the day, if possible, and hoist the "bravo" flag. • 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 <p><u>Response</u></p> <ul style="list-style-type: none"> • Response procedures shall be outlined in the site-specific OSCP/ERP. • Limit the spill at the source to the extent possible and contain or recover the material before it reaches 	
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						<p>the coastal or marine resources.</p> <ul style="list-style-type: none"> • 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. <p>Refer to the Communication Plan included as part of the EMP.</p>	
4	MANGROVE	HIGH	Drilling operations and support operations	Effects on coastal mangroves due to hydrocarbon spills	MINOR TO MAJOR	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on the mangroves (Action # 3).	MINOR
5	SEAGRASS AND CORAL COMMUNITIES	VERY HIGH	Drilling operations and support operations	Effects on coral reefs and seagrass beds due to hydrocarbon spills	MINOR TO MAJOR	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on the shallow water macrobenthic communities (Action # 3).	MINOR

6	FAUNA (FISH; MARINE MAMMALS, MARINE TURTLES, SEA BIRDS)	HIGH	Drilling operations and support operations	Effects on marine mammals, turtles, fish and seabirds due to hydrocarbon spills	MINOR TO MAJOR	<p>The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on marine fauna (Action # 3).</p> <p>Response measures include the use of marine mammal deterrents with the buoys signaling the spill to prevent the animals from entering affected areas.</p>	MINOR
7	PROTECTED AREAS	VERY HIGH	Drilling operations and support operations	Effects on protected areas due to hydrocarbon spills	MINOR TO MAJOR	<p>The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on the protected areas (Action # 3).</p>	MINOR
8	POPULATION	MEDIUM	Drilling operations and support operations	Effects on population due to a hydrocarbon spills	MINOR TO MAJOR	<p>The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on population (Action # 3).</p>	MINOR
9				Effects on population due fire/explosions	MINOR TO MAJOR	<p>The implementation of the proposed mitigation measures for reduced air quality due to fire explosions will ensure the minimization of such impacts on population (Action # 2).</p>	MINOR

10	ARTISANAL FISHERIES	HIGH	Drilling operations and support operations	Effects on artisanal fisheries due to hydrocarbon spills	MINOR TO MAJOR	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on artisanal fisheries (Action # 3).	MINOR
11	TOURISM	HIGH	Drilling operations and support operations	Effects on tourism due to a hydrocarbon release	MINOR TO MAJOR	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on tourism (Action # 3).	MINOR
12	COASTAL INDUSTRIES	VERY LOW	Drilling operations and support operations	Effects on coastal industries due to a hydrocarbon release	MINOR TO MAJOR	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on coastal industries (Action # 3).	INSIGNIFICANT

8.0 CONCLUSIONS AND RECOMMENDATIONS

The Environmental and Socio-economic Setting

The proposed shallow water seismic survey and exploratory drilling operations will take place within the AMA1 Concession area, in water depths less than 200m for drilling and 50m for seismic. The Project area is characterized by the presence of sensitive habitats, such as coral reefs, mangroves, seagrass beds and sandy beaches (some of which are known to be turtle nesting beaches).

Seventeen species of marine mammals occur in the Project area including nine dolphin species and eight whale species. Two species of whales are currently listed by the IUCN as Vulnerable, (i.e., humpback whale and sperm whale). Humpback whales are migratory and occur in the coastal waters off the Cabo Delgado coast between the months of July to December.

Historically, the highly endangered dugong occurred in the littoral waters of the northern Cabo Delgado coastline but it has not been recorded in the area in recent years.

Green, hawksbill, and olive ridley turtles are known to nest on beaches on several of the islands. Reported nesting seasons are from November through July for green turtles and December through March for hawksbills. Olive ridley nesting season is not reported, but is assumed similar to that of hawksbills. All turtle species occurring in the Project area are protected under Mozambican law and are listed as threatened by the IUCN Red List,

At least 78 fishing centres are located along the coastline and islands within the Project area supporting an estimated 9,713 fishers (comprising 7,530 artisanal fishers and 2183 subsistence fishers). Artisanal fisheries are thus an important source of protein and income generation in the study area for the coastal communities living in Macomia, Mocimboa da Praia and Palma coastal areas.

Two of the islands (Medjumbe and Vamizi Islands) currently provide luxury accommodation and leisure activities such as diving, deep sea fishing and eco-tourism. New lodges are in the process of being established on Macaloe, Rongui and Tecomaji Islands.

Two protected areas occur to the south and north of the Project area viz., the Quirimbas National Park (QNP) located 7.8km south of the AMA1 Concession Area and the Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP) in Tanzania located 3km to the north of the Concession Area.

Habitat Mapping and Environmental Screening of the Initial Seismic Program

The EIA included detailed habitat mapping of the entire Project area. High resolution QuickBird imagery covering 5,665 km² of near shore and island habitats was classified. Twenty habitats (both on-shore and marine) were identified and mapped.

In parallel with the habitat mapping exercise an environmental sensitivity analysis of near shore and coastal marine habitats within the Project area was conducted. The objective of the environmental sensitivity analysis was to develop an impact mitigation strategy consisting of recommendations for no-activity zones and or buffers zones for each habitat category.

An initial seismic program proposed by AMA1 was evaluated as part of this EIA. The evaluation of the initial seismic program took into account several environmental and socio-economic criteria to determine which seismic lines would not be acceptable from an environmental and socio-economic perspective. These criteria included:

- Seismic lines occurring within, or near to, sensitive habitats identified in the sensitivity mapping analysis.
- Seismic lines occurring near to islands with tourism complexes
- Seismic lines occurring with, or near to, the buffer zone of the Quirimbas Nation Park.

Based on these criteria, revisions to the initial seismic configuration were made *viz.*:

- Seismic lines passing through certain sensitive habitats and associated buffer zones as defined in the Environmental Sensitivity Analysis Report (CSA, October 2008) were excluded.
- Seismic lines passing adjacent to islands with tourist complexes (Vamizi and Medjumbe islands) were moved or excluded
- Seismic lines within the Concession Area 1 but also falling within the Quirimbas National Park buffer zone were excluded.

Of the initial seismic program comprising 2503 km of seismic lines, 1323 km of the lines were eliminated (i.e., a reduction of 53% of the original seismic program) resulting in a revised seismic program comprising 1180 km of seismic lines. By carrying out this initial evaluation or screening, many of the potential major impacts on sensitive habitats, protected areas and tourism activities were reduced or eliminated.

For this EIA, the environmental and socio-economic impacts were assessed for the revised seismic program covering 1180 km of seismic lines.

Impact Assessment

With regards to impact assessment for shallow water seismic surveys and exploratory drilling, the following factors should be taken into consideration:

- The overall seismic survey is a temporary activity (not more than three months) and the presence of the seismic vessels at any one location will be very short (only a few days) before moving to a new location ;
- The drilling program is an exploratory activity;
- Well locations are still undecided;
- The duration of the drilling activity is temporary (up to 3 months per well).

For the purpose of evaluation of environmental impacts, the receiving environment was divided into several discrete Environmental Components (EC): air, water, flora, shallow water and deep water macrobenthic communities, fauna, protected areas, population and local economy, artisanal fisheries, tourism, navigation and coastal industries. Each of these ECs is considered important on the basis of cultural values and/or scientific and public concern, and have been used to support the impact assessment. Potential environmental and socio-economic impacts on each of the Environmental Components associated with the seismic and drilling activities were identified for both routine and non-routine events.

Impacts associated with seismic surveys

Impact-producing factors associated with the proposed seismic survey program include sound pressure waves produced by the seismic sound source on marine fauna and the human environment (tourism and fisheries) and physical impacts on benthic habitats from the deployment and recovery of receiver ocean bottom cables and individual autonomous receivers. The main potential bio-physical and socio-economic impacts associated with the seismic survey are the following:

Routine Events

- Water contamination around the seismic vessels and accommodation barge from the discharge of liquid and solid wastes
- Impacts of underwater noise arising from the seismic sound sources on mangroves, corals, sea grass beds, marine mammals, sea turtles and fish;
- Impacts of retrieval and deployment of ocean bottom cables/autonomous receivers on mangroves, corals and sea grass beds;
- Interruption of artisanal fishing due to the safety zone around the seismic vessels, support vessels, and the deployment of receiver ocean bottom cables and individual autonomous receivers;
- Impacts on artisanal divers due to the underwater noise coming from seismic sound sources;
- Impacts on tourist activities (scuba diving), due to the underwater noise arising from seismic sound sources, or from the safety exclusion zones around the seismic vessels (affecting sports fishing);
- Interference with local shipping due to the safety zone around the seismic vessels, support vessels, and the recording cables

Non-routine Events

- Reduced water quality due to accidental diesel spills;
- Effects on mangroves, seagrass beds, corals and marine fauna due to accidental diesel spills;
- Effects on artisanal fisheries on tourism due to accidental diesel spills.

Impacts associated with drilling operations

The exploratory drilling in shallow waters will be conducted by a jack-up rig. The rig will be configured for no discharge of drilling mud and cuttings in shallow waters except for

small amount (approximately 40 m³) of cuttings which may be generated when drilling the initial hole section prior to setting the first structural casing and well head. There will also be no discharges of other solid and liquid wastes in shallow water except for treated deck drainage (in compliance with MARPOL). ***The drilling impact assessment reflects this pre-condition when addressing the impacts related to discharges.***

Actions to be taken in the absence of information regarding the drilling sites

The precise locations of the drilling sites are not currently known. The locations of the drilling sites can only be determined after processing and interpretation of the seismic survey data. Once the exact locations of the drilling sites are known the following specialist studies must be carried out: (i) drilling and mud cuttings dispersion modelling and (ii) oil spill modelling. In addition, once exact drill sites are determined, a site-specific addendum to the EIA report should be compiled taking in to account both the biophysical and socio-economic receiving environments. The type and level of the studies will be determined on a case-by-case basis.

The main potential bio-physical and socio-economic impacts associated with exploratory drilling are the following:

Routine Events

The potential impacts from routine events associated with offshore drilling operations include:

- Localized impacts on air quality;
- Localized impacts on water quality due to the discharge of solid wastes (other than drilling muds and cuttings);
- Localized impacts on water quality due to the discharge of drilling muds and cuttings (from the drilling of the initial hole section prior to setting the first structural casing and well head some cuttings (approximately 40 m³) may be extruded to the sea floor);
- Localized, physical impacts on habitats (such as sea grasses and coral communities) resulting from the positioning of the drilling rig on the substrate;
- Localized, behavioral and physical impacts to marine mammals and sea turtles from drilling operations and vessel traffic associated with drilling operations;
- Interruption of artisanal fisheries due to the safety zone around the drilling rig;
- Interference with the tourism activities in the area (safety zone and aesthetic impacts).

Non-routine Events

The potential non-routine events associated with offshore drilling operations are:

- Accidental leaks and spills;
- Fires and explosions;
- Collisions with other vessels;
- Blow outs

Of these potential incidents, blowouts releasing large volumes of hydrocarbons (crude oil or gas) are likely to create the most significant impacts. Such an event, while extremely unlikely to occur, could result in extensive negative biophysical and socio-economic impacts should the released hydrocarbons enter nearshore waters and coastline habitats.

The potential impacts from non-routine events associated with offshore drilling operations include:

- Reduced water quality and effects on coastal mangroves, seagrass beds, corals and marine fauna due to hydrocarbon spills. The significance of a crude oil or diesel spills will go from minor, for small⁵ spills, to major for large⁶ spills should the spilled material escape containment
- Effects on artisanal fisheries and tourism due to hydrocarbon spills. Again the significance of a crude oil or diesel spills will go from minor, for small spills, to major for large spills.
- Effects on population due to fire/explosions

The majority of impacts associated with the drilling and seismic programme are considered to be minor with some exceptions:

Potential (unmitigated) major impacts associated with drilling include potential impacts of positioning of a drilling rig on corals and seagrass, potential impacts of a major hydrocarbon spill on components of the biological and socio-economic environments and potential visual impacts on tourism activities.

Potential (unmitigated) moderate impacts associated with seismic surveys in shallow waters include underwater seismic sound on marine mammals, marine turtles and recreational and artisanal divers.

Mitigation Measures

The following mitigation measures are recommended to avoid and reduce major and moderate potential impacts:

Mitigating measures associated with impacts from seismic operations

Potential impacts of underwater noise on marine mammals and marine turtles:

- Scheduling – Plan surveys to avoid the humpback whale season (July to December).

⁶ Large spill: That would escape containment and require rapid mobilization of equipment not available in the region (ie, an international oil spill response company)

- Soft start – Every time the use of the seismic array is initiated, “soft-start” procedures must be used to allow time for marine mammals and turtles to move away before the array reaches full power.
- Visual monitoring – Beginning at least 30 minutes before start-up during daylight hours, visual observers should monitor a safety (exclusion) zone of a 1 km radius around the source vessel for whales and dugongs and 500 m for marine turtles.
- Shutdown of the array – Visual monitoring of the sea surface should continue while the seismic array is operating during daylight hours, and the array should be shut down if a whale or dugong enters the 1 km safety zone or a marine turtle enters the 500 m safety zone during visual monitoring.

Potential Impacts from seismic survey on habitats

These may arise from:

- Impacts from underwater sound pressure
- Physical impacts of retrieval and deployment of ocean bottom cables/autonomous receivers

Mitigating measures include:

- Respect all buffer zones around sensitive habitats as laid out in the EMP
- Careful deployment of ocean bottom cables/autonomous receivers to be accompanied by monitoring as laid out in the EMP

Human Divers

- Ensure no diving in 1500m buffer zone around the seismic vessel.
- Through the Communications Plan coordinate with dive operators and artisanal fishers to ensure they are aware of survey locations and timing.

Temporary decrease in catch volumes by artisanal fishers

- Through the Communications Plan coordinate with artisanal fishers to ensure they are aware of survey locations and timing.
- Prepare Compensation Plan

Potential loss of revenue to the tourism operators

- Prepare a media fact sheet to assist the tourism operators as to how to convey information relating to the seismic program

- Prepare a Compensation Plan and Grievance Procedures that outlines strategies for compensation to tourism operators.

Mitigating measures associated with impacts from drilling operations

Effects of positioning a jack-up rig on seagrass and coral community

- Prepare an environmental survey of the seafloor prior to the mobilization of the rig.
- A 100 m buffer zone will be maintained to avoid physical impact on coral reefs and seagrasses.

Effects of disposal of drilling muds and cuttings on coral reefs and seagrass beds⁷

- Maintain a 100 m buffer zone to avoid impacts to coral reefs and seagrasses.
- Prepare a site specific mud/cuttings dispersion model to determine if the 100m buffer zone is sufficient once the location of the rig is known.

Potential Impacts on water quality and marine fauna and flora due to a hydrocarbon release (in the case of a large diesel or oil spill)

- Preparation of, and compliance, to the Emergency Response Plan and Oil Spill Contingency Plan.
- Regular maintenance and verification of the Blowout Preventer (BOP).

Potential visual impacts on tourism activities

- Once exact drill sites are determined, a site-specific addendum to the EIA Report should be compiled

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⁷ Refers to cuttings that may be produced during the drilling of the first hole section and that may be discharged in shallow water

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- Prepare a site specific mud/cuttings dispersion model to determine if the 100m buffer zone is sufficient once the location of the rig is known.

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Potential visual impacts on tourism activities

- Once exact drill sites are determined, a site-specific addendum to the EIA Report should be compiled

Communication and Compensation

As indicated above, effective communication is a key measure for mitigating many of the potential adverse environmental impacts associated with seismic acquisition and drilling. Early consultation with all relevant authorities, prior to seismic vessel and rig mobilization, must be established to avoid interference with maritime traffic and other activities by providing detailed drilling locations, the seismic plan, transportation routing and scheduling information.

During seismic acquisition and drilling effective and transparent lines of communication between the proponent and the tourism industry, the artisanal fishers and the other relevant stakeholders must be maintained. To achieve this objective a Communication Plan has been prepared as part of the Environmental Management Plan. Through proper liaison, due notification of activities and careful monitoring of grievances, many of the potential impacts can be either avoided or minimized. Where impacts cannot be avoided, the affected parties should be compensated and a Compensation Plan has been prepared with a Grievance Procedure. These must be agreed to by with the relevant Government Authorities (INP, MICOA; Fisheries and Tourism sectors).

While the drilling vessel is operational, a 500m radius safety zone will be maintained around the drilling site and the Communication Plan is designed to inform the key stakeholders of the location and timing of the drilling operations and the exclusion zone.

A 1500 m safety zone for divers will be maintained around the seismic vessels. Again the Communications Plan is designed to ensure that tourism operators, artisanal fishers and other stakeholders are aware of survey locations and timing.

⁸ Refers to cuttings that may be produced during the drilling of the first hole section and that may be discharged in shallow water

Hydrocarbon spills, fires and accidents

Hydrocarbon spills during drilling and seismic operations include small diesel fuel releases from the rig or seismic vessels during routine operations or bunkering. For drilling operations a barge storing 3000m³ of diesel will be anchored near Mocimboa da Praia. A catastrophic accident (such as an explosion on the barge) could potentially result in a very large diesel spill, with the 3000m³ being spilled into the sea. However the probability of a catastrophic event of this nature is highly unlikely.

Of these potential incidents, blowouts releasing large volumes of crude oil are likely to create the most significant impacts. Such an event, while extremely unlikely to occur, could result in extensive negative impacts should the released hydrocarbons enter nearshore waters and coastline habitats.

Although a low-probability non-routine event, a hydrocarbon spill could reach shore, island or mainland, within several hours as indicated by the oil trajectory modelling.

An Oil Spill Contingency Plan - OSCP/Emergency Response Plan – (ERP) has been prepared that outlines procedures for dealing with all types of spills and emergencies including a spill that cannot be contained locally and would require the rapid mobilization of resources from outside the region (the OSCP/ERP is enclosed as an Appendix to the EMP, Volume II, Part B). The OSCP/ERP should be updated when the exact locations are of the drill sites are known.

Waste Management

A Waste Management Plan has been included in this EIA (Appendix of EMP, Volume II, Part B). The drilling rig and seismic vessels must comply all with procedures outlined in the Plan, The EMP which forms part if this EIA (Volume II, Part B) as well as with regulations detailed in the Annex V of MARPOL 73/78, which clearly defines the procedures to be applied for each category of liquid and solid waste.

Overall Environmental Management

Management of all identified impacts (implementation of the mitigating measures and monitoring their implementation) is required during all phases of the seismic and drilling programs. This EIA includes an Environmental Management Plan (EMP) – see Volume 2, Part B of this EIA, that clearly defines responsibilities and obligations when implementing the mitigation measures and when monitoring their implementation.

Adherence to environmental operating procedures described in this report, in conjunction with adherence to the EMP will reduce adverse environmental impacts to a minimum for both routine and non-routine events.

With proper implementation of the mitigation measures outlined in this EIA, as detailed in the EMP, the project is feasible from biophysical and socio-economic viewpoints.

APPENDIX

Letter from MICOA Categorizing the Project



REPUBLICA DE MOÇAMBIQUE

MINISTÉRIO PARA A COORDENAÇÃO DA ACÇÃO AMBIENTAL
DIRECÇÃO NACIONAL DE AVALIAÇÃO DO IMPACTO AMBIENTAL
DNAIA

A:

IMPACTO, Lda
Exmo Senhor Dr António E. L. Couto
Director Geral

Maputo

Sua Ref^o Nossa Ref^o N^o 588 /DNAIA/GDN/08 Data: 29-04-2008

Assunto: Projecto de Pesquisa Sísmica e Perfuração de Pesquisa em Águas não Profundas na Concessão Marinha da Área 1 da Bacia do Rovuma, Moçambique

Exmo Senhor,

A DNAIA recebeu de V.Excia, o documento em epígrafe para a instrução do processo. Da sua análise, e de acordo com o anexo I, 4.6, alínea b, do Decreto 45/2004, de 29 de Setembro, a sua implementação, é condicionada à elaboração do Estudo de Impacto Ambiental(EIA).

A anteceder ao EIA, o proponente deverá submeter quinze(15) cópias do Estudo de Pré-Viabilidade Ambiental e Definição de Âmbito(EPDA) e Termos de Referência (TdR), em suporte de papel, e uma(1) em suporte electrónico à DNAIA, e oito(8) cópias em suporte de papel deverão ser submetidas na Direcção Provincial para a Coordenação da Acção Ambiental de Cabo Delgado.

Com os melhores cumprimentos.



C.C: DPCA-Cabo Delgado

JJ

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