E4834 v3

Annex A
Stakeholder Engagement Plan

ABSTRACT

This Annex describes the Stakeholder Engagement Plan (SEP) for the Offshore Cape Three Points (OCTP) Phase 2.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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A.1. INTRODUCTION

A.1.1 PURPOSE AND OBJECTIVES

A.1.1.1. Purpose

This document describes the Stakeholder Engagement Plan (SEP) for the Offshore Cape Three Points (OCTP) Phase 2 Development (the Project).

The value of engagement with stakeholders affected by development is widely recognized and discussed in the literature. There is clear evidence that the greater the level of stakeholder engagement, the more thorough the identification of potential impacts. Early engagement and ongoing dialogue with stakeholders also allows for earlier identification of potential stakeholder issues and risks as or before they arise, and informs more appropriate project design. This all contributes to a stronger more sustainable relationship between stakeholders and the project proponent. This is particularly true for the groups and individuals most directly affected by planned projects. Establishing trust between parties through a participatory process that allows for open and constructive engagement is acknowledged as key for satisfactory resolution of grievances and issues which, if left unmanaged, can present risks to a development in terms of unplanned delays and costs.

For a project to obtain and continually maintain its "social license to operate" (1), a two-way process of engagement between all parties is highly important. Achieving and maintaining a social license is a key objective of a stakeholder engagement process.

A.1.1.2. Objectives

The overarching goal of this SEP is to define a suitable programme and plan for stakeholder engagement that will apply across the Project's life and that will support the Project in achieving and maintaining a social license to operate.

The specific objectives for the plan are summarised in Table A1.1.

Table A1.1 Objectives of the Stakeholder Engagement Plan

Objective	Rationale
Identify all relevant stakeholders for this Project	Involving as many stakeholders as possible will facilitate inclusive communication and capture a wide range of issues and concerns.
Distribute accurate project information in an open and transparent manner	Ensuring that stakeholders, particularly those directly affected by the proposed development, have information at their disposal with which to make informed comments and enable them to plan for the future. This reduces levels of uncertainty and anxiety. Information should allow affected parties to develop an understanding of potential impacts, risks and benefits and an open and transparent approach is central to achieving this aim.
Gather information that will contribute to the environmental and technical	Identifying issues through people familiar with the local environment and incorporating these into the Terms of Reference (TOR) for specialist investigations meets legislative requirements and ensures that specialists

(1) The social license is the level of acceptance or approval continually granted to an organization's operations or project by local communities and other stakeholders.

Objective	Rationale
investigations	focus on all relevant issues. It is also critical in ensuring the most appropriate project design and management measures possible.
Form partnerships to promote constructive interaction between all parties	Developing relationships of trust between the developer and stakeholders will contribute to proactive interactions and avoid, where possible, unnecessary conflicts based on rumour and misinformation. Identifying structures and processes through which to deal with conflicts and grievances, in contrast to attempting to quash any disputes, would allow the Project a better understanding of stakeholder concerns and expectations thereby increasing the opportunities to increase the Project's value to local stakeholders.
Record and address public concerns, issues and suggestions	Documenting stakeholder issues allows project decisions to be traced and motivated and lets stakeholders see where their input has been incorporated into planning and design. This approach addresses potential concerns that stakeholder engagement may be a token gesture by the developer that meets legislative requirements but that it is not taken seriously in the project planning.
Manage stakeholders' 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 with limited development, infrastructure and service provision. Ensuring that expectations are kept at realistic levels (e.g. around job opportunities; provision of local infrastructure; social development; disruption and resettlement) 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.

A.1.2 PROJECT DESCRIPTION

The proposed Project involves the development of the Sankofa and Gye Nyame Fields in the OCTP license block located approximately 60 km offshore of the Western Region of the Republic of Ghana (Figure A1.1). The fields will be developed in two Phases:

- **Phase 1**: Oil Development Project
- **Phase 2**: Gas Development Project

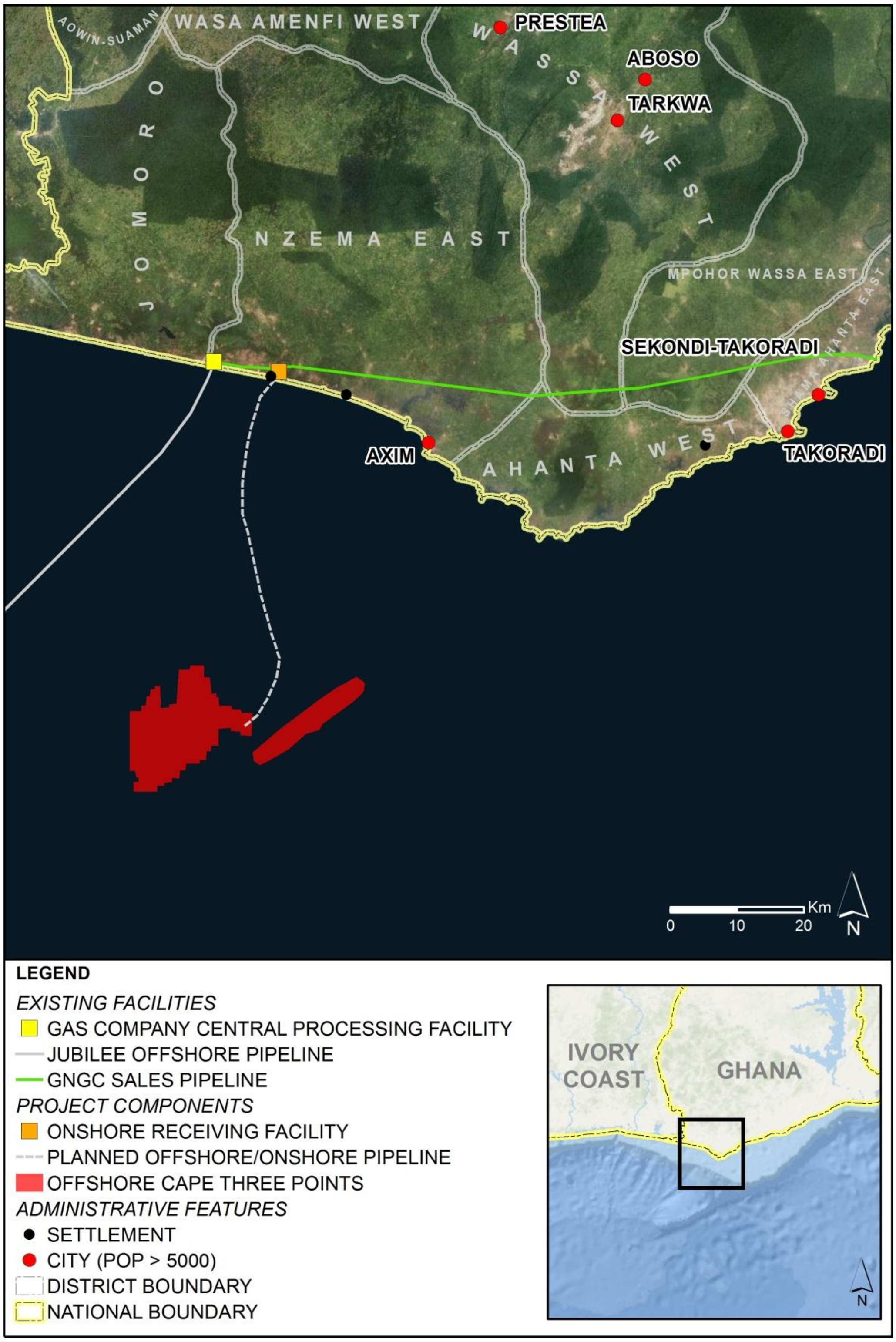
This document is the SEP for the Phase 2 Development.

The Phase 2 Development is a gas production project. First gas production is planned for 2018. The development infrastructure will consist of:

- Five subsea Non-Associated Gas (NAG) wells;
- Subsea umbilicals, risers and flowlines from the NAG wells to an FPSO;
- 63 Km subsea gas pipeline from the FPSO to shore;
- Onshore pipeline from the shore to an Onshore Receiving Facility (ORF);
- ORF including a compression station, accommodation camp, warehouse, workshop, firefighting station and medical facility

- Gas from the ORF will be exported via a direct connection between the ORF and the existing GNGC gas pipeline.

Figure A1.1 Project Location



Source: eni, 2014

Activities associated with the Phase 2 Development construction phase include drilling, completion and connection of the wells, laying and testing of the subsea facilities and pipeline to ORF, site clearance and construction of the ORF.

Once operational, gas will be produced, transferred, and gathered at the FPSO unit. Gas will be sent from the FPSO by pipeline to the ORF. At the ORF the gas will be combined with the gas from the GNPC gas plant and sent to users.

A.1.3 AREA OF INFLUENCE

This area of influence includes the Project sites (ORF, offshore and onshore pipelines, subsea facilities and NAG wells), the area surrounding the site and the local communities between Mpein in the East, Atuabo in the West and Amis Hibiebo Kaso in the North as well as the Ghana marine and socio-economic environment at a wider scale. The Project and Project activities will affect receptors in the Direct Area of Influence (DAoI) and the Extended Area of Influence (EAoI).

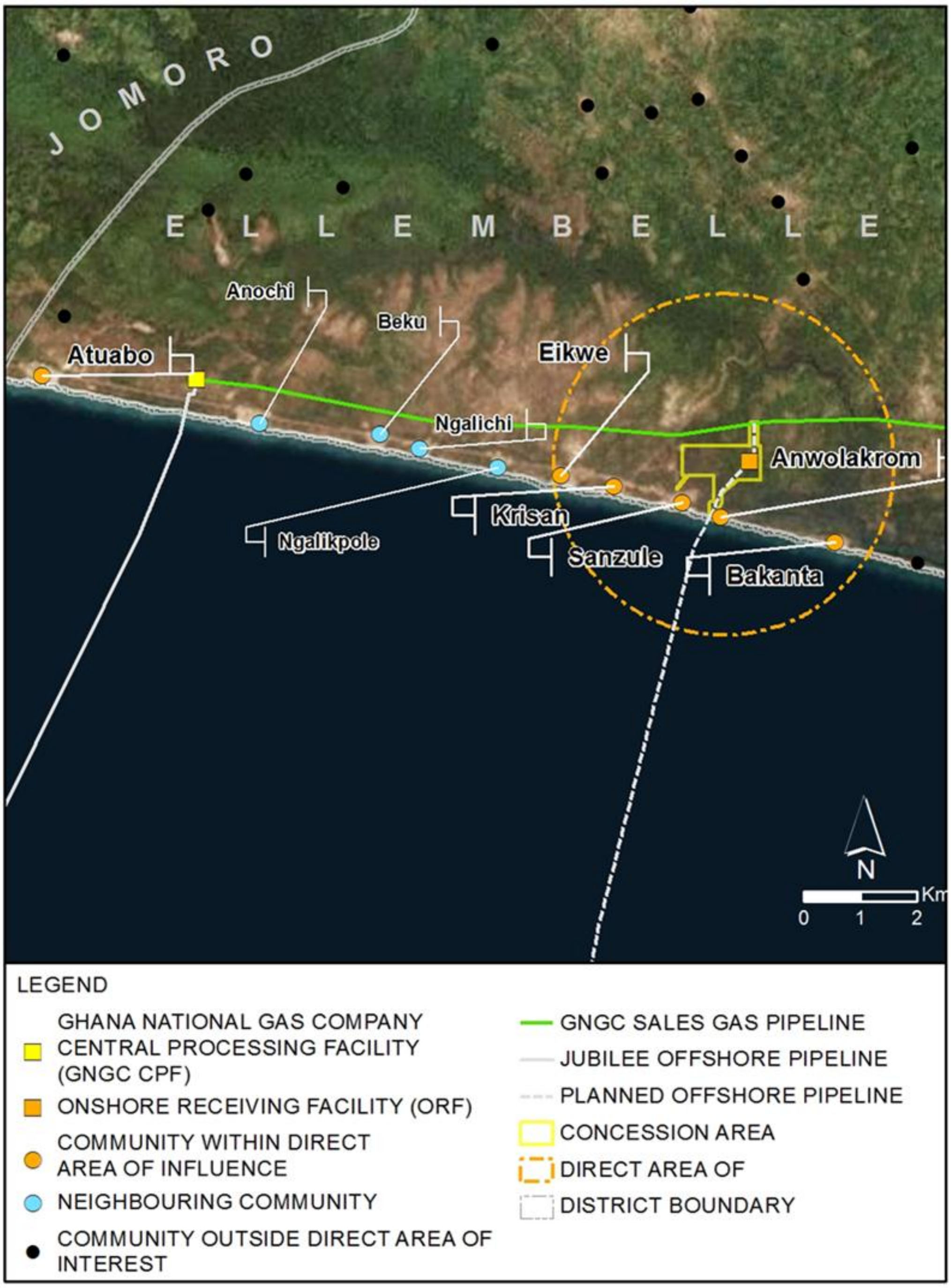
The Direct Area of influence (DAoI) for engagement includes communities in a 3 km buffer zone around ORF (Figure A1.2).

The Extended Area of influence (EAoI) includes selected key localities, communities and stakeholder groups (eg, District Assemblies and Chief Fishermen) close to the ORF site in the six wider coastal Districts. The selection of these communities was based on a set of criteria which are fully explained in the Project's EIS.

It should be noted that when stakeholder engagement activities took place in the context of the Scoping of the EIA [1] the project included the possibility of the construction of a pipeline to transfer gas from the ORF to the GNGN CPF in Atuabo. Although this is no longer considered an option, stakeholder engagement activities also took place at Anochi, Beku, Ngalichi and Ngalikpole which were considered potentially affected by that development.

[1] Stakeholder Engagement activities performed during the Scoping Phase was only the first phase of an ongoing process which will continue throughout the entire Project Life (e.g., development and production operations), in order to achieve the overarching goal of the SEP.

Figure A1.2 Direct Area of Influence



Source: ERM, 2015

A.1.4 Stakeholder Engagement Approach

A.1.4.1. Definitions

The following terms are used in this SEP:

<u>Consultation</u>

Consultation involves two-way communication between the client and the affected communities. The consultation process is undertaken in a manner that is inclusive and culturally appropriate. It provides the affected communities with opportunities to express their views on project risks, impacts and mitigations measures, and in turn allows the client to consider and respond to them.

Stakeholders

Stakeholders are persons or groups of people who are directly or indirectly affected by a project, as well as those who may have interests in or the ability to influence the Project's outcome, either positively or negatively. Stakeholders may include locally affected communities and their formal and informal representatives, national, provincial or local government authorities, religious leaders, civil society organizations and special interest groups such as the academic community, amongst others.

Stakeholder Engagement

Stakeholder engagement is a process whereby efforts are made by one party to understand and involve the other parties' (the stakeholders') concerns in the first party's activities and decision-making processes.

A.1.4.2. Principles

The key principles that guide the approach for stakeholder engagement are as follows:

- **Transparency**: to be open and transparent with stakeholders.
- **Accountability**: to be willing to accept responsibility as a corporate citizen and to account for impacts associated with the Project activities.
- **Trust**: to have a relationship with stakeholders that is based on mutual commitment to acting in good faith.
- **Mutual respect**: to respect stakeholders' interests, opinions and aspirations.
- **Collaboration**: to work cooperatively with stakeholders to find solutions that meet common interests.
- **Responsiveness**: to coherently respond in good time to stakeholders.
- **Pro-activeness**: to act in anticipation of the need for information or potential issues.
- **Fairness**: to engage with stakeholders such that they feel they are treated fairly and their issues and concerns are afforded fair consideration.
- **Accessibility**: to be within reach of stakeholders so that they feel heard and to provide comprehensive information.
- **Inclusivity**: to proactively anticipate, identify and include all stakeholders.

A.1.4.3. Levels of engagement

There are various levels of engagement and types of engagement that can often involve a combination of approaches. Box A1.1 shows the various levels of stakeholder engagement appropriate in a given situation and the objectives of that engagement and Box A1.2 describes the key types of engagement outline in eni. As part of stakeholder identification and analysis, the level of engagement per stakeholder was determined as appropriate to the phase of the Project and taking into account the issues pertinent to the specific stakeholder.

Box A1.1 Levels of Stakeholder Engagement

Level of Stakeholder Engagement	Objective	Direction of Information Exchange
Inform	To provide balanced and objective information to improve understanding of the issues, alternatives and/or solutions.	One way
Consult	To obtain feedback from stakeholder on issues, alternatives and/or decisions.	Two way
Collaborate	To partner with stakeholders and enable their participation in each aspect of a decision-making process.	Two way
Empower	To place final decision-making in the hands of the stakeholders.	Two way

Source: International Association for Public Participation (IAP2), 2004

Box A1.2 Types of Engagement

Types of Engagement	Description
Information Disclosure	Disclosure means making information accessible to interested and affected parties. Communicating such information in a manner that is understandable to the interested stakeholders is an important first (and ongoing) step in the process of stakeholder engagement.
Stakeholder Consultation and Public Consultation	Stakeholder consultation requires more effort than just informing and should not be seen as one-off activity. It is an interactive process of engaging stakeholders using participatory methodologies, that begins during the conceptual design of a Project and continues throughout construction and operations. The feedback from consultation will feed the management process. Initial public consultation is often used to assist in stakeholder analysis to ensure that no relevant groups are excluded and to develop culturally appropriate and effective engagement with relevant groups.
Consultation with Vulnerable Groups	It is important to keep in mind that eni's activities and projects are likely to affect the vulnerable groups differently than the rest of the population. Normally these groups, individuals or social groups who are potentially disadvantaged compared to the rest of the population - vulnerability may be based on, among other things: age, gender, ethnicity, income level, physical and/or mental disabilities) will have fewer opportunities to make their voice heard and less power to negotiate.
Establishing Collaborations	Identifying potential collaborating stakeholders, assessing their suitability for collaborating with eni, and identifying what areas of mutual interest are shared with the regional community development programs.

Source: opi sums ssc 001 eni spa UPS r00 Stakeholder Engagement 18-12-2014

A.1.4.4. Developing the Approach

This SEP outlines a technical and culturally appropriate approach to consultation and disclosure in the project area of influence to ensure that adequate and timely information is provided to all stakeholders. This approach allows groups sufficient opportunity to voice opinions, concerns and issues which need to be taken into account in Project design and when making Project decisions. In addition, the process has been designed to encourage early and active participation of stakeholders so that suggestions can be incorporated into Project design and so that concerns and conflicts can be openly addressed in an ongoing manner both during the EIS process and continuing into the construction, operation and decommissioning.

Various activities/steps have been undertaken and are planned as part of this stakeholder engagement planning process. These include:

- Stakeholder identification and analysis (development of stakeholder register);
- Development of appropriate engagement and information dissemination tools;
- Notification and invitation to participate and comment;
- Scoping and baseline engagement meetings with key informants and affected community representatives;
- Recording issues raised and commitments;

- Recording activities undertaken within the process;
- Development of SEP appropriate to the scope of the project to guide the engagement process during the Project's lifetime;
- Update of SEP following EIS disclosure and throughout the life of the project;
- Facilitating ongoing stakeholder input into Project design and implementation;
- Ongoing engagement of stakeholders throughout construction, operation and through to decommissioning of the Project.

A.2. REGULATIONS AND REQUIREMENTS

This Section describes the legal, regulatory, policy and guidance that relates directly to stakeholder engagement activities. Refer to Chapter 2 of the EIS for a broader legal and policy context for the Project.

The stakeholder engagement process has been designed to ensure compliance with Ghana's legal and regulatory requirements, the IFC Performance Standards (2012), and industry good practice guidance such as that developed by IPEICA.

A.2.1 NATIONAL LEGISLATION

Stakeholder engagement is an integral part of the Environmental Impact Assessment (EIA) process. The EIA process is legislated through the Environmental Assessment Regulations (LI1 652, 1999) as amended (2002), the principal enactment within the Environmental Protection Act (Act 490 of 1994). The Regulations require that activities likely to have an adverse effect on the environment must be subject to environmental assessment and issuance of a permit before commencement of the activity.

The Regulations (1999) require that a scoping notice be advertised to relevant Ministries and in at least one national and one local (in the DAoI) newspaper. Copies of the Scoping Report must be made available to the general public in the project locality for inspection, and the Project must advertise in a local and national newspaper on the release of the EIS Report.

Once the Environmental Impact Statement (EIS) is published it must be advertised and made available to the general public, public agencies, organisations, NGOs, Metropolitan, Municipal and District Assemblies and local communities and mechanisms must be put in place so that stakeholders can make comments and suggestions on the Project, as required by the Environmental Protection Agency (EPA). There is also provision within the Regulations for the EPA to hold public hearings if there is an adverse public reaction to the Project, there is a need for resettlement, or the project could have extensive effects on the environment.

Stakeholder engagement activities during the EIS process are informed by the EIA regulations and guidelines, although these activities are required also at the discretion of the EPA.

A.2.2 LENDER STANDARDS

A.2.2.1. IFC Performance Standards

The IFC Performance Standards on Environmental and Social Sustainability (2012) are generally accepted as the benchmark of good practice for environmental and social sustainability risk management in private sector developments. The Performance Standards include specific detail on conducting stakeholder engagement both during the impact assessment process and throughout a Project's life-cycle, and are a key source of guidance in planning for engagement activities.

The Performance Standards require clients to engage with affected communities through disclosure of information, consultation, and informed participation, in a manner commensurate with the risks to and impacts of the Project on the affected communities.

Box A2.1 outlines the main requirements for consultation and disclosure under Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.

The IFC Good Practice Manuals (1) highlight issues that should be considered in undertaking engagement with affected communities. These are reinforced by the details contained within the Performance Standards, including written and oral communication in local languages, accessibility to information, the use of oral and visual methods, respect of local traditions, care that vulnerable groups are included in the process, and mechanisms are employed to respond to peoples' needs, fears and expectations.

Box A2.1 Performance Standards Requirements for Stakeholder Engagement

IFC PS1: Assessment and Management of Environmental and Social Risks and Impacts

Stakeholder engagement is an on-going process that may involve, in varying degrees, the following elements: stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and on-going reporting to Affected Stakeholders.

Disclosure of relevant project information

Provide affected stakeholders with access to relevant information on: (i) the purpose, nature, and scale of the project; (ii) the duration of proposed project activities; (iii) any risks to and potential impacts on such stakeholders and relevant mitigation measures; (iv) the envisaged stakeholder engagement process; and (v) the grievance mechanism.

Informed Consultation and Participation

For projects with potentially significant adverse impacts on affected stakeholders, conduct an informed consultation and participation process. It should involve deep exchange of views and information, and an organized and iterative consultation, leading to the project incorporating into their decision-making process the views of the affected stakeholders on matters that affect them directly, such as the proposed mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

The process should be documented, in particular the measures taken to avoid or minimize risks to and adverse impacts on the affected stakeholders. The stakeholders should be informed about how their concerns have been considered.

External Communications

Implement and maintain a procedure for external communications that includes methods to (i) receive and register external communications from the public; (ii) screen and assess the issues raised and determine how to address them; (iii) provide, track, and document responses, if any; and (iv) adjust the management program, as appropriate. In addition, clients are encouraged to make publicly available periodic reports on their environmental and social sustainability.

Grievance Mechanism for Affected Stakeholders

Establish a grievance mechanism to receive and facilitate resolution of affected stakeholders' concerns and grievances about the client's environmental and social performance.

On-going Reporting to Affected Stakeholders

(1) IFC. (1998). Doing Better Business through Effective Public Consultation and Disclosure; IFC (2007) Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets.

Provide periodic reports to the affected stakeholders that describe progress with implementation of the project Action Plans on issues that involve on-going risk to or impacts on affected stakeholders and on issues that the consultation process or grievance mechanism have identified as a concern to those stakeholders.

The Performance Standards require that after completion of an environmental assessment the consultation and disclosure must continue throughout the life cycle (construction and operation phase) of the project.

Source: IFC Performance Standard 1, January 2012.

In addition to the requirements for stakeholder engagement outlined in PS1, the additional standards that contain requirements for stakeholder consultation and participation and have been considered in developing this SEP include PS 2, 4, 5, 6 and 8 (see Table A2.1). The development and implementation of a Grievance Resolution Procedure is also referenced within PS 1, 2, 4 and 5.

Table A2.1 Stakeholder Engagement Requirements from PS 2, 4, 5, 6 and 8

Standard	**Key Components**
Performance Standard 2: Labour and Working Conditions	Recognizes that the pursuit of economic growth through employment creation and income generation should be balanced with the protection of basic rights for workers. Acknowledges that constructive worker-management relationship and safe and healthy working conditions may enhance the efficiency and productivity of operations.
Performance Standard 4: Community Health, Safety & Security	Recognizes that project activities, equipment and infrastructure bring benefits to communities including employment, services and opportunities for economic development. However, the project can also increase the potential for community exposure to risks from development. Where project activities pose risks of adverse impacts on the health and safety of affected communities the developer is required to make available relevant information (including the details of an Action Plan), in an appropriate form, to affected parties and government authorities so that they can fully understand the nature and extent of the risks.

Performance Standard 5: Land Acquisition and Involuntary Resettlement	In such instances the developer will undertake extensive consultation and negotiation with affected parties. Such communication will include transparent access to project related information in a timely fashion to enable people to plan for the future. Here public participation will include the establishment of appropriate representative forums through which resettlement and compensation are discussed. Most of this consultation is part of the SIA and Livelihood Restoration Plan (LRP) but it should be recognized as a component of the SEP. Although resettlement is ALWAYS seen as a last resort, this Standard recognizes that involuntary resettlement occurs as a result of projects and refers to both physical and economic displacement as a result of project related land acquisition. Resettlement is considered involuntary when affected individuals or communities do not have the right to refuse land acquisition that result in their displacement. Consultation shall also take place with host communities.
Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management	Recognizes that protecting and conserving biodiversity in all its forms is fundamental to sustainable development. Where the project has potential impacts on legally protected or critical habitats consultation with relevant authorities, specialists and communities must be undertaken.
Performance Standard 8: Cultural Heritage	Recognizes the importance of cultural heritage for current and future generations and is consistent with the convention concerning the protection of the world's cultural and natural heritage. Where sites of cultural heritage are potentially impacted by the project the developer will consult with local communities as well as relevant national authorities responsible for the maintenance of such sites.

A.2.2.2. Equator Principles

The Equator Principles (EPs) are an environmental and social risk management framework voluntarily adopted by 79 member financial institutions (Equator Principle Financial Institutions - EPFIs). They are intended to provide a minimum standard for due diligence to support responsible risk decision-making by financiers to private-sector projects. The Equator Principles were developed by private-sector banks and launched in June 2003. They were first revised in July 2006 and new revisions, referred to as EP III, took effect in June 2013.

The EPs emphasise that lenders involved with the Project will seek to ensure that the Project is developed in a manner that is socially responsible and reflects sound environmental management practices. They further stipulate that host country legislation must be adhered to and provide requirements for stakeholder engagement and disclosure.

Table A2.2 Stakeholder Engagement Requirements from PS 2, 4, 5, 6 and 8

Principle	**Requirement**
Principle 2	Highlights the requirements for "*consultation and participation of affected parties in the design, review and implementation of the project*".
Principle 5	To facilitate stakeholder engagement, the client will, commensurate to the Project's risks and impacts, make the appropriate Assessment Documentation readily available to the Affected Communities, and where relevant Other Stakeholders, in the local language and in a culturally appropriate manner .
	There's an overall requirement for the EPFI to require the borrower to demonstrate effective stakeholder engagement as an on-going process in a structured and culturally appropriate manner with Affected Communities and where appropriate with Other Stakeholders.
	States that for Projects with potentially significant adverse impacts on Affected Communities, the client will conduct an Informed Consultation and Participation process.
Principle 6	Specifically highlights the need for a Grievance Mechanism that includes requirements for engagement during the construction and operation of the Project *"…to ensure that consultation, disclosure and community engagement continues throughout construction and operation of the project, the borrower will, scaled to the risks and adverse impacts of the project, establish a grievance mechanism as part of the management system. This will allow the borrower to receive and facilitate resolution of concerns and grievances about the project's social and environmental performance raised by individuals or groups, from among project-affected communities".* An important component is the project-level grievance mechanism for all Cat A and, as appropriate, Cat B Projects - designed to receive and facilitate resolution of concerns and grievances about the Project's E&S performance. Requires that the client will inform the Affected Communities about the mechanism in the course of the Stakeholder Engagement process.

Source: Equator Principles Financial Institutions - EPFIs, 2012

A.3. SUMMARY OF PREVIOUS STAKEHOLDER ENGAGEMENT ACTIVITIES

This Chapter describes the stakeholder activities that have already been conducted as part of the Project development. The engagements occurred mainly as part of the EIS for the Phase 2 Development, but also previously as part of the of the EIS for the related Phase 1 Development.

A.3.1 PHASE 1 DEVELOPMENT STAKEHOLDER ENGAGEMENT

Stakeholder engagements were carried out as part of the EIS for the Phase 1 Development. The stakeholder engagement planning and actions for Phase 1 were used to inform this stakeholder engagement plan, especially the stakeholder identification process. This facilitated a more efficient engagement process for the Phase 2 Development.

A.3.2 SCOPING PHASE STAKEHOLDER ENGAGEMENT

A.3.2.1. Objectives

Scoping phase consultations were undertaken from 01 to 05 December 2014 as part of a combined scoping and baseline data gathering site visit. The other objectives of the scoping phase engagements were as follows:

- Inform the government and traditional authorities and communities about the Project;
- Gather and record the communities' initial issues and concerns about the Project;
- Inform people about the upcoming public participation process for the Project (ie, future consultations and information disclosure);
- Re-open dialogue and strengthen relationships between stakeholders and eni Ghana; and
- Understand and refine the approach and methodology of engaging the communities in the area for the future phases of the Project.

A.3.2.2. Notifications

The stakeholder mapping exercise identified those stakeholders that should be notified and engaged through face-to-face meetings. Table A3.1 below demonstrates the types of notification undertaken.

Table A3.1 Stakeholder Notification

Type of Notification	Action Taken
Invitation letters	Formal letters of invitation and Background Information Documents (BIDs) were sent or given by hand to national, regional, and district authorities as well as to the Chiefs informing them of the consultation process and proposing a date and time for a meeting with the relevant people. Copies of the invitation letters sent are in Appendix A
Distribution of the Background Information Document (BID)	A Background Information Document (BID) was prepared in English and distributed by hand at all meetings. The BID provides a description of the proposed project, an overview of the EIS process and contact details in order for stakeholders to provide comments on the Project. See Appendix B for a copy of the BID.
Through word of mouth via headmen/women	Chiefs and Chiefs' linguists (spokespersons) were given prior notification about community meetings, and they informed the people within their villages

A copy of a Background Information Document (BID) and a covering letter requesting a meeting were hand-delivered to stakeholders and in certain cases meetings were confirmed through subsequent telephone and email communication. A copy of the transmittal letter and the BID is provided in Appendix B. The BID provides an overview of the Project and outlines the key potential environmental, social and health issues that have been identified. It also provides stakeholders with information on how to formally register additional issues and comments on the EIS process and the Project with eni Ghana.

Additional stakeholders identified later will be engaged with through written communication that includes the up to date BID, an invitation to submit written comment and detail on the Project's Grievance Mechanism.

A.3.2.3. Stakeholder Engagements

During scoping, a total of 30 meetings were held with 30 national and regional stakeholder groups or organisations. Stakeholders included national, regional, district and local authorities, Non-Governmental Organisations (NGOs), international organisations and fisher association. A list of the scoping consultation meetings undertaken is provided in **Error! Reference source not found.**.

A further 10 scoping consultations with directly affected communities were conducted in the form of Village Meetings. Due to the parallel scheduling of the scoping and baseline study activities these meetings took place just prior to the commencement of Focus Groups and Key Informant Meetings for the purposes of baseline data gathering. Since they were conducted by the baseline EIS team these meetings are listed in both Table A3.2 and again in Table A3.3.

Each of the face-to-face meetings followed this general format:

- Introduction by the meeting facilitator;
- Introduction to eni Ghana and the EIS team;
- Description of the proposed Phase 2 development and the Project's components; and
- Discussion of the key issues and any information that may be relevant to the Project including identification of additional stakeholders that should be consulted as part of the EIS process.

All stakeholders that participated in consultation meetings during scoping and baseline data gathering activities were invited to sign an attendance register. Copies of the registers are found in Appendix C of this SEP. Minutes of the meetings are found in Appendix D of this SEP.

Table A3.2 Scoping Consultations

No.	Organisation'/Group	Date	Location	Attendees
1-10	Directly Affected Communities (Village scoping consultation meeting see **Error! Reference source not found.**)	02-Dec-14 to 05-Dec-14	Asemdesauzo, Krisan, Bakanta, Eikwe, Sanzule, Atuabo, Ngalekpole, Ngaliki, Anoyki, Beku	N/K* (1)
11	EPA	02-Dec-14	Accra	3
12	Ministry of Energy & Petroleum	02-Dec-14	Accra	2
13	Wildlife Division of Forestry Commission	02-Dec-14	Accra	3
1	Fisheries Commission	02-Dec-14	Accra	7
15	Petroleum Commission	03-Dec-14	Accra	4
16	Ricerca e Cooperazione	04-Dec-14	Accra	1
17	Ghana National Petroleum Corporation (GNPC)	04-Dec-14	Tema	8
18	Ghana Ports & Harbour Authority	04-Dec-14	Tema	3
19	Friends of the Nation	05-Dec-14	Takoradi	2
20	Conservation Foundation	05-Dec-14	Takoradi	1
21	EPA: Western Region	08-Dec-14	Takoradi	5
22	Ghana Ports & Harbour Authority: Western Region	08-Dec-14 and 17-Dec-14	Takoradi	4
23	Marine Police	08-Dec-14	Takoradi	5
24	Fisheries Commission	08-Dec-14	Takoradi	3
25	Western Region Coordinating council (WRCC)	08-Dec-14	Takoradi	6
26	Enterprise Development Center (Jubilee & Ministry of Energy)	08-Dec-14	Takoradi	3
27	Ghana Tourism Authority	09-Dec-14	Takoradi	3
28	Museums and Monument Board	09-Dec-14	Cape Coast	5
29	Jomoro District Assembly	03-Dec-14	Half Assini	9
30	Ellembelle District Assembly	03-Dec-14	Nkroful	10
31	Sekondi Takoradi Metropolitan Assembly	08-Dec-14	Takoradi	3

(1) These meetings were held in public locations (e.g. Chief's Palace) in each village and although majority of attendees noted their names in the circulated registers, many additional attendees also arrived and left during the proceedings or listened at the edges of the group and did not formally register their presence. It was therefore not possible to accurately capture total attendance in each case.

No.	Organisation'/Group	Date	Location	Attendees
32	Shama District Assembly	09-Dec-14	Shama	3
33	Nzema East District Assembly	08-Dec-14	Axim	8
34	Western Region Regional Health Director	02-Dec-14	Sekondi	3
35	Ellembelle District Health Director	02-Dec-14	Nkroful	4
36	Fisherman of Shama	05-Dec-14	Shama	24
37	Fisherman of Essiama	09-Dec-14	Essiama	15
38	Chief Fisherman of Upper Dixcove	08-Dec-14	Dixcove	2
39	Chief Fisherman of Upper Axim	08-Dec-14	Axim	6
40	Chief Fisherman of Half Assini	03-Dec-14	Half Assini	4
41	Chief Fisherman of Sekondi	09-Dec-14	Sekondi	2

A.3.2.4. Disclosure

This Scoping Report was submitted to the EPA for review on 30th December 2014. On review of the Scoping Report, the EPA indicates the requirements to be undertaken by the proponent for disclosure of the Scoping Report to stakeholders, including other Ministries.

The anticipated disclosure process is expected to include an advertisement announcing the release of the Scoping Report for comment published in two newspapers and placement of the Scoping Report at central locations for public review such as:

- EPA library in Accra;
- Public Library in Sekondi;
- Ellembelle District Assembly office in Nkroful; and
- Paramount Chief's palace in Atuabo.

A.3.3 Stakeholder Engagement during Baseline Studies

A.3.3.1. Objectives

Baseline studies were conducted as part of the EIS to develop an up-to-date description of the existing environmental and social conditions. Specifically to the social aspects the studies were intended to:

- Identify the key social conditions in areas potentially affected by the Project and highlight those that may be vulnerable to aspects of the Project;
- Describe the characteristics (nature, condition, quality, and extent) now and in the future in the absence of the Project; and
- Provide sufficient data to inform judgments about the importance, value and sensitivity/ vulnerability of resources and receptors to allow the prediction and evaluation of potential impacts.

The objective of baseline stakeholder engagement activities was therefore to gather recent supporting primary data and information from directly affected stakeholders in the area to inform the development of an accurate baseline description. Stakeholder views and concerns on the proposed project were also gathered during these engagements.

A.3.3.2. Stakeholder Engagements

Table A3.3 below provides a summary and schedule of meetings with affected communities. Baseline Stakeholder Engagement activities took place in the following communities Sanzule, Bakanta, Krisan, Eikwe, Ngalekpole, Ngaliki Beku, Anochi, Atuabo and Asemda-Suazo. A total of 49 engagement meetings were held across the 10 communities and comprised the following:

- Village meetings, focus group discussions and key informant interviews at the ten communities located within the Direct Area of Influence, and selected key informants across 6 districts in the Extended Area of Influence.
- Focus group discussions were undertaken respectively with women groups, leaders and men, and fishermen groups (in some instances the latter FGDs were combined if the participants represented were clearly the same individuals). A structured social and health questionnaire was deployed during these FGDs.
- Finally, key informant interviews were used to engage representative individuals for health, education, and tourism.

The engagement team for the baseline engagements included translators who speak Fante and Nzema so that the key technical elements of the Project and the main issues arising could be described and discussed with non-English-speaking stakeholders.

Copies of the registers are found in Appendix C of this SEP. Minutes of the meetings are found in Appendix D of this SEP.

Table A3.3 Summary of Baseline Data Gathering Engagements and Combined Scoping Meetings with Affected Communities

02/12/2014	**Team 1**	**Team 2**	**Team 3**
Community	Sanzule, Bakanta, Krisan and Eikwe	Ngalekpole, Ngaliki Beku, and Anochi	Atuabo and Asemdasuazo
Engagement	Introductory meeting with village Chiefs	Introductory meeting with village Chiefs	Introductory meeting with village Chiefs

03/12/2014	**Team 1**	**Team 2**	**Team 3**	**Team 4**
Community	Asemdesauzo	Krisan	Bakanta	Eikwe
Engagement	Village scoping consultation meeting, FGD with women, and FGD with men (Scoping Meetings)	Village scoping consultation meeting, FGD with women, and FGD with men Education KII- Headmaster at Ngalichi and Supervisor of the schools at district level and Assemblyman Chief)	Village scoping consultation meeting, FGD with women, and FGD with men Education KII- Teachers at Bakanta Kindergarten and Bakanta primary school	Village scoping consultation meeting, FGD with women, and FGD with men Education KII: Educators of the Catholic Primary School, Eikwe Health KII's- Hospital Administrator, Health Information Officer, Sub-District Public Health Nurse and HR Manager at Eikwe Hospital

04/12/2014	**Team 1**	**Team 2**	**Team 3**	**Team 4**
Community	Sanzule	Atuabo	Ngalekpole	Ngaliki

Engagement	Village scoping consultation meeting, FGD with women, and FGD with men KII Education: Teachers from Sanzule/Krisan Primary School Vice head at Sanzule vocational school KII Health: Health Workers at the Sanzule CHPS Compound (Dr Eric Odei (SRC))	KII's Education- Head Teacher Atuabo Methodist Junior High School and Assistant Head Teacher Atuabo Methodist Primary School KII Health: Health workers at the Atuabo CHPS Compound (Dr Eric Odei (SRC))	Village scoping consultation meeting, FGD with women, and FGD with men KII Education: Kindergarten Teachers at Ngalekpole	Village scoping consultation meeting, FGD with women, and FGD with men Education KII: Head Teacher Ngaliki/ Beku JHS and Head Teacher at Ngaliki/ Beku Primary School

05/12/2014	**Team 1**	**Team 2**	**Team 3**
Community	Anoyki	Beku	(ORF Site visit)
Engagement	Village scoping consultation meeting, FGD with women, and FGD with men	Village scoping consultation meeting, FGD with women, and FGD with men KII Education: Headmaster and the Asemdesauzo Primary School	KII Krisan Refugee Camp Manager
08/12/2014	**Team 1**	**Team 2**	**Team 3**
Community	Atuabo	Eikwe	(Scoping Meetings)
Engagement	Village scoping consultation meeting, FGD with women, and FGD with men, and meeting with Paramount Chief	KII Health: District Health Administration(Ghana Heath Service Outstanding Scoping Meetings in EAoI see **Error! Reference source not found.**	(Outstanding Scoping Meetings in EAoI see **Error! Reference source not found.**)

Figure A3.1, Figure A3.2, Figure A3.3 and Figure A3.4 illustrate some of the baseline data gathering engagement activities:

Figure A3.1 Community Meeting at Sanzule

Source: ERM, December 2014

Figure A3.2 FGD with Teacher Group in Sanzule

Source: ERM, December 2014

Figure A3.3 FGD with Men and Women Ngalikpole

Source: ERM, December 2014

Figure A3.4 Community Meeting at Bakanta

Source: ERM, December 2014

A.3.4 SUMMARY OF CONCERNS

Table A3.4 provides a summary of the issues raised by stakeholders during the scoping and baseline consultations.

Table A3.4 Summary of Scoping and Baseline Consultation Issues

Issue Group	Summary of issues	Addressed in EIS
Accidents	Several stakeholders mentioned concerns over accidental damage to gas pipeline and possible gas leakage.	Chapter 10 and Annex G – Impact Assessment, Section G.7.9
Employment and Local Content	Several stakeholders emphasized the need for local content and youth employment.	Chapter10 and Annex G – Impact Assessment, Section G.7.1
Security	Several stakeholders mentioned that the offshore gas pipeline should be buried to prevent any damage from ships dropping anchors. They also added that the offshore pipeline route needs to be clearly marked and updated in the (admiral chart) navigational chart so the sea farers (including fishers) will avoid the ROW. Stakeholders highlighted that policing of the offshore pipeline ROW and FPSO exclusion zones from encroachment from other uses could cause conflict.	Chapter 4 Chapter 10 and Annex G – Impact Assessment, Section G.7.7
Livelihoods and compensation	Stakeholders indicated that the proposed Project area is currently used for fishing, farming and grazing and expressed concern regarding the loss of livelihoods and the stressed the need for compensation of any lost livelihood.	Chapter 10 and Annex G – Impact Assessment, Section G.7.2
Cultural heritage	Stakeholders expressed concern over the affection to the cemeteries and potential archaeological resources currently located within the Project area. Stakeholders identified those cultural resources in the area need to be preserved and buffer areas should be implemented.	Chapter 10 and Annex G – Impact Assessment, Section G.7.4
In-migration	Stakeholders expressed concern that there would be in-migration of people (especially job-seekers) into the area resulting in impacts to the socio-economic structure, traditional values, demographics and cultural heritage.	Chapter 10 and Annex G – Impact Assessment, Section G.7.3 and G.9.7
Tourism impacts	Some stakeholders expressed concern regarding the conflicting proposed industrial land use and activities with the plans for the development of the Western Region coastline as an area for sustainable tourism. They also expressed concern over the project activities and their potential effect on the tourism potential of the area.	Chapter 10 and Annex G – Impact Assessment, Section G.7.1
Sensitive biodiversity	The impacts on marine fauna (fish, marine mammals) and onshore wildlife were raised as important aspects for consideration, and that biodiversity offsets should be implemented if appropriate. Concerns were also raised regarding the Project's impacts on the annual algae bloom.	Chapter 10 and Annex G – Impact Assessment, sections G.4 and G.5
Fisheries Impact Assessment	Several stakeholders mentioned the need for the EIS Team to undertake a separate Fisheries Impact Assessment.	Chapter 10 and Annex G – Impact Assessment, sections G.6
Pollution and waste management	Stakeholders highlighted the importance of marine and onshore pollution control and ensuring responsible waste management.	Chapter 12, section 12.4 and Annex F
Fishing	Apart from the livelihoods aspects (above), stakeholders indicated their concerns regarding disturbance to fishing activities including access to fishing areas (exclusion zones) and potential catch reduction. Stakeholders expressed concerns related to increased exclusion zones as a result of additional FPSOs in the area.	Chapter 10 and Annex G – Impact Assessment, Section G.7.2 and G.9.7

Issue Group	Summary of issues	Addressed in EIS
Air emissions	Stakeholders were concerned about the potential air emissions from the onshore receiving facilities and from vessels, including potential for gas leaks and the resultant impacts on human health and marine fauna.	Chapter 10 and Annex G – Impact Assessment, Section G.4.1
EIS process and stakeholder engagement	A number of stakeholders highlighted the requirements for thorough stakeholder consultation process as part of the EIS. Some also mentioned that the planned timing for the EIS process could impact the quality of the process. The stakeholders highlighted that engagement is needed in collaboration with local, district and regional authorities. Stakeholders indicated that there should be thorough engagement with the local fishers regarding security measures and restrictions, as well as social investment needs.	Chapter 5 and Annex A - SEP
Alignment with regional planning, industrial growth and other developments	Stakeholders indicated that the planning and design for the Project should be integrated with other local and regional planning processes. Planning for the Project was encouraged to include and anticipate future or other developments in the area.	Chapters 2, 5 and Annex A - SEP
Operational safety	Stakeholders suggested that the location of the helipad should consider the proximity to any waste disposal sites due to the operational interactions of the helicopters with avian fauna which are attracted to the disposal site.	Chapter 4
Community Health and Safety	Stakeholders indicated that there should be clear warning signs along the onshore pipeline right of way.	Chapter 10 and Annex G – Impact Assessment, section G.7.7
Cumulative impacts	Stakeholders highlighted that cumulative impacts need to be thoroughly assessed in the EIS.	Chapter 10 and Annex G – Impact Assessment, section G.10

A.3.5 ENGAGEMENT TOOLS

Stakeholder engagement activities used all or some of the following information dissemination and data gathering tools and methodologies:

- During introductory village meetings and description of the Project was given using the Background Information Document. In addition, an A3 map in colour poster form showing the project footprint in relation to communities in the DAoI, was also used to illustrate to community members the key locations and planned siting of Project infrastructure.
- A structured questionnaire was used to conduct FGDs with women, men and elders and fishing groups. Each group was engaged separately and asked a series of questions (See Appendix E). The questions followed several themes for example; demographics of the village; leadership; land tenure and land use; health, education; livelihoods; heritage, policing and crimes, and concerns and expectations of the project.
- Key Informant Interviews (KIIs) with selected stakeholders included healthcare professionals, educators, and tourism business people used structured questionnaires as well as open ended discussion (See Appendix F). Themes and topics covered during

health interviews include government policy on health in the area; heath facilities and practitioners; traditional medicine; lifestyle indicators; and diseases. Themes covered during education KII's include status of school infrastructure, information on pupil numbers, drop-out rates; and concerns and expectations in relation to the project.

A.4. PROJECT STAKEHOLDERS

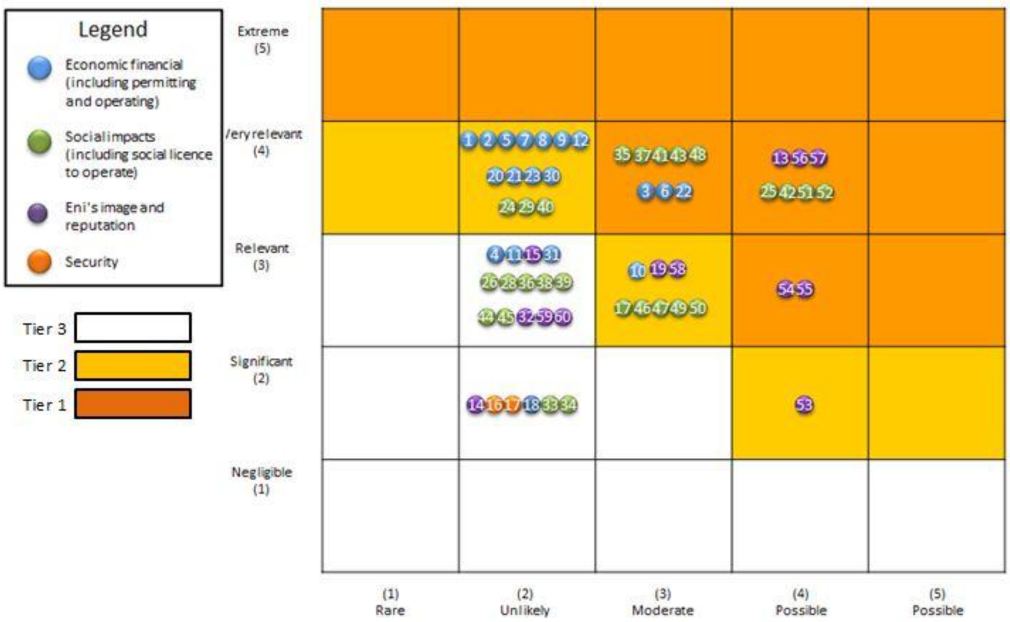
As part of the EIS scoping phase a stakeholder mapping categorization and analysis exercise was undertaken to identify key stakeholder groups and organisations and assess their potential to impact on and influence the Project, based on ERM's experience in similar EISs in Ghana and the Western Region and previous engagement activities by eni Ghana. These stakeholders were selected on the basis that they would have an interest in the Project and would also have knowledge through which to provide insight into possible issues and concerns related to the Project. For example stakeholders can be identified by geography (or location in which the stakeholder is located or exerts its influence), its potential impact over the project, and the perceived degree of awareness that the stakeholder has about eni's project or future operations. In addition, further stakeholder groups were identified through the consultation process

An EIS stakeholder register has been developed (Appendix G) listing all possible Project stakeholders (individuals and organisations) with interest in or potential to influence on the Project. The stakeholders are categorized in the register according to eni's level I and level II categories as defined within the eni corporate guidance on developing a stakeholder register (See Table A4.1). Category Level I is the primary stakeholder category and category level II is the Secondary stakeholder category or subcategory. eni has established categories for both level one and level two stakeholders. For example, institutions are one of the category level one delineations and Local agency and authorities, Provincial Agencies and authorities, and Governments and Ministries are category level two delineations. Stakeholders are classified according to these categories and the power, disposition and potential risks associated with each group analysed. Tailored strategies are developed for engaging each group/sub-category based on this analysis

Vulnerable groups are not classified under a separate category within the eni guidance but these groups were identified to exist largely within the Directly Affected Communities category and include: women, the elderly, children, sharecroppers, refugees and fishermen.Table A4.2 provides a summary list of the stakeholders that were engaged as part of the scoping and baseline data collection activity as contained in more detail in the register (Annex G).

A visual representation of the Stakeholder Mapping is presented in Figure A4.1 showing each stakeholder represented by a number mapped according to their potential impacts on the Project. Impact categories include Economic/Financial impacts, Social impacts, impacts on Eni's image and reputation, Security impacts. Stakeholders mapped within Tier 1 are considered high risk to the Project, those in Tier 2 are medium risk and in those in Tier 3, low risk. Please refer to Annex G for a more detailed explanation of the stakeholder analysis mapping methodology used as a basis for the development of this matrix.

Figure A4.1 Stakeholder Map



The stakeholder register is a "live" document: stakeholder mapping will be ongoing throughout the life cycle of the Project, and stakeholder mapping updated periodically.

Table A4.1 Stakeholder Categories

Stakeholders were identified and classified according to the following categories.

A more detailed breakdown of stakeholder Categories (Level I and Level II) are described in the Stakeholder Register.

- *National government:* these stakeholders are of primary national political importance to the project and the EIA process.
- *Regional government and District Assemblies:* these stakeholders are of Regional and local importance to the project.
- *Traditional Authorities, chiefs and elders*: these stakeholders are the key leadership figures representing communities at a local level and as such are highly influential;
- *Directly affected communities:* communities at local level, living in settlements or towns that will be directly impacted (positive and/or negative) by the project.
- *National and Local NGOs:* these are local NGOs (based mainly in Accra) and Community Based Organisations (CBOs) with potential interests in the project. NGOs may also have useful data or insights into the local and national issues raised by the project.
- *International organisations:* these comprise organisations based within and outside Ghana with an interest in the project. These include international NGOs, multilateral and bilateral organisations.
- *Academic institutions:* these are universities, colleges and research organisations which may have an interest in the project and may be able to provide useful baseline information related to the culture, history, or environment of the area.

- *Other interest groups:* these comprise, for example, media (both national and international), and political parties/groups, religious organisations.
- *Economically interested parties:* organisations, businesses and individuals with direct interest in the project e.g. running businesses or providing services and supplies to the project.

Table A4.2 Summary Stakeholder List

Category	Stakeholder Group
Institutions	EPA
	Ministry of Energy & Petroleum
	Ministry of Roads and Highways
	Ministry Of Fisheries And Aquaculture Development
	Ministry of Environment, Science, Technology and Innovation
	Wildlife Division of Forestry Commission
	Fisheries Commission
	Petroleum Commission
	Ghana National Petroleum Corporation (GNPC)
	Ghana Maritime Authority
	Ghana Ports & Harbour Authority
	EPA: Western Region
	Ghana Ports & Harbour Authority: Western Region
	Ghana Navy
	Marine Police
	National Fisheries Commission
	Marine Fisheries Research Division
	Western Region Coordinating council (WRCC)
	Enterprise Development Center (Jubilee & Ministry of Energy)
	Ghana Tourism Authority
	Museums and Monument Board
	Jomoro District Assembly
	Ellembelle District Assembly
	Sekondi Takoradi Metropolitan Assembly
	Shama District Assembly

Category	Stakeholder Group
	Nzema East District Assembly
	Western Regional House of Chiefs
	Western Region Regional Health Director
	Ellembelle District Health Service, Director
	Ellembelle Education Service
Communities	Fisherman on Essiama
	Fisherman of Shama
	Chief Fisherman of Upper Dixcove
	Chief Fisherman of Upper Axim
	Chief Fisherman of Half Assini
	Chief Fisherman of Sekondi
	Anochi Community
	Asemda-Suazo Community
	Atuabo Communty
	Bakanta Community
	Beku Community
	Krisan Community
	Eikwe Community
	Ngalekpole Community
	Ngaliki Community
	Sanzule Community
Civil Society	Friends of the Nation
	Conservation Foundation
	Ricerca e Cooperazione
	Oil Watch Ghana
	Ghana National Canoe Fisherman Council
	Ghana Wildlife Society
	Current Large Marine Ecosystem (GCLME)

Category	**Stakeholder Group**
Contractors, Suppliers, Business Partners and Non-Partners	Kosmos
	Tullow Oil
	GNPC
	GNGC

On the basis of findings of the initial stakeholder consultation results (i.e. from screening and scoping activities), stakeholders logged in the stakeholder register were analysed as per the eni Upstream Stakeholder Engagement Operating Instructions.

Specifically, using the eni Stakeholder Assessment Matrix guidance all stakeholders have been assessed for:

- The level of stakeholders' power on the Project (low-medium-high);
- Stakeholders' disposition/attitude towards the project (positive –neutral- negative).

In addition, using the eni Stakeholder Risk Matrix guidance, an assessment of the primary key potential risk associated with each stakeholder has been undertaken, considering:

- The degree of the impact on the project of the identified risk; and
- The probability of its occurrence.

Each stakeholder's attendance at consultation activities and every interaction with stakeholders as part of this EIS process is recorded in this document, which along with the register will be updated following EIS disclosure process and then at key milestones in the lifecycle of the Project.

A.5. EIS STAKEHOLDER ENGAGEMENT PROGRAMME

The Stakeholder Engagement Plan for the EIS process comprises four key phases of activity:

- Scoping Phase Engagement and Disclosure of the Scoping Report (already completed);
- Stakeholder Engagement during Baseline Studies (already completed);
- Disclosure of the EIS Report and Public Hearings;
- Ongoing Stakeholder Engagement (construction and operation phases).

The programme for the EIS Consultation and Disclosure and Ongoing Engagement during the Construction and Operation Phases are described in more detail in the sections below.

A.5.1 Disclosure of EIS and Public Hearings

Once the EIS has been completed it will be submitted in a draft form to the EPA for consideration. At this time the EPA will inform the Project of the required next steps for Stakeholder Engagement which may include public notification and public hearings prior to a final decision being taken.

A.5.1.1. Objectives of the Engagement

The objectives of consultation with stakeholders during EIS disclosure are to:

- Promptly identify issues/concerns to avoid conflict in the future.
- Gain consensus on potential impacts identified and to proffer mitigation measures before the project gets underway.
- Avoid any misunderstanding about the project development and for stakeholders to be jointly and severally acquainted with the project.
- Ensure that any apprehension and fears expressed by stakeholders about the project, nature, scale and impact of the operation have been addressed.
- Collate all comments and recommendations of all stakeholders for incorporation into the EIS report as appropriate.
- Consult with host communities and minutes of such consultation incorporated into the EIS report.
- Consolidate any new information into the stakeholder register and key issues register.

A.5.1.2. Disclosure and Final of the EIS

Disclosure of the Draft EIS Report/ EIS will provide detailed information about the proposed Project activities, an assessment of the potential impacts and the planned mitigation and monitoring measures. The EIS will be published in mass media and announced in local media of the Western Region of Ghana. In addition, a Reconnaissance Survey will be carried out throughout 6 coastal regions, the Western Regional House of Chiefs and engagement of CSOs, Media and other Governmental Institutions. During the Reconnaissance Survey, all engaged stakeholders will be informed of the public hearing venues and where to access the copies of the EIS (located mainly in District Assemblies, Regional EPA Offices, Main Libraries etc.). National regulation request the provision of twelve (12) copies of the document, but eni has agreed to extend the number to twenty (20) to maximize its distribution.

Public hearings have initially taken place in Takoradi-Sekondi on 8th, 9th, and 10th April. Public hearings were be divided in three venues, by type of stakeholders:

- Civil Societies (CSOs, represented by the Relevant Ministries, Agencies and Department Heads), Media and the General Public;
- Six (6) Coastal Districts, represented by Municipal Chief Executives, District Chief Executives, Presiding Members of the six coastal Districts an Assembly Members; and
- The Western Regional House of Chiefs (Traditional Leadership).

During these initial public hearings, copies of the non-technical summaries were made available for the general public, facilitating the general access to the project.

In addition, a dedicated workshop was held at the Community of Sanzule on 31st March, where the project was presented to the Community and better interaction could be achieved. Copies of the presentation were made available to facilitate visual access to the information.

Eni Ghana will collaborate with the EPA if necessary to ensure that the hearing meets objectives and requirements of stakeholder engagement under IFC PS1. EPA may grant provisional approval for commencement of the Project following review and the Public Hearing. The comments received on the EIS Report/ EIS from EPA will be addressed and a Final EIS Report/ EIS will be submitted to EPA.

A.5.2 Ongoing Engagement (Construction and Operation Phases)

This section references current good practice guidance in outlining key objectives and activities planned for ongoing Stakeholder Engagement during the construction and operation phases:

A.5.2.1. Construction Phase

Construction Phase

Ongoing Stakeholder Engagement during the construction phase has the following key objectives:

Key Objectives of Engagement

- Identify all stakeholders likely to be affected by construction activities and keep aware/abreast of any changes to stakeholder base e.g. through in-migration;
- Keep stakeholders regularly informed of construction activities and schedule, and progress in implementing environmental and social management programme;

- Maintain visibility and site presence of Community Liaison staff and keep open communication lines with stakeholders and their key representatives;
- Anticipate, receive and quickly respond to grievances; and
- Identify responsible contractors, and carefully manage and oversee contractors interactions with stakeholders.

Activities

In order to meet these objectives a number of key activities will be undertaken. The precise resourcing arrangements and schedule for these activities will be refined and finalised in consultation with stakeholders following the disclosure of the EIS:

Regular update of the stakeholder register and stakeholder risk analysis

In order to ensure all stakeholders affected by construction are identified and engaged the CLO will be responsible for ensuring the stakeholder register is regularly updated and risks associated with stakeholders are assessed and re-evaluated as necessary based on information revealed through interactions, engagement and grievance management. Any new stakeholders that may have arrived in the Project area or developed an interest or interest in the Project should be monitored, analysed and strategies developed for engaging them. The FLO and GO respectively will be responsible for feeding back information on new stakeholders or changing stakeholder issues/risks which arise through their stakeholder interactions, to the CLO as part of this process.

Regularly engage and inform stakeholders of construction activities and schedule

The CLO (supported by the FLO) will be responsible for designing and implementing regular proactive and structured, engagement with stakeholders through appropriate methods or forums. This engagement will be focused on informing and updating community members about the Project construction activities and schedule including anticipated delays or changes, in that given month, and on the potential impacts that can be expected to occur along with the measures planned to mitigate these.

These engagements may include:

- Face to face information dissemination meetings with local leadership and other key authorities;
- Community/group meetings or information sharing on topics of community concern such as community health and community safety awareness sessions;
- FGD's for special interest groups with particular concerns such as fishing groups and land users; and
- Targeted and appropriately designed activities will be conducted to engage vulnerable groups and individuals.

Where appropriate for special interest groups/vulnerable groups eni may need to facilitate and provide support in the establishment of a committee or representative forum through which to engage and share new information e.g. for those affected by economic displacement who will be receiving compensation. This should be done in coordination with the team responsible for the Land Acquisition process.

All engagements will be documented both in writing and photographically, with minutes taken in standardised format and attendance recorded. Minutes should be shared with and approved by participants.

Any issues and or grievances raised during engagements will be logged in the stakeholder issues register. Grievances raised in these engagements will be dealt with according to the steps described in Section 8 below.

Establish a site presence

In order to ensure the Community Liaison Team is visible and accessible to the affected stakeholder base, the Project will consider establishing a permanent site based Community Liaison Office at Sanzule to ensure easy access for the community during the construction phase to be staffed by a CLO. At least one of the two CLOs planned to be recruited by the Project will be a Sanzule resident. This will be publicised to the communities as a location where information is available to them about the Project construction activities and schedule and where their issues/grievances will be registered and if possible responded to.

If a physical office cannot be permanently or regularly staffed, then a schedule of visits at a regular pre agreed time/ location by CLO/FLOs/GOs at Sanzule will be made available to stakeholders.

It is recommended that the frequency of these engagements is at least weekly at the commencement of construction activities. The need for this engagement will be monitored and if required this frequency will be maintained into the operational phase of the Project. Based on this review this engagement may be reduced over time to less frequent (every other week or monthly) after the schedule of activities is well established and had been communicated.

Information Dissemination

Information dissemination tools will be used to support the above activities for example: distribution of printed material e.g. an accessible Project update document such as a newsletter will be considered as a medium for communicating changes to stakeholders concerning Project design, progress on meeting social and environmental management commitments, details of upcoming construction activities and or changes to schedule. The Project will also provide information to stakeholders through other media (newspaper, radio, etc.)

Receive, track and respond to grievances

Unresolved stakeholder grievances can quickly escalate, often leading to unforeseen work stoppages and delay. It will therefore be key during the construction phase to respond quickly and effectively to grievances raised, and work closely through regularly engaging with stakeholders to try and anticipate where stakeholder issues or concerns may arise before they do. The GO and FLO will be responsible for supporting the CLO in identifying, logging and responding to all grievances and resolving locally those that can be managed in the immediate term, or reporting and escalating more complex issues to eni management as appropriate.

The planned process for tracking and responding to stakeholder grievances is described in more detail in Section 8.

Oversee Contractor Stakeholder Engagement

Unmanaged or poorly documented contractor-stakeholder interaction or engagement can also present risks to the Project. It may result in inconsistent or contradictory messages or conflicting commitments from the contractor/Project representatives to stakeholders which can give rise to unmet expectations.

The CLO will liaise with and oversee the construction Contractor to ensure that any interaction taking place between contractor workforce and stakeholders is consistent with the standards, core principles and procedures for undertaking, recording and documenting stakeholder engagements, as is outlined in this SEP.

Operation Phase

Ongoing Stakeholder Engagement during the operation phase has the following key objectives:

Key Objectives:

- Achieve a smooth transition from construction to operations including the integration of social and environmental commitments into the operational management system;
- Maintain visibility (albeit a reduced presence) and continuity of stakeholder relationships;
- Continue with regular engagement and disclosure to stakeholders as required;
- Continue to review and update stakeholder information; and
- Continue to receive, track and respond to grievances.

Activities

The operation phase will consist of a continuation of many of the same Stakeholder Engagement activities that have been undertaken during construction, but at a reduced frequency. These are described below:

Continue Regular Engagements

Regular direct engagement will continue between the community liaison function and key project stakeholders, and will be aimed primarily at maintaining continuity of relationships, monitoring the effects of project impacts on stakeholders and particularly on vulnerable groups, and demonstrating long term organisational commitment to delivering on social and environmental mitigations or to resolving outstanding issues and grievances.

As at Construction Phase, the Community Investment Team (including CLOs (supported by the FLO) will be responsible for designing and implementing this engagement with stakeholders through appropriate methods or forums. This engagement will be focused on continuing to inform and update community members about the Project operation activities and schedule including anticipated delays or changes, in that given month, and on the potential impacts that can be expected to occur along with the measures planned to mitigate these.

These engagements may include:

- Face to face information dissemination meetings with local leadership and other key authorities;
- Community/group meetings or information sharing on topics of community concern such as community health and community safety awareness sessions;
- FGD's for special interest groups with particular concerns such as fishing groups and land users; and
- Targeted and appropriately designed activities will be conducted to engage vulnerable groups and individuals.

Regular scheduled engagement through an appropriate forum for special interest groups/vulnerable groups will continue (final schedule to be developed during the preparation of the detailed Annual implementation plan).

Information Dissemination

Information dissemination tools and media will continue be used to support engagement activities as detailed in the Construction Phase activities.

Design engagements to manage stakeholder expectations around the transition to operations

Operations phase engagement activities will be designed to clearly communicate anticipated changes brought by the transition from construction to operations and to manage community expectations around the associated impacts eg a reduction in employment and other economic opportunities, and an expected high turnover in Project staff.

Ensure continuity of community liaison staff or sufficient handover period

The loss of familiar project staff can impact on established stakeholder relationships and cause a loss of institutional knowledge and often a breakdown in trust. If possible, Community Liaison Officers/other staff employed during the construction phase will be retained and or an adequate handover period secured in order for any new personnel to be introduced and to establish relationships before taking over key liaison roles.

Regular update of the stakeholder register and stakeholder risk analysis

In order to ensure all stakeholders affected by operations are identified and engaged the CLO will be responsible for ensuring the stakeholder register is regularly updated and risks associated with stakeholders are assessed and re-evaluated as necessary based on information revealed through interactions, engagement and grievance management. Any new stakeholders that may have arrived in the Project area or developed an interest or interest in the Project should be monitored, analysed and strategies developed for engaging them. Specific changes in the Project design and economics, affecting Project demands and plans (e.g. levels of production, change of suppliers, improvements in operations, modifications of plans and procedures, etc.) will be monitored, and the stakeholder mapping adapted as necessary, as these can result in new stakeholders arising or lead to a change and stakeholder interest in and concerns about the Project. The FLO and GO respectively will be responsible for feeding back information on new stakeholders or changing stakeholder issues/risks which arise through their stakeholder interactions, to the CLO as part of this process.

Continue documenting engagements and logging and responding to grievances

Engagements will continue to be recorded and documented in minutes, and all stakeholder issues and grievances logged and managed according to the given procedures.

Evaluate stakeholder perceptions towards continuous improvement

Finally, it may be helpful during operations as part of project monitoring activities, to assess and evaluate stakeholder perceptions towards the Project and how these may have changed during the course of the construction period. This information can help inform approaches to engagement and provide insights to facilitate continued relationship building with stakeholders through the operations phase of the Project.

<u>Next Steps towards Implementation</u>

An Annual or more detailed operation/implementation plan and a schedule detailing ongoing Stakeholder Engagement activities during both the construction and operation phases of the Project, and throughout its lifecycle through to decommissioning will be developed, following disclosure and submission of the final EIS report to EPA.

The plan will include detail on planned engagement activities and how they will be carried out and operationalised including:

- Frequency and location of engagements;
- Methods for summoning stakeholders for meetings and engagements;
- How meetings and meeting materials will be developed; and
- What methods and media will be used to disclose information (e.g. newspaper, local radio, pamphlets) including tools to ensure accessibility of information to non-literate or vulnerable groups.

The plan will contain additional detail on the type of information to be disclosed, how issues, comments and concerns of stakeholder will be incorporated into the Project and how feedback will be provided to stakeholders on issues and concerns.

Finally, a section on monitoring and evaluation including performance indicators will be included.

This SEP and the stakeholder register, along with the issues register will be updated at this point and iteratively at key milestones during the construction and operations phases.

Therefore, the next formal stakeholder engagement activities will occur under the auspices of the EPA when it holds public hearings before finalising a permitting decision on the Project.

A.6. SCHEDULE

Table A6.1 illustrates the potential schedule for the EIS showing key milestones for disclosure:

Table A6.1 EIS Stakeholder Engagement Schedule

Milestone	Approximate Date
Register Phase 2 Development Project EIS with EPA	December 2014
Scoping and Baseline Stakeholder Engagement	December 2014
Submit Scoping Report /TOR to EPA	December 2014
Receive acceptance of TOR from EPA	pending
Submission of Final Draft EIS to Authorities	March 2015
EIS Disclosure and Public Hearings	March 2015
Submission of Final EIS to Authorities	March 2015
Receive Environmental Permit for Project	March –April 2015
Ongoing engagement Construction Phase	2015-2019
Ongoing engagement Operations Phase	2019 onwards

A.7. RESOURCES AND RESPONSIBILITIES

Resources, roles and responsibilities for implementation of the SEP and of ongoing stakeholder engagement as part of the Project are not yet fully defined, but are likely to include:

A.7.1 Community Liaison Officer

Eni already has Community Liaison Officers (CLO) in place who is responsible for continued community engagement, facilitation of meetings, distribution of information to stakeholders and eliciting comments, translation of material into the local languages and record keeping. The CLO is a Ghanaian citizen who is fluent in the local languages and familiar with the local customs.

The CLO is and will continue to be responsible for:

- Interfacing with National, Regional and District Authorities, Traditional Authorities and Project Affected Villages;
- Responding to low priority grievances and initiating and coordinating responses from the appropriate managers to mid and high priority grievances;
- Reporting to the HSE Manager on a weekly or monthly basis regarding engagement activities and community issues and concerns including the management of grievances;
- Being present in and accessible to the communities and overseeing the Grievance Mechanism function; and
- Directing communication with stakeholders around the resolution of stakeholder issues and grievances.

A.7.2 Community Investment Coordinator

Eni foresees and has planned hiring a "Community Investment Coordinator" to manage a team of at least three people (including the current CLO and one additional and one Community Investment Advisor).

- Coordinating local programs including local employment (recruiting), training, community investment;
- Organising of participatory monitoring programme with affected communities;
- Analysis of issues and grievances to propose actions to reduce potential conflicts;
- Organizing information sessions; and
- Delivering regular reports to Communities and stakeholders containing information regarding project activities and project environmental and social performance.

A.7.3 Grievance Officer

Should the need arise; the eni will appoint a Grievance Officer (GO) to assist the CLO. The Grievance Officer will be responsible for:

- Collection, logging and prioritising grievances;
- Coordinating and tracking timely responses;
- Monitoring corrective actions;
- Communicating with stakeholders around the resolution of grievances;
- Interfacing directly with the community at regular intervals in appropriate forums;
- Being based on site and available to the community at well publicized times and at accessible locations; and
- Reporting to the CLO on a weekly basis.

The CLOs and GOs should receive appropriate training in stakeholder engagement, facilitation, presentation skills and conflict management.

The Grievance Officer reports to the CLO, who, in turn reports to the Project Environmental Manager. While most of the stakeholder engagement activities are undertaken by a small number of junior staff within the organisation, it is important that there is senior level buy-in and oversight of the process. Without the support and buy-in of senior staff, the process will have limited success.

A.7.4 Fisheries Liaison Officer

Should the issues arising during the EIS process indicate a need the eni cold consider appointing a Fisheries Liaison Officer (FLO) to support the CLO and GO during the construction and operation phase. The FLO will be responsible for:

- Interfacing directly with Fishers/Fishmongers in Project Affected Villages and the DAoI and IAoI at regular intervals in appropriate forums;
- Reporting to the HSE Manager on a weekly or monthly basis regarding engagement activities and issues and concerns raised by Fishers/Fishmongers including the specific Fishing related grievances;
- Being present in and accessible to the fishers on site in both the onshore and if appropriate the offshore environment;
- Directing communication with fishers around the resolution of their specific issues and grievances;
- Responding to low priority fishers/fishmongers' grievances and initiating and coordinating responses from the CLO and appropriate managers to mid and high priority grievances.
- Reporting to the CLO on a weekly basis.

A.7.5 Land Acquisition/RAP Liaison Officer

Should the issues arising during the EIS process indicate a need the eni could consider appointing a Land Acquisition/RAP Liaison Officer (RLO) to support the CLO and GO during the construction and operation phases. The RLO will be responsible for:

- Interfacing with Traditional Authorities and Project Affected Villages undergoing resettlement;
    - The management of RAP specific Grievances including:
    - Collection, logging and prioritising of RAP specific grievances;
    - Coordinating and tracking timely responses;
    - Monitoring corrective actions;
    - Responding to low priority RAP related grievances and initiating and coordinating responses from the appropriate managers to mid and high priority grievances; and
    - Communicating with stakeholders around the resolution of grievances;
- Being present at site and accessible to the RAP affected communities and overseeing and providing support where required (e.g. with RAP related consultation activities) to the RAP implementation team;
- Reporting to the CLO on a weekly basis /or Reporting to the HSE Manager on a weekly or monthly basis regarding RAP engagement activities and community issues and concerns specific to the RAP process including the management of RAP related grievances.

A.8. GRIEVANCE MECHANISM

A.8.1 DEFINITIONS AND GOOD PRACTICE

The IFC's Good Practice Guide to addressing grievances from Project-affected communities describes a grievance as: 'a concern or complaint raised by an individual or a group within communities affected by company operations. Both concerns and complaints can result from either real or perceived impacts of a company's operations, and may be filed in the same manner and handled with the same procedure'.

It describes a project-level grievance mechanism for affected communities as: 'a process for receiving, evaluating, and addressing project-related grievances from affected communities at the level of the company, or project' (IFC, 2009) (1).

IPIECA also gives good practice guidance around the management of Project related grievances for Oil and Gas developments.

According to IPIECA a grievance is 'a specific incident and the alleged damage, impact or dissatisfaction that occurred as a result of company or contractor actions, perceived or actual' (IPIECA, 2014). Furthermore a grievance mechanism is: 'a proactive and structured approach to receive, acknowledge, investigate, respond to and remedy complaints and grievances from local stakeholders in a planned, timely and respectful manner' (IPIECA, 2014).

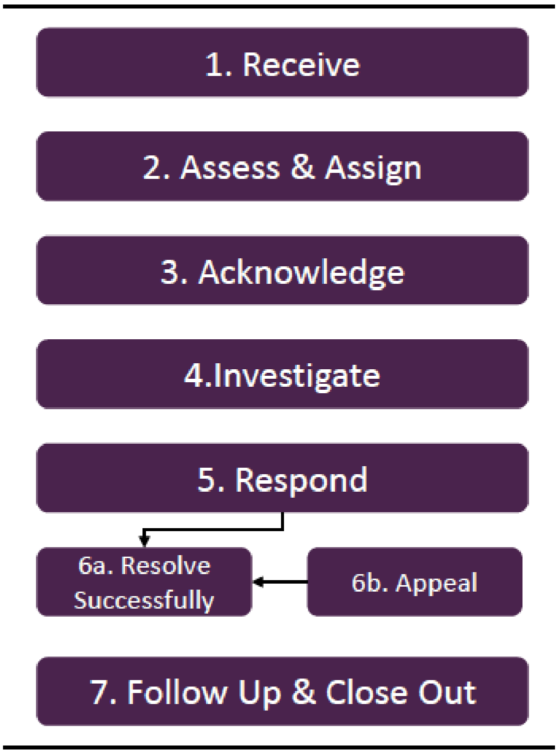
A.8.2 PURPOSE

For the Project Affected Community, a grievance mechanism provides a simple, accessible alternative to an external dispute resolution process, which is local and has the aim of finding mutually beneficial solutions to settle issues taking into account the specific context of the Project environment and the company-community relationship. Such a mechanism still recognizes the rights of the complaining party to seek help externally from a formal dispute body or legal/administrative system in the case of difficult or unresolved grievances. But it first aims to provide an initial port of call for less complex issues to be quickly resolved, to avoid involvement in more costly or time consuming processes. For a Project proponent such a mechanism represents a critical risk management tool and early warning system and, by allowing the Project demonstrate responsiveness to its stakeholders' concerns, can form the basis of much stronger long lasting relationships and a more secure 'social license to operate'. Moreover, it is important to note that the mechanism will be transparent, culturally appropriate, at no cost, and without retribution for the party presenting the grievance.

IPIECA recommends that a grievance mechanism is structured around seven key steps illustrated in Table A8.1 and described in the paragraphs below:

(1) http://www.ifc.org/wps/wcm/connect/cbe7b18048855348ae6cfe6a6515bb18/IFC%2BGrievance%2BMechanisms.pdf

Figure A8.1 IPIECA Recommended Grievance Mechanism Process



Source: IPIECA; 2014

This process flow has been directly adopted by eni in its draft corporate guidance on developing grievance management procedures and the same structure has guided the development of the process described for this EIS.

A.8.3 CURRENT GRIEVANCE MANAGEMENT

Currently all Project related grievances and concerns that are raised at a community level are raised informally via direct interaction or communication with the Project CLO who responds to them himself or escalates them to the eni Ghana HSE & Community Investments Department as needed basis. The HSE & CI structure are responsible for co-ordinating grievances as they come into the Project and following the Grievance Procedure in ensuring resolution.

Accordingly, there is a requirement to establish a more formal and documented grievance procedure both as a risk management tool for eni Ghana, and in order to provide community members with an accessible and transparent channel for communicating concerns to the Project and for receiving a formal and documented response to those concerns.

A.8.4 GRIEVANCE PROCEDURE

A Project grievance register and formalised grievance process will be developed and implemented in the next 4 months.

The process is structured according to recommended good practice and draft eni guidance, as described above and will comprise the following steps:

- Step 1: Establishing and Publicising the Grievance Management Procedure;
- Step 2: Receive and Track Grievances;
- Step 3: Assess and assign responsibility for resolution;
- Step 4: Investigate Grievances;
- Step 5: Respond and Resolve and Close Out; and
- Step 6: Monitor Report, and Evaluate the Grievance Mechanism

A.8.4.1. Step 1: Establishing and Publicizing Grievance Management Procedure

The grievance procedure needs to be available and accessible to all affected communities and therefore once established will need to be publicized and communicated within Project Affected Communities.

Consultation on the workings of the procedure will take place with communities and stakeholders at District, Municipal and Metropolitan Assemblies across the DAoI and with institutions in selected locations in the IAoI.

A range of different approaches will be used for this communication as deemed appropriate, including face to face meetings and group (e.g. village) meetings. In addition, information materials such as a brochure or flyer, describing the process will be produced and distributed by hand and via posting in publicly accessible locations in the Project DAoI and IAoI.

The contact details of the Project Community Liaison Officer (CLO) and Grievance Officer (GO) will be provided clearly on this notice as the key points of contact for receiving grievances.

A.8.4.2. Step 2: Receive and Track Grievances

Grievances can be submitted in writing, telephonically or presented verbally to the Project CLO or Grievance Officer.

<u>Logging Grievances</u>

All grievances shall be logged using a Grievance Form. Eni will log, document and track all grievances within a Grievance register to be managed and updated by the Grievance Officer with oversight from the Project CLO.

The database shall be monitored regularly for recurring grievances so that appropriate standardised mitigation can be developed.

The following information shall be recorded for each grievance:

- Grievance case number;
- Complainant's name and contact details[(1)]
- Date of complaint;

(1) Name and contact details are necessary for interaction around the resolution of the grievance. Anonymous submissions will be permitted, but the party submitting should understand that direct response will not be possible.

- Details of complaint;
- History of other complaints / queries / questions (if known);
- Resolutions discussed and agreed with the party(ies) in question;
- Actions implemented (including dates) and;
- Outcome of the actions implemented.

For complaints in person, typically the responsible eni staff (CLO or GO) shall either complete himself of help the complainant with the completion of a feedback form.

For complaints by phone, eni's staff shall register the complaint themselves using the feedback format.

<u>Acknowledging Receipt of a Grievance</u>

eni shall formally acknowledge receipt of any grievance as soon as possible, and within a standardised time period.

An initial response should be provided not more than (5) five days from the date it was submitted and shall inform the complainant about the timeframe in which a response can be expected. A full response should then be provided no later than a month from receipt and acknowledgment of the grievance.

The acknowledgement must be sent in written form although it can be anticipated by phone depending upon the complainant.

The process of acknowledgement shall include responding to the complainant, using appropriate communication channels, about the following issues:

- explaining next steps;
- providing a target date for resolution of the issue or, if necessary, the full response to the feedback;

Ideally, acknowledgment of a grievance to the complainant should include the name of the person assigned to resolve the issue.

A.8.4.3. Step 3: Assess and Assign Responsibility for Resolution

eni will assess each type of grievance for an understanding of the types of response required and in order to assign responsibility of the appropriate individual to manage the response.

The following risk levels indicated in Table A8.1 may be considered and assigned to classify the type of response required.

Table A8.1 Grievance/Issue Risk Level

Issue Risk Level	Description
Level 1	Positive feedback requiring acknowledgement and thanks to the remittent and or feedback that is not related to eni Upstream Area and needs to be directed elsewhere.
Level 2	A question or request for information.
Level 3	A grievance that is not a breach of law or of an eni policy and is not related to • death or serious illness or • a recurrent question /request for information
Level 4	A repeated or widespread grievance or • a grievance that is a breach of law or eni policies or • a direct accusation of breach of human rights or • a grievance related to death or serious illness.

In some cases, an issue may require specialised support to be addressed; e.g. from the Health, Safety and Environment, Procurement or Operations Departments and will be escalated accordingly.

Please note all grievances assessed as level 3 or 4 require the involvement of Senior Management of the eni company involved.

A.8.4.4. Step 4: Investigate Grievances

eni will investigate fully all grievances submitted, and where necessary will involve other departments, contractors and senior management in the process in order to fully understand the circumstances that led to the grievance being raised. eni's companies or projects may decide to invest in this type of assistance as deemed necessary for grievances of a significant risk level (Level 3 and 4).

This investigation should be performed in a timely manner to avoid delaying the resolution of a grievance. eni will aim to resolve any grievances within 30 days from the date that of receipt. This timeframe can be extended to 60 days for more complex grievances (eg level 4 grievances), if required

The following steps shall be performed as part of an investigation to avoid delaying resolution of a grievance:

- Obtain as much information as possible from the person who received the complaint, as well as from the complainant to gain a first-hand understanding of the grievance. In addition, an appropriate liaison official (CLO, GO, FLO) must be present during any interactions with eni Ghana and the stakeholder registering agrievance.
- Undertake a site visit, if required, to clarify the parties and issues involved. Gather the views of other stakeholders including eni employees, if necessary and identify initial options for settlement that parties have considered.
- Determine whether the grievance is eligible for consideration and valid.
- Eligible grievances include all those that are directly or indirectly related to eni' Project and that fall within the scope of the Grievance Mechanism as outlined above.

- Ineligible complaints may include those that are clearly not related to the eni Project or its contractors' activities, whose issues fall outside the scope of the Grievance Mechanism procedure or where other eni or community procedures would be more appropriate to address the grievance.
- If the grievance is deemed ineligible it can be rejected however a full explanation as to the reasons for this must be given to the complainant and recorded in the Grievance Database.
- If the grievance is eligible, its risk level should be determined using the significance criteria in Table A8.1. This will help to determine whether the grievance can be resolved immediately or requires further investigation and whether senior management will need to be informed of the grievance.
- If the grievance concerns physical damage, (e.g. fishing boat, crop, house, community asset) a photograph should be taken of the damage and its exact location recorded the as accurately as possible.
- Inform the complainant of the expected timeframe for resolution of the grievance.
- Enter the findings of the investigation in the Grievance Database.

A.8.4.5. Step 5: Respond, Resolve and Close Out

A response should be provided to the complainant in all cases, by the CLO, and if necessary the local eni's management. This may only consist in a simple clarification of a technical issue. Responses can be either oral or written, depending on whether the grievance was received orally or in writing.

Ineligible Claims

If a claim is rejected as ineligible (not considered to be related to eni's or its contractor's activities) or without basis the and the response is that the grievance does not require action by the company to resolve it, it should still be documented and included in company systems for grievance tracking for further reference. The message that the Project does not intend to provide a response, should be handled sensitively to the complainant.

Eligible Claims

Preliminary Response

In the case of all eligible complaints, eni will provide an initial response within a stipulated period of time and propose the next steps and actions for resolution. The CLO/GO will then communicate the results of the assessment and the status of their claim to the complainant.

Final Response

This response should provide clear information on the proposed final corrective action and detail any related commitments made by both parties. It should obtain the written agreement of the complainant.

If the complainant is not happy with the proposal they should be free to seek resolution through a formal external dispute resolution mechanism.

Should the grievance be of level 3 or 4 (see table 7.1), the response or update may need to be provided directly by eni local senior management in order to demonstrate responsiveness and commitment by eni to resolving stakeholder grievances.

Appeal Process

The grievance process will include an appeal process with the involvement of third parties to mediate in cases where no agreement is reached to the satisfaction of the affected person. If deemed necessary this may include forming a grievance committee with participation of local representatives and involving a third party in the process of grievance resolution.

The mechanism will not impede access to judicial or administrative systems.

Close out

A complaint is closed out when no further action can be or needs to be taken.

When closing out, it is important to ensure full proof of close out based on fully documented evidence of the resolution process including:

- Written internal record internally, with the date and time it took place, and sign off by responsible staff sign off;
- Photographs if relevant documenting the resolution; and
- Written confirmation of the complainants' agreement with the resolution (a template close-out agreement or similar may be used).

The final close out status of the complaint e.g. open (under investigation), resolved (resolution has been agreed), unresolved (not possible to reach an agreed resolution and case has gone to external dispute resolution), abandoned (complaints where the complainant is not contactable after a certain period and complaint becomes null and void), must be recorded in the Grievance Register.

A.8.4.6. Step 6: Monitor, Report and Evaluate

Eni management will monitor grievances routinely as part of the broader management of the Project. This entails good record keeping of complaints raised throughout the life of the construction and operation of the Project. On receipt of grievances, electronic notification to management must be distributed. Grievance records must be made available to management at all times.

Monthly internal reports will be compiled by the Grievance Manager and distributed to the management team.

As part of the grievance monitoring ENI will implement a process to analyse grievances. This will ensure wider actions are taken where required to solve root problems causing grievances rather than just individual grievances. ENi will also develop performance indicators to evaluate the grievance management process.

A.8.5 GRIEVANCE SPECIFIC TO RESETTLEMENT ISSUES

Finally, Box A8.1 below gives some guidance on the IFC's requirements for a RAP specific Grievance Mechanism:

Box A8.1 A note on RAP Grievance Management

According to the requirements of IFC Performance Standard 5, a Land Acquisition and Resettlement specific grievance mechanism (or sub-section of the Project Grievance Mechanism) must be developed and managed as a stand-alone process (albeit one that is coordinated and aligned with the overall Project Grievance mechanism), and that sufficient and appropriate resources must be allocated to this function.

This requirement is intended to ensure any complaints raised specifically in association with the RAP are managed as quickly as possible and in a relevant and sensitive way to avoid disputes causing stakeholder challenge to land access, which can lead to very costly Project delays.

It is important to note that the complex technical nature of resettlement processes calls for a specifically trained resource, familiar with both the steps in the RAP process and the agreements in place within that process (e.g. land lease agreements, compensation agreements) to handle the investigation and formulation of responses to RAP related grievances, and where required the escalation of the those grievances to senior eni management.

A.9. MONITORING, EVALUATION AND REPORTING

A.9.1 MONITORING AND EVALUATION

The SEP will be monitored and evaluated regularly using the indicators in the IFC Guidance Notes on Public Consultation and Disclosure. The monitoring results, both qualitative and quantitative, will be disclosed to all stakeholders. Suggested monitoring and evaluation activities are outlined below:

- Monitor the grievance register in terms of response times to address complaints logged as well as the recurrence of complaints over time;
- Regular update of the stakeholder register and stakeholder risk analysis;
- Monitor media coverage of eni and the project;
- Keep records of all engagement activities including meetings attended, open-house events, focus group discussions, road shows, etc.;
- Keep a library (electronic or hard copy) of all communication material;
- Develop a stakeholder satisfaction survey format and conduct stakeholder interviews to gauge level of satisfaction;
- Develop and assess performance in terms of Key Performance Indicators (KPIs); and
- Revise plans and activities.

A.9.2 REPORTING

eni will report internally and to stakeholders at least once a quarter on all engagement activities and particularly on all complaints (both open and closed).

ANNEX B – BIOPHYSICAL BASELINE REPORTS

ABSTRACT

This Annex provides additional data and details to support the biophysical baseline description contained within Chapter 6 of the ESHIA Report.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
March 2015	03	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
27-02-2015	02	Issued for submission to Authorities	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
23-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
26-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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B. BIOPHYSICAL BASELINE

This Annex provides additional data and details to support the biophysical baseline description contained within Chapter 6 of the ESHIA Report. Please note that additional figures of the sampling locations are contained within Chapter 6 and are additionally supported by maps included in Annex C.

This Annex includes additional information on the following aspects:

- **Atmosphere** including additional description of the local meteorological conditions (wind speed, wind direction, precipitation) as well as data from sampling of air pollutants
- **Onshore geophysical components** including physico-chemical surface water and groundwater sampling results
- **Flora and Fauna** including species.

B.1 ATMOSPHERE

This Section is meant to describe the climate, air quality and noise baseline conditions of the Project area, meant as the eni Concession and the abutting communities.

The available data reported in the following Sections is the result of the field surveys performed by ESL in March, 2014 and October, 2014 at monitoring points shown in Table B.1 and of other literature data available for the Project area. A complete list of reference documents is included in Chapter 14.

Table B.1 Monitored Locations and Parameters with Respective GPS Coordinates

Location	GPS Coordinate	Parameters monitored
Sanzule Town	N 04° 57′ 38.1″ W 002° 27′ 16.9″	CO_2, NO_2 , SO_2, VOCs, TSP, PM_{10} Noise Meteorological data
Eikwe Town	N 04° 57′ 27.8″ W 002° 26′ 44.5″	CO_2, NO_2, SO_2, VOCs, TSP, PM_{10} Noise Meteorological data
eni Concession [1]	N 04° 57′ 52.5″ W 002° 27′ 05.3″	CO_2, NO_2 , SO_2, , VOCs, TSP, PM_{10} Noise Meteorological data
Note: [1] The monitoring point labeled as eni Concession is located about 1 km south-west of the ORF planned location.		

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report (ESL Consulting, 2014)

B.1.1 Climate and Meteorology

The purpose of this Section is to describe the climate and seasonal distribution of the meteorological parameters of the Project area, including the eni Concession and the abutting communities (Sanzule and Eikwe Town).

Regional Climate

The regional climate of southwest Ghana is characterized by the Inter Tropical Convergence Zone (ITCZ). As the ITCZ moves seasonally northwards or southwards it leads to a change in the air mass that is prevalent in the region. As a result during the boreal winter, climate is dominated by dry and continental air from the Sahara, while the humid and warm maritime air from the Atlantic Ocean is prevalent during the boreal summer. This alternation leads to the existence of two well-marked seasons, dry and wet respectively.

Rainfall values present high inter annual variability with maximum values usually taking place in between May and July and again between September and November. Dry season occurs between December and April.

Temperatures in the region are relatively stable throughout the year with mean temperatures varying between 25 and 27 ºC between November and April and between 21 and 23°C from July to September. Average relative humidity shows a consistent daily variation, reaching 95 percent overnight and decreasing to 70 percent to 80 percent during the day (REF.3).

The prevailing wind is from the south-west. The region experiences few storms and moderate wave action.

Local Climate

A set of primary data, related to air temperature, relative humidity and wind speed and direction, were collected during two field surveys performed in March, 2014 (dry season, REF. 1) and October, 2014 (wet season, REF. 2). A 24-hr on site monitoring was undertaken; the meteorological station was installed at a height of 4 m above the ground level ensuring free flow of winds, and integrated into the AQM 60 for real-time and per minute measurement. The meteorological data, particularly wind speed, is useful for interpreting the baseline data as well as for prediction analysis.

Furthermore, secondary data, obtained from the onshore meteorology and climatology stations of Takoradi and Axim in the western coast for the period 1999-2008 (REF. 4), was collected to integrate the climate and meteorology baseline with precipitation data.

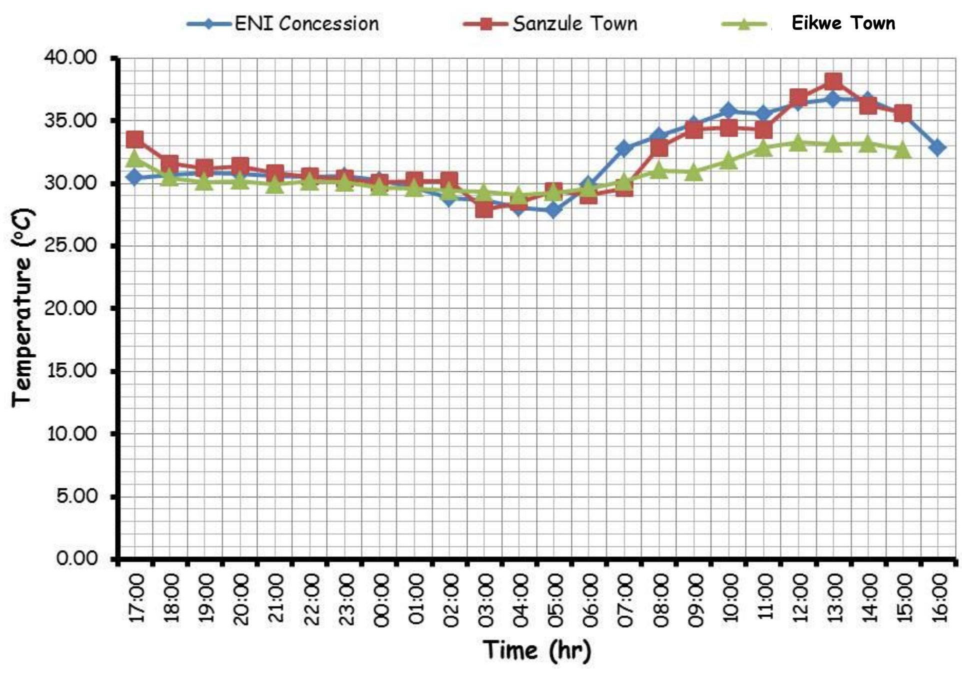
Temperature

During the dry season, the monitored air temperature ranged:

- from 27.49 °C to 38.09 °C, with an average of 32.03±2.90 °C, at the proposed eni Concession site;
- from 27.3 °C to 39.3 °C with an average of 31.97±2.80 °C, at Sanzule Township; and
- from 28.39 °C to 35.99 °C with an average of 30.84±1.53°C, at Eikwe Town.

The lowest recorded temperature in the area occurred at 06:00 hrs in the Sanzule Township and the highest temperature occurred at 13:00 hrs in the same location. Air temperature showed a gradual increase from 06:00 hrs after which it declined gently from 14:00 hrs to 05:00 hrs (Figure B.1).

Figure B.1 Hourly Temperature Variations during the Dry Season



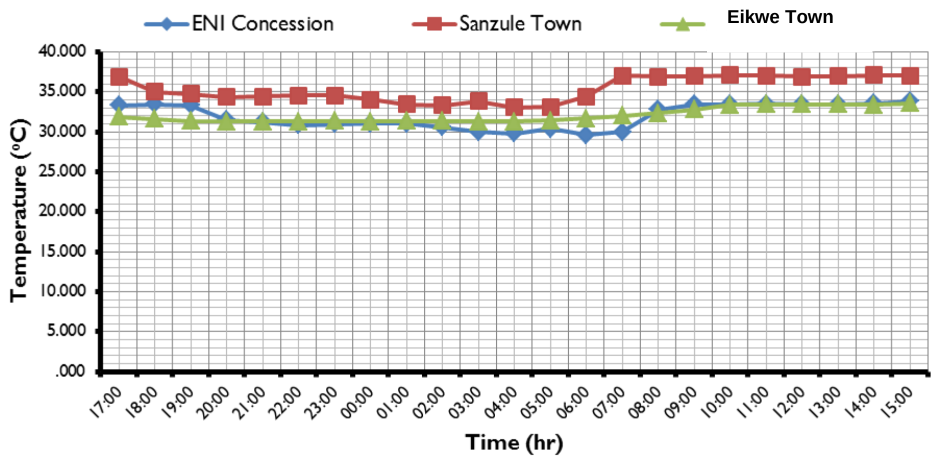
Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

During the October, 2014 wet season survey the 24-hour monitored air temperature ranged:

- from 28.47 °C to 34.15 °C, with an average of 31.82±1.99 °C, at the eni Concession;
- from 31.97 °C to 37.65 °C with an average of 35.37±2.00 °C, at Sanzule Township;and
- from 30.89 °C to 34.10 °C with an average of 32.06±1.01°C, at Eikwe Town.

Temperature patterns for all locations indicate steady night-time trends, rising sharply at 7:00 GMT, and then steadily until 17:00 GMT. With the exception of the readings at the eni Concession area, which recorded 24-hour average less than the monitoring value for similar study during the dry season, the wet season temperatures were numerically higher than the dry season values. The temperature distribution for wet season is provided as Figure B.2.

Figure B.2 Hourly Temperature Variations during the Wet Season



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

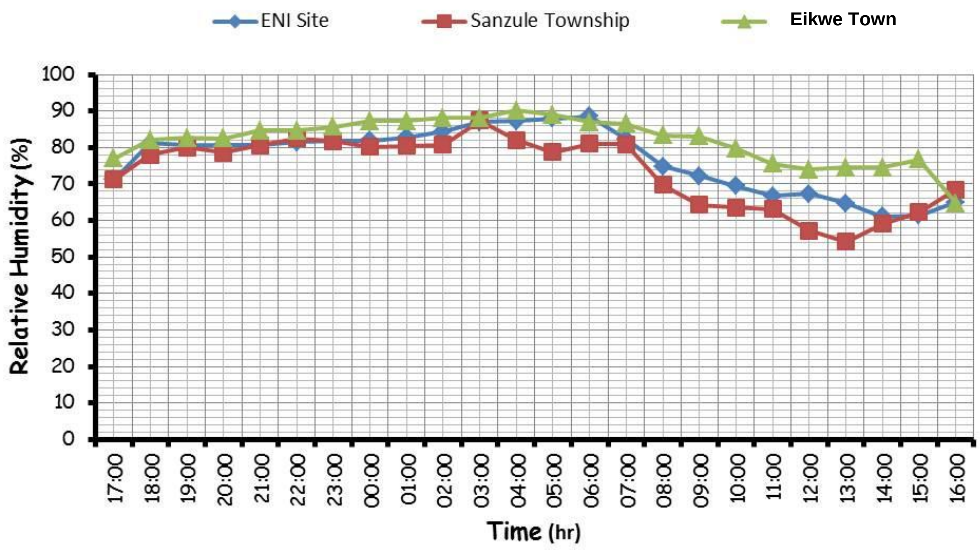
Relative Humidity

The pattern of distribution for relative humidity was converse to that of the air temperature as Figure B.3 for dry season and as Figure B.4 for wet season.

During the dry season, relative humidity throughout the monitored area varied between 52.2-90.6% with an average value of 76.7%, 74.09% and 82.49% for the eni Concession, Sanzule township and Eikwe town correspondingly. This suggests an eastward increase in daily humidity regimes. Generally, the relative humidity tends to increase overnight reaching 90.6% and decrease to 52% during the day. There was a gradual decrease from about 03:00 to about 16:00 hrs, followed by a gradual increase from 17:00 hrs to 03:00 hrs.

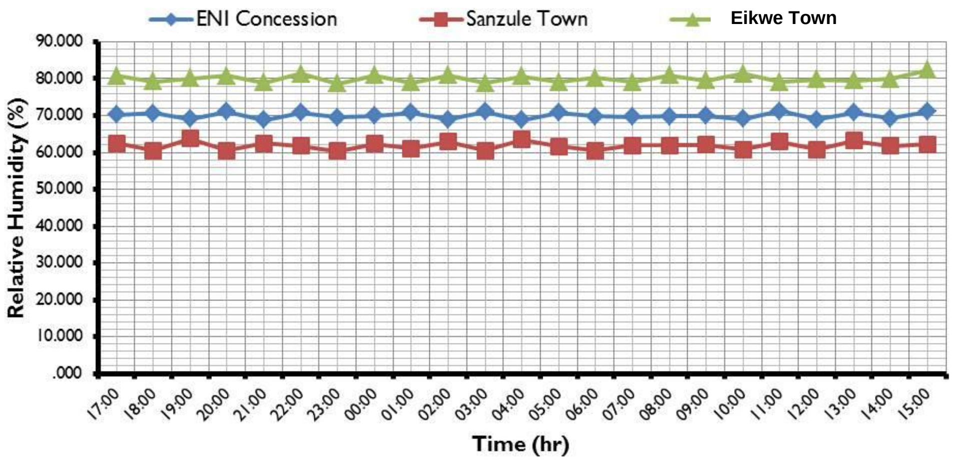
During the wet season, relative humidity throughout the monitored area varied between 57.51 – 85.19% with 24-hour average values of 69.95%, 61.81% and 79.95% for the eni Concession, Sanzule Township, and Eikwe town respectively. The hourly distributions indicate high relative humidity at Eikwe town and the least at Sanzule township. Also, narrow and regular fluctuating pattern was observed across all the locations, against a general increase overnight recorded during the dry season.

Figure B.3 Hourly Relative Humidity Variations during the Dry Season



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Figure B.4 Hourly Relative Humidity Variations during the Wet Season



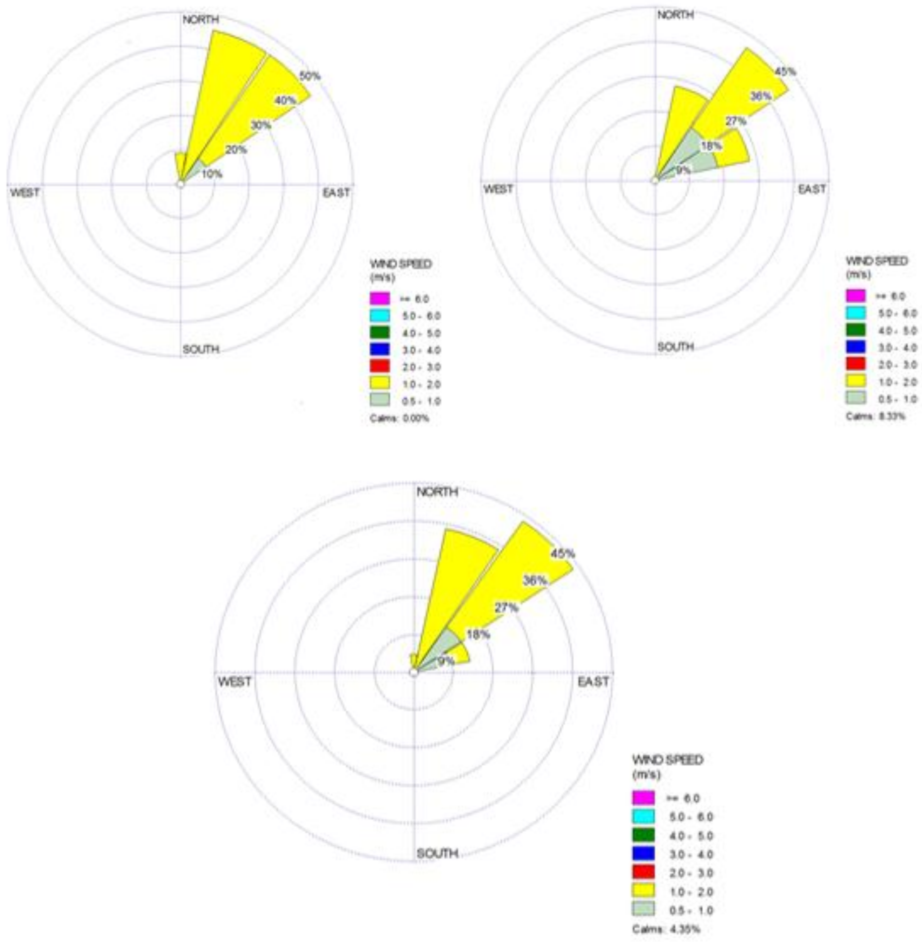
Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Wind Regime

The wind rose plots below depict the local meteorological condition for period, daytime and night-time during the dry season (Figure B.5 to Figure B.7) and the wet season (Figure B.8 to Figure B.10).

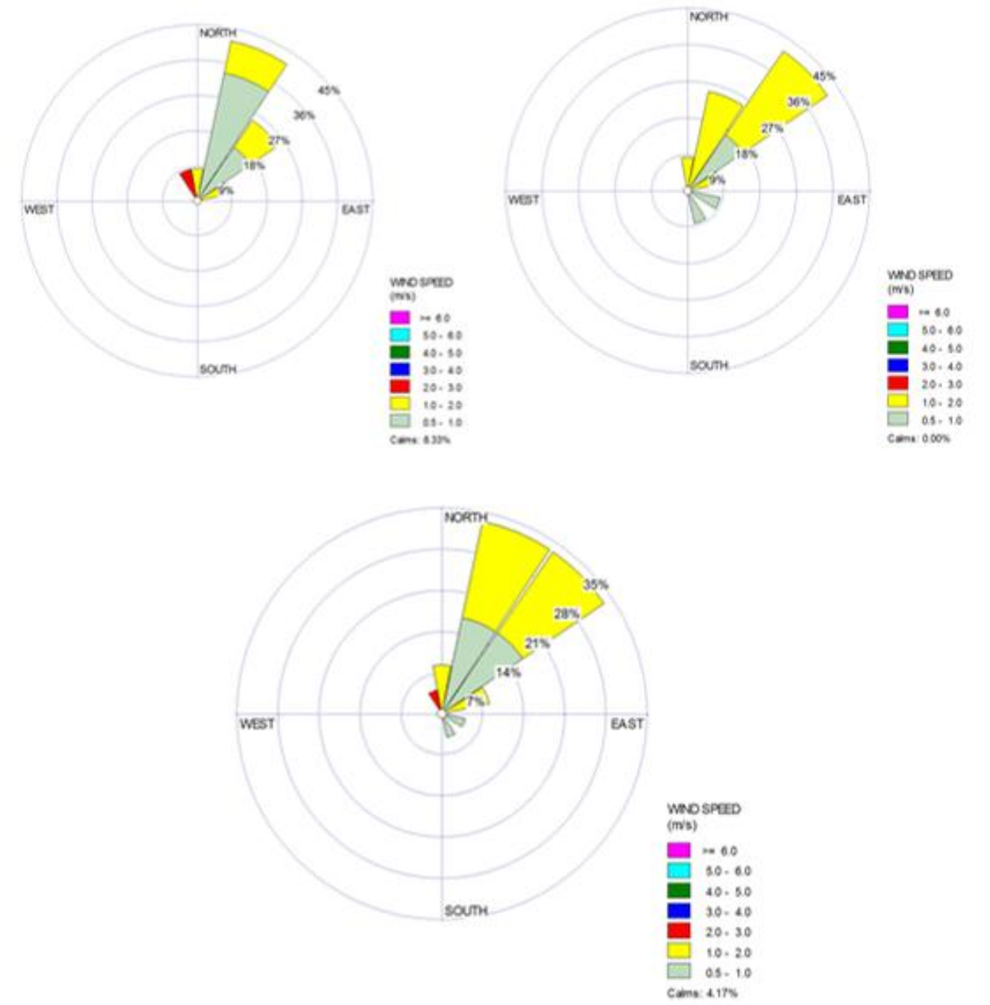
During the dry season, wind directions in all the monitored locations were predominantly from the north-east; at the eni Concession monitoring location also a south-eastern component was recorded, especially during night-time. The wind speed at the two near shore locations (Sanzule Township & Eikwe Town) recorded a moderate increase from 23:00 hrs to 03:00 hrs; this declined from 04:00 hrs to 06:00 hrs. Generally, the speed of wind in the area is relatively stable. The highest wind speed blew in the southerly direction (175.9°) at about 03:00 hrs. The zero calm recorded for Sanzule township and Eikwe town day-time indicate a continuous wind blowing for the entire monitoring period. It is therefore expected that any pollutants within the Sanzule township and Eikwe town are likely to be dissipated to the south-west. Calm night-time wind speeds in the two near-shore locations and day, night and the entire period for the eni Concession were however found to be low. Table B.2 reports the detail of the average wind speed and calm recorded during the field survey performed in March, 2014.

Figure B.5 Wind Rose Plot for Day-Time (Left), Night-Time (Right) and 24hour Period (Bottom Middle) for Eikwe Town during the Dry Season



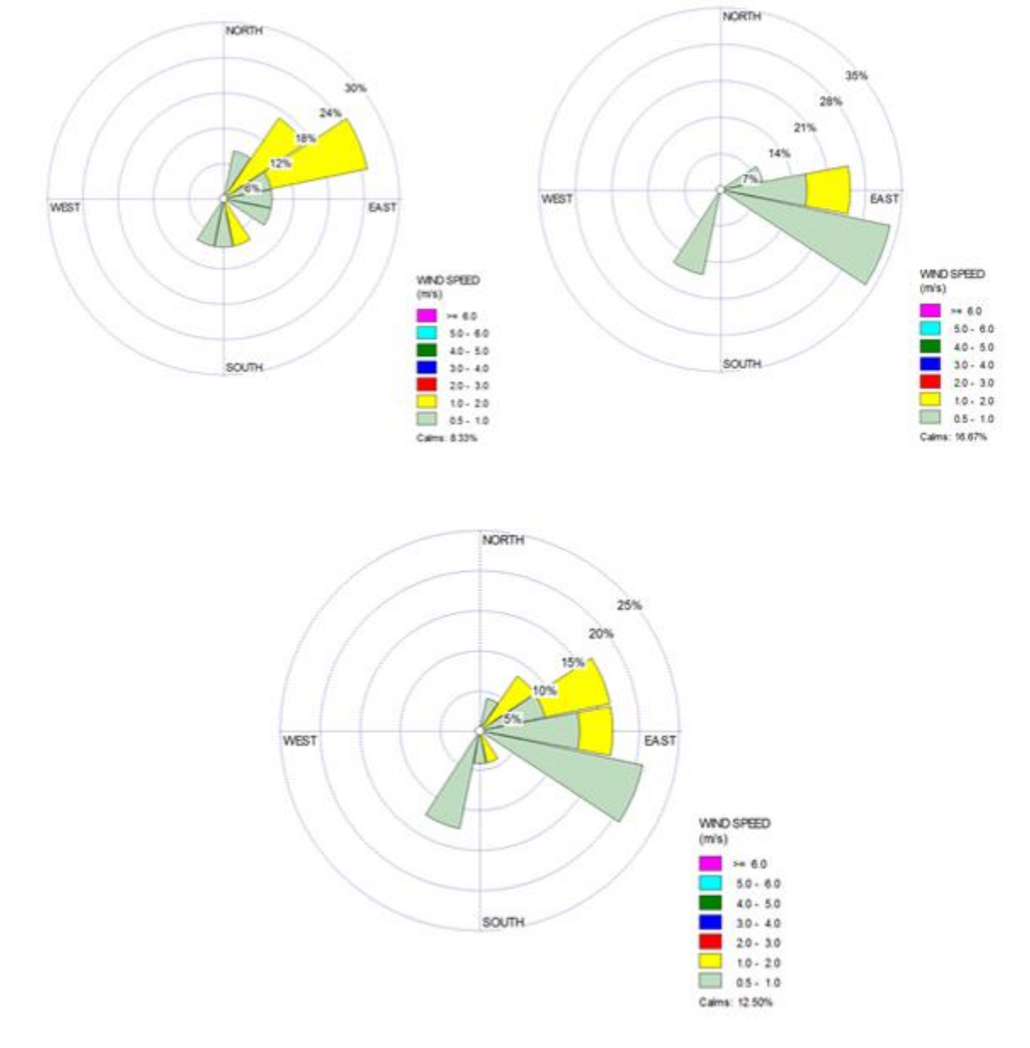
Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Figure B.6 Wind Rose Plot For Day-Time (Left), Night-Time (Right) and 24hour Period (Bottom Middle) for Sanzule Town during the Dry Season



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Figure B.7 Wind Rose Plot for Day-Time (Left), Night-Time (Right) and 24hour Period (Bottom Middle) for eni Concession during the Dry Season



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Table B.2 Average Wind Speed and Calm Recorded during the Dry Season at the Monitoring Sites

Location	Time	Average Wind Speed (m/s)	Calm (%)	Wind Direction (Blowing to)
eni Concession	Day-time	0.69	8.33	North-East North-West
	Night-Time	0.47	16.67	North-East
	Overall Period	0.58	12.50	North-East North-West
Sanzule town	Day-time	0.36	0.00	North-East North-West South-East
	Night-Time	0.36	8.33	North-East North-West
	Overall Period	0.86	4.17	North-East North-West South-East
Eikwe town	Day-time	1.31	0.00	North-East South-East South-West
	Night-Time	0.86	8.33	North-East South-East South-West
	Overall Period	1.07	4.35	North-East South-East South-West

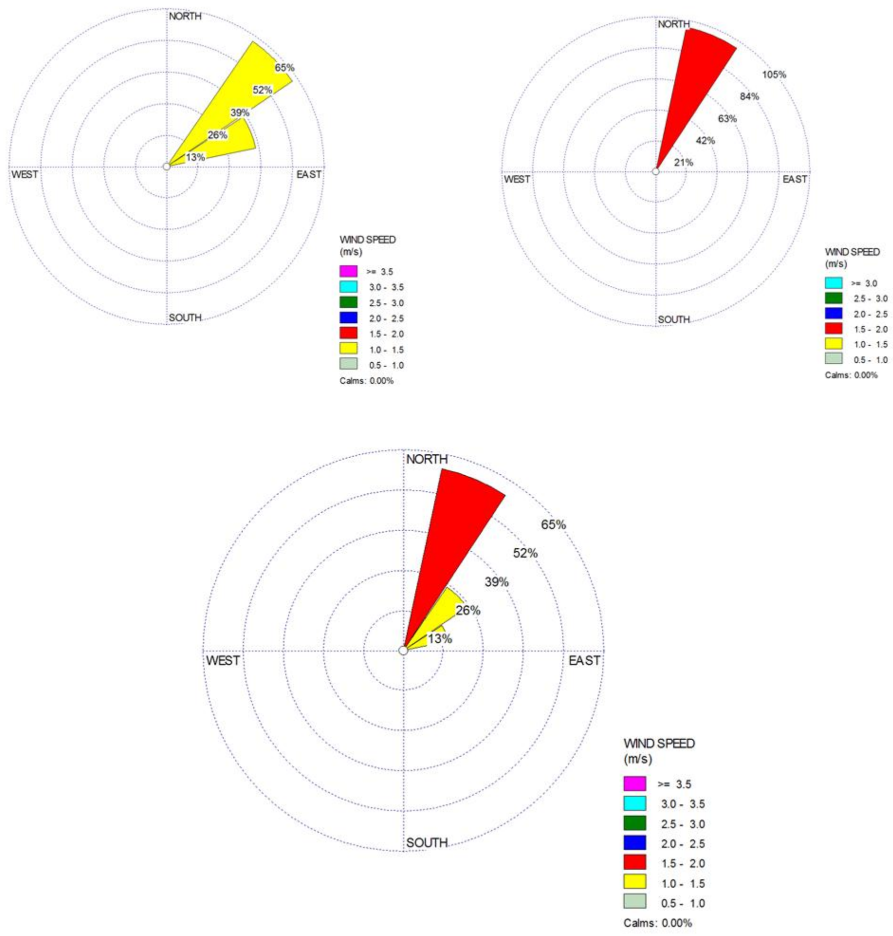
Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

During the wet season wind directions in all the monitored locations were predominantly in the north-east, showing the same wind behaviour recorded during the dry season.

The plots for Eikwe town indicate an increase in wind speed from 1 – 1.5 m/s category to 1.5 – 2 m/s during night-time. Wind speed at the Sanzule Township was mostly within the 1 – 1.5 m/s range with slight fluctuations. Wind speed recorded for eni Concession ranged from 0 to 1.5 m/s. Generally, the speed of wind in the area was relatively stable. The highest wind speed blew in the southern direction (175.9°) at about 03:00 hrs. The zero calm recorded for Sanzule town (night-time) and Eikwe town (throughout the period) indicate a continuous wind blowing for the entire monitoring period. It is therefore expected that air pollutants within the Sanzule town at night and Eikwe town are likely to be blown away to other places during the zero calm periods.

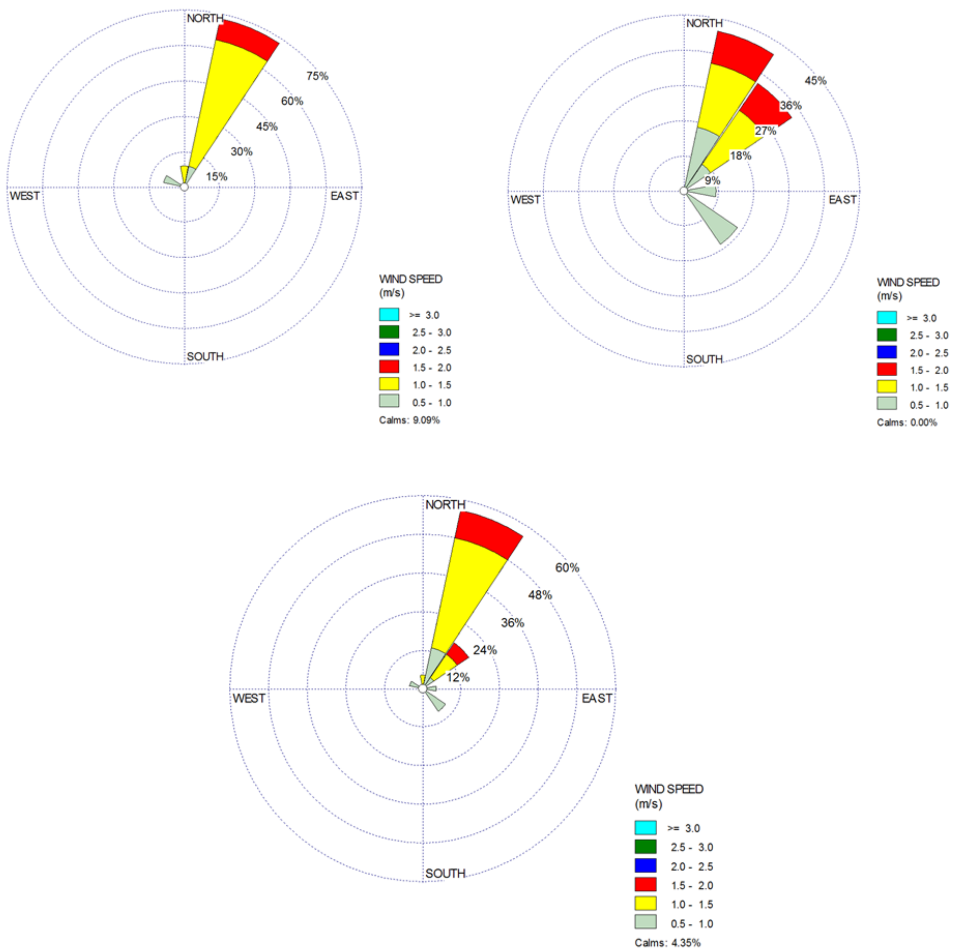
Table B.3 reports the detail of the average wind speed and calm recorded during the field survey performed in October, 2014.

Figure B.8 Wind Rose Plot for Day-Time (Left), Night-Time (Right) and 24hour Period (Bottom Middle) for Eikwe Town during the October, 2014 Wet Season



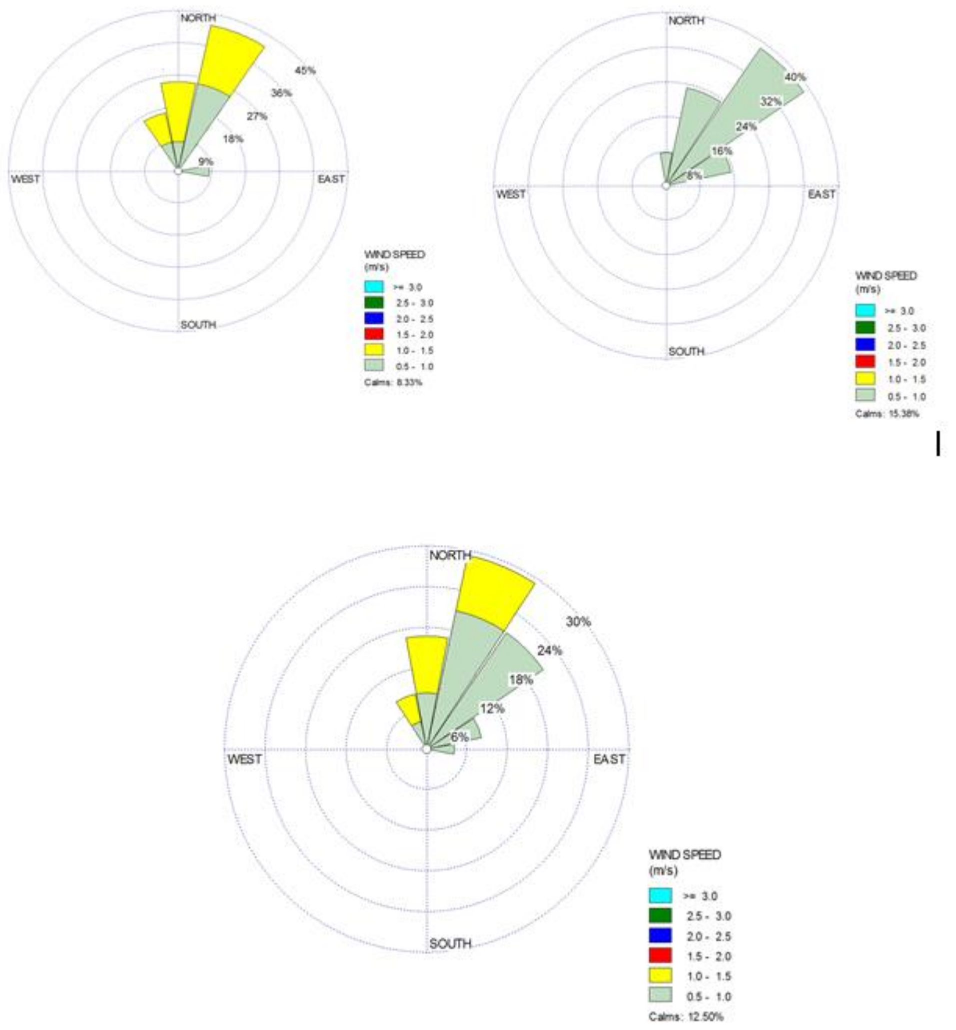
Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Figure B.9 Wind Rose Plot for Day-Time (Left), Night-Time (Right) and 24hour Period (Bottom Middle) for Sanzule Town during the October, 2014 Wet Season



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Figure B.10 Wind Rose Plot for Day-Time (Left), Night-Time (Right) and 24hour Period (Bottom Middle) for eni Concession during the October, 2014 Wet Season



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Table B.3 Average Wind Speed and Calm Recorded during the Wet Season at the Monitoring Sites

Location	Time	Average Wind Speed (m/s)	Calm (%)	Wind Direction (Blowing to)
eni Concession	Day-time	0.69	8.33	North-East
	Night-Time	0.44	15.38	North-East
	Overall Period	0.56	12.50	North-East
Sanzule town	Day-time	0.39	9.09	North-East
	Night-Time	0.86	0	North-East
	Overall Period	0.87	4.35	North-East
Eikwe town	Day-time	1.03	0.00	North-East
	Night-Time	1.54	0.00	North-East
	Overall Period	1.34	0.00	North-East
	Night-Time	0.69	0.00	North-East North-West
	Overall Period	0.73	0.00	North-East North-West South-West

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

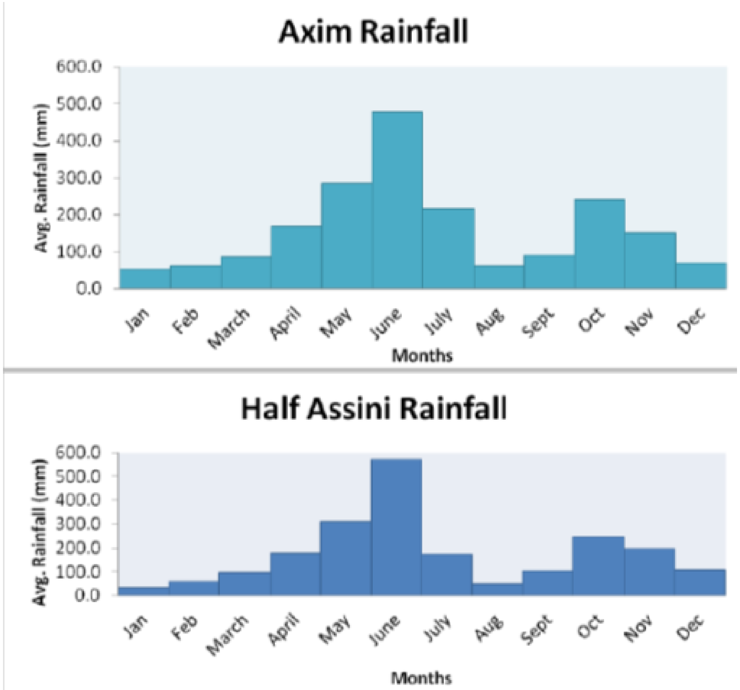
Precipitation

In absence of primary data collected on the field in the surroundings of the Project area, precipitation data were extracted from the onshore meteorology and climatology stations of Half Assini and Axim for the period 2002-2011 (REF. 5), from the stations of Takoradi, located in the western coast, for the period 1999-2008 (REF. 4) and from the Meteocean Design Basis developed by Saipem for the period 1931-2008 (REF. 4).

Generally, in Ghana there are two rainy seasons, the first begins in May and ends in mid-July and the second begins in late August and ends in October. The average annual rainfall is about 730 mm. Considering rainfall throughout the year, all source data show a bimodal pattern that means two peaks of precipitation in May-June and October-November.

Half Assini and Axim experience rainfall throughout the year. The average rainfall recorded in the Project area during the years 2002-2011 ranged from 0 to 1290.2 mm (Figure B.11). During the peak periods, Half Assini records slightly higher rainfall than Axim. Mean peak value for Half Assini in June is about 568.3 mm and the mean peak value for Axim is about 479.0 mm, normally in June. Both stations experience lowest rainfall in January of 33.9 mm and 50.9 mm for Half Assini and Axim respectively. During the peak periods, Half Assini records slightly higher rainfall than Axim. Mean peak value for Half Assini in June is about 568.3 mm and the mean peak value for Axim is about 479.0 mm, normally in June. Both stations experience lowest rainfall in January of 33.9 mm and 50.9 mm for Half Assini and Axim respectively.

Figure B.11 Axim and Half Assini Average Monthly Rainfall for the Period 2002-2011

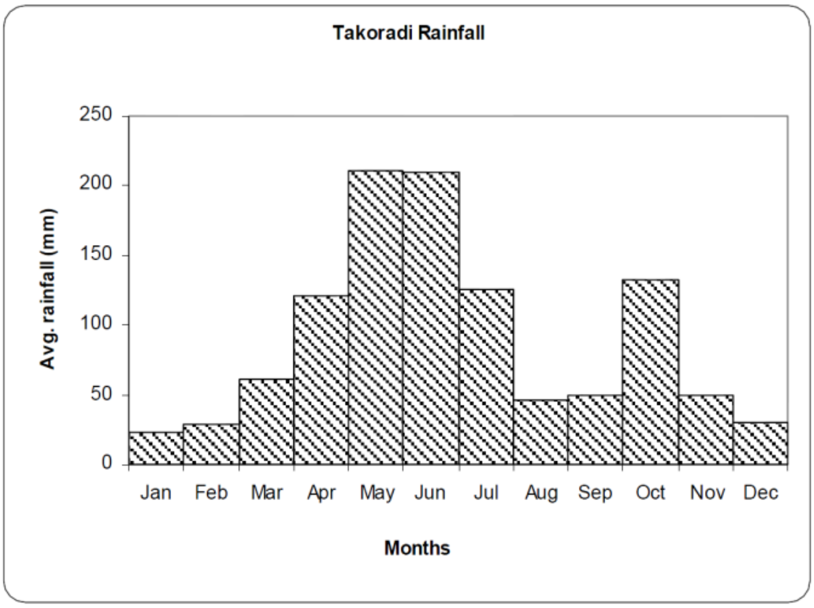


Source: Ghana Oil Services Terminal: Environmental and Social Impact Assessment (Lonrho plc, April 2014) (REF. 5)

A deeper characterization of the precipitation trend over the Project area have been assessed based on the data available for a period of more than 30 years for the Takoradi station. The trend of average monthly rainfall in Takoradi considering data collected from 1999 to 2008 (Figure B.12) and the other that covers the period 1931-1960 (

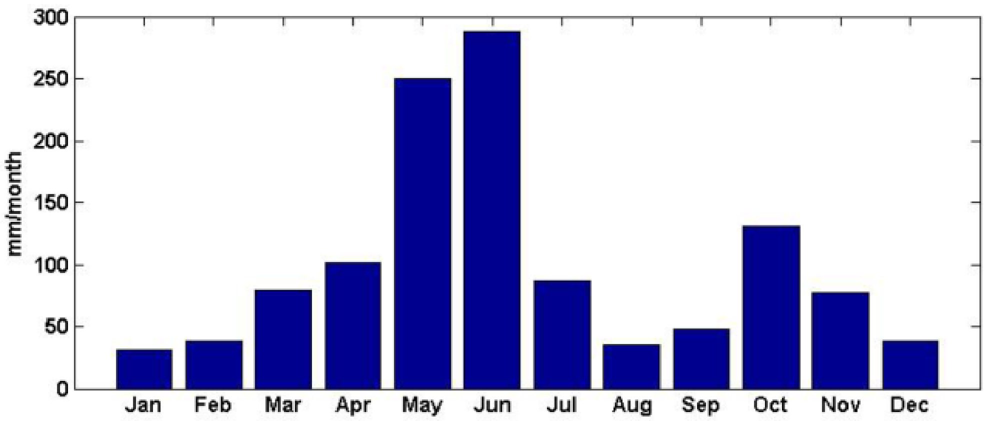
Figure B.13) are similar and confirm the occurrence of two peak periods, with only a slight difference for the peak values.

Figure B.12 Takoradi Average Rainfall for the Period 1999-2008



Source: Ghana OCTP Block Phase 1 ESHIA (ESL Consulting, November 2014) (REF. 4)

Figure B.13 Monthly Cycle of Precipitation at Takoradi for the Period 1931-1960 (Saipem - Meteocean Design Basis)



Source: Ghana OCTP Block Phase 1 ESHIA (ESL Consulting, November 2014) (REF. 4)

B.1.2 Air Quality

The AoI of the Project is characterized by the absence of major industrial activities. As a result most emissions arise from the smoke of cooking fires, generators used for power supply and vegetation clearing to create lands for farming.

Measurements of ambient air quality were carried out using the highly flexible AEROQUAL air quality monitor (AQM 60). The AQM instrument is based on analytic Gas Sensitive Semiconductor (GSS) technology. The air pollutants of interest included those that might be generated by the project or may be formed as a by-product of project emissions including nitrogen dioxide (NO_2)/Carbon dioxide (CO_2), sulfur dioxide (SO_2), volatile organic compounds (VOCs), particulate matter (TSP, & PM_{10}). The ambient concentrations were recorded for every minute for 24-hours, from which hourly concentrations and daily mean concentration were determined.

A summary of the results of the ambient air quality monitoring performed in March, 2014 and October, 2014, and the respective Ghana EPA guidelines and WB/IFC EHS standards are presented in Table B.4 and Table B.5. The analysis of the results of monitored concentrations for each pollutant of interest is reported in the paragraphs below.

Table B.4 Ambient Air Quality Results - Field Survey March 2014 (Dry Season)

Parameter	24 h Average Concentration			Ghana EPA 24hour time weighted average guideline	IFC/WHO Guideline µg/m³
	eni Concession	Sanzule town	Eikwe town		
NO_2 (µg/m³)	1.90	1.88	1.38	150	40 (annual) 200 (1-hour)
SO_2 (µg/m³)	**130.34** (b)	**78.65** (b)	**218.69** (a) (b)	150	20 (24-hour) 500 (10-minute)
TSP (µg/m³)	19.04	28.76	25.72	150	NG
PM_{10} (µg/m³)	14.56	20.32	21.28	70	20 (annual) 50 (24-hour)
VOC (ppm)	0.07	0.06	0.05	NG	NG
CO_2 (µg/m³) [1]	523651.25	505007.68	496228.87	NG	NG

Notes:

NG=No Guideline
Values highlighted in **bold** exceeded the (a) Ghana EPA guideline or (b) the IFC standard.
The comparison with IFC/WHO can be done only for SO_2 and PM_{10} for which a 24-hour limit has been set by IFC/WHO.

[1] CO_2 is not considered an air pollutant, and no concentration limit or emission limit for CO_2 is defined by international stadards. Anyway, as greenhouse gas, it was included in the monitoring activity.

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Table B.5 Ambient Air Quality Results - Field Survey October 2014 (Wet Season)

Parameter	24hour Average Concentration			Ghana EPA 24hour time weighted average guideline	IFC/WHO Guideline µg/m³
	eni Concession	Sanzule town	Eikwe town		
NO_2 (µg/m³)	0.10	0.05	0.08	150	40 (annual) 200 (1-hour)
SO_2 (µg/m³)	19.74	**65.93** (b)	**30.49** (b)	150	20 (24-hour) 500 (10-minute)
TSP (µg/m³)	28.77	81.38	133.35	150	NG
PM_{10} (µg/m³)	18.42	**52.53** (b)	**84.52** (a) (b)	70	20 (annual) 50 (24-hour)
VOC (ppm)	0.07	0.02	0.04	NG	NG
CO_2 (µg/m³) [1]	542621.7	598222.89	585411.4	NG	NG

Notes:

NG=No Guideline
Values highlighted in **bold** exceeded the (a) Ghana EPA guideline or (b) the IFC standard.
The comparison with IFC/WHO can be done only for SO_2 and PM_{10} for which a 24-hour limit has been set by IFC.

[1] CO2 is not considered an air pollutant, and no concentration limit or emission limit for CO2 is defined by international stadards. Anyway, as greenhouse gas, it was included in the monitoring activity.

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

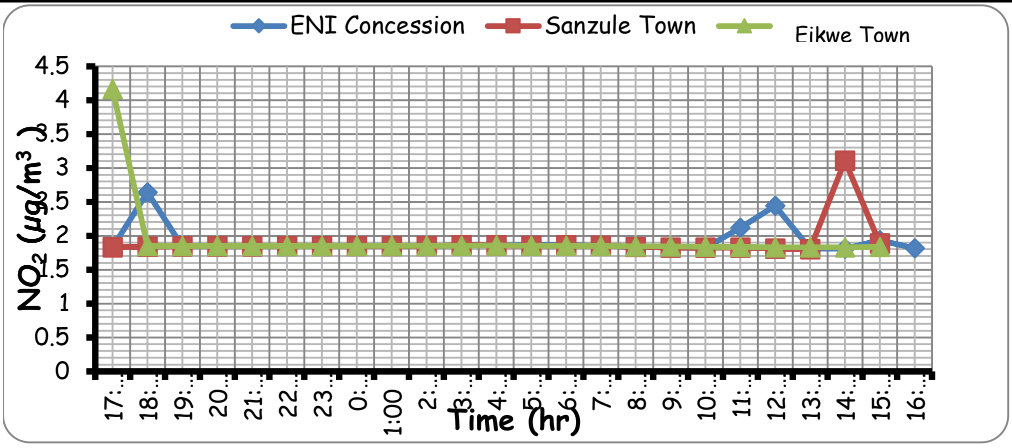
Nitrogen Dioxide (NO_2)

Nitrogen is an essential component of all living matter. However, excessive concentrations of certain nitrogen species including nitrogen dioxide in the atmosphere can lead to significant environmental problems including photochemical smog, global warming, stratospheric ozone depletion and acid formation. Gaseous oxides of nitrogen also exhibit a greenhouse effect. Oxides of nitrogen react with partially oxidized organic matter and sunlight under certain meteorological conditions and series of complex chemical and photochemical reactions to produce substances that affect the eyes, reduce visibility, crop damage and severe adverse human health impacts.

During the monitoring survey performed in March, 2014 (dry season), hourly variations in NO_2 concentrations were observed in the range of 1.81-4.16 µg/m³ with recorded 24hr averages values of 1.88 µg/m³, 1.38 µg/m³, and 1.90 µg/m³ for Sanzule Town, Eikwe Town and the eni Concession respectively. Highest NO_2 concentration during the March, 2014 monitoring was recorded at Eikwe Town at 18:00 GMT. Generally, the NO_2 levels within the studied area were uniformly distributed with isolated peaks at 18:00 and 12:00 GMT.

The hourly variation in NO_2 levels for the three monitored locations recorded in March, 2014 is presented in Figure B.14.

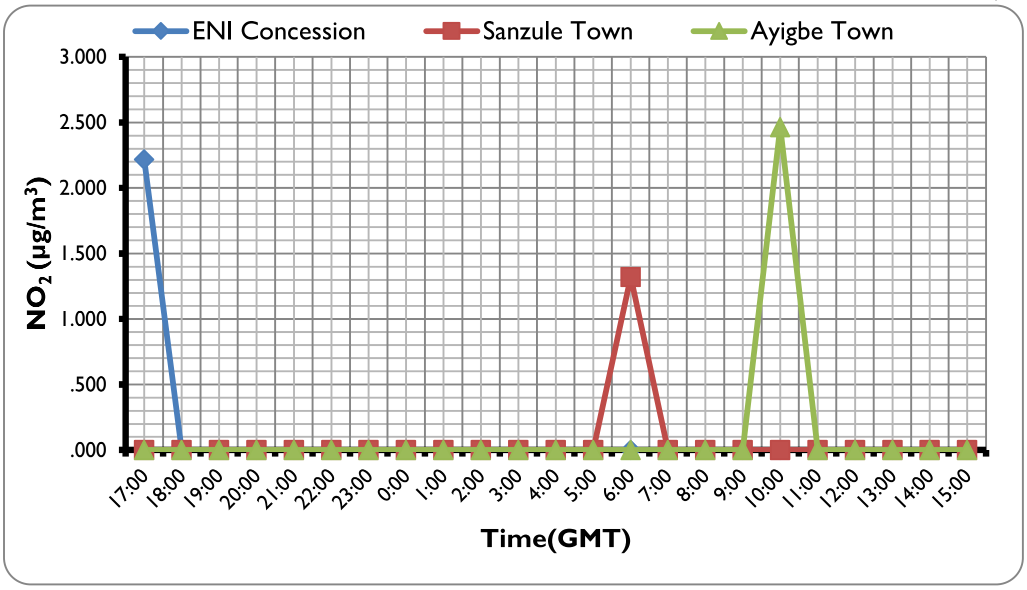
Figure B.14 Variations in Hourly NO_2 Levels in the Monitored Locations during the Field Survey of March 2014 (Dry Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

During the monitoring survey performed in October, 2014 (wet season), variations in NO_2 concentrations for the entire monitoring range from <0.01-2.47 µg/m^3 with recorded 24hr average values of 0.05 µg/m^3, 0.08 µg/m^3, and 0.10 µg/m^3 for Sanzule Town, Eikwe Town and the eni Concession respectively. Highest NO_2 concentration during the monitoring was recorded at eni Concession at about 17:00 GMT. The hourly averages indicated uniform NO_2 distribution with isolated peaks at 17:00 (eni Concession), 6:00 (Sanzule Town) and 10:00 GMT (Eikwe Town).

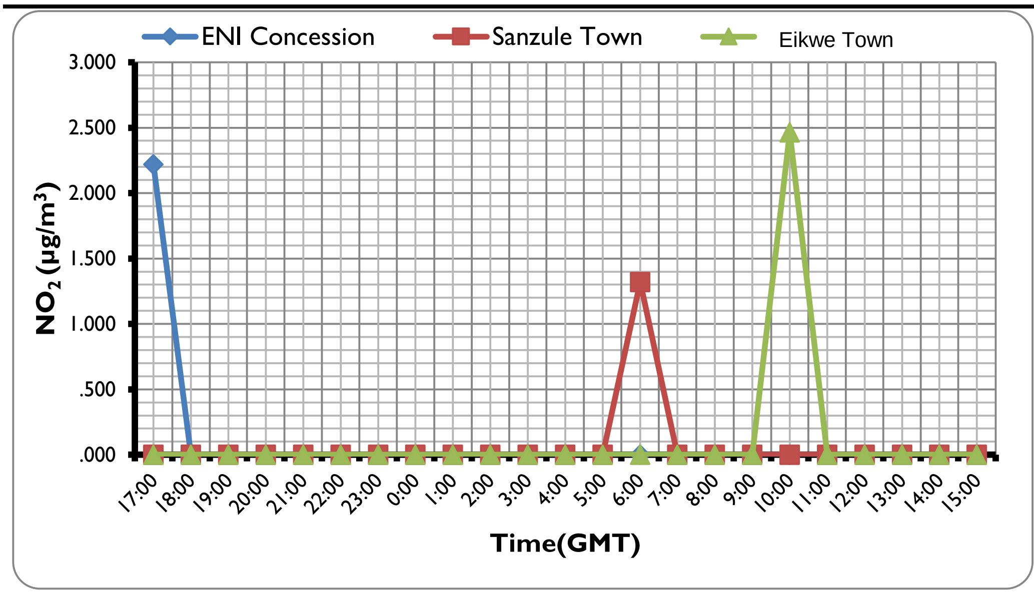
The hourly variation in NO_2 levels for the three monitored locations recorded in October, 2014



is presented in

Figure B.15.

Figure B.15 Variations in Hourly NO_2 Levels in the Monitored Locations during the Field Survey of October 2014 (Wet Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Generally, the NO_2 averages for the wet season monitored in October, 2014 were considerably lower than the values recorded at the same locations for the dry season assessment in March.

The recorded values were considerably low comparing to the Ghana EPA permissible limit, (24-hour, 150 µg/m^3), both during dry and wet season. IFC sets an hourly concentration limit for NO_2, instead of a 24-hour limit, thus the comparison have been done between the 1-hour IFC standard (200 µg/m^3) and the hourly monitored data [1]. As described above, the maximum hourly NO_2 concentrations were observed during the dry season and ranged from 1.81 to 4.16 µg/m^3; thus the maximum value is well below the IFC limit.

Given the absence of any major industrial activity in the study area, the apparent low NO_2 levels are expected to reflect background concentrations other than anthropogenic sources.

Sulphur Dioxide (SO_2)

Sulphur dioxide is a major air pollutant, typically found in the combustion products of oil and coal. It is the most corrosive of the sulphur oxides while SO_3 and SO_2 could react with atmospheric water vapour to produce sulphuric acid, which can be precipitated as acid rain. The major adverse health effects associated with exposure to SO_2 pertains to the upper respiratory tract. SO_2 is a respiratory irritant with constriction of the bronchioles occurring with inhalation of SO_2 at 5 ppm or more. The EPA has set a primary SO_2 standard of 1-hour concentrations not to exceed 900 µg/m^3 for industrial areas and 24 hour period not to exceed 150µg/m^3.

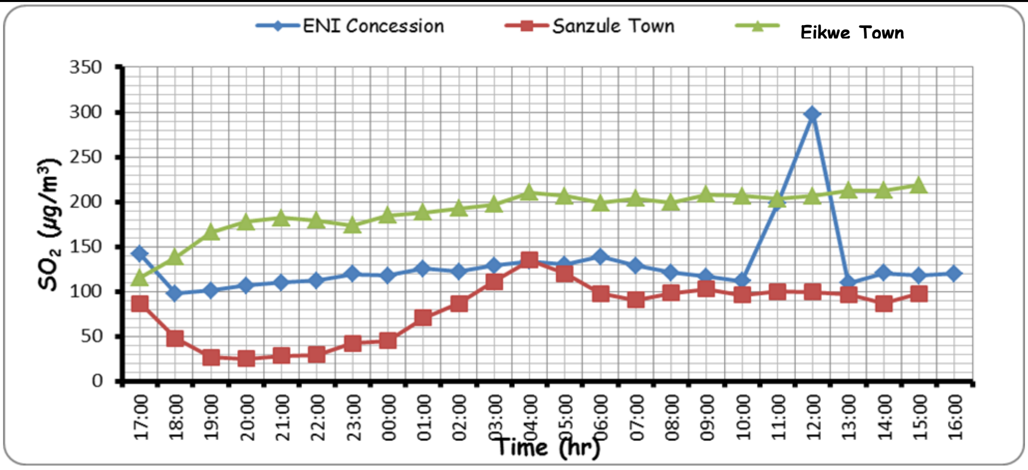
During the monitoring survey performed in March, 2014 (dry season), sulphur dioxide (SO_2) levels varied between 24.78 – 297.38 µg/m^3 with 24-hr averages of 78.65 µg/m^3, 218.69 µg/m^3 and 130.34 µg/m^3 for Sanzule Town, Ayibge Town and eni Concession respectively.

Spatial variation analysis revealed highest hourly SO_2 concentrations at the Eikwe town site, which reflected in the 24-hour average of 218.69 µg/m^3 at the location exceeding the Ghana EPA permissible level of 150 µg/m^3. The IFC 24-hour limit (20 µg/m^3), more stringent than Ghanaian limit, is exceeded at all three monitoring sites.

Elevated levels of SO_2 at that monitored location could be attributed to anthropogenic activities such as smoking of fishor burning of refuse at the monitored location. Generally, SO_2 levels within the Sanzule town ranked lowest, only peaking at 04:00 GMT. The hourly variation in SO_2 levels recorded in March, 2014 for the three monitored locations is presented in Figure B.16.

[1] The hourly average readings for the three monitoring sites for each pollutant are reported in the documents REF. 1 and REF. 2

Figure B.16 Variations in Hourly SO_2 Levels in the Monitored Locations during the Field Survey of March 2014 (Dry Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

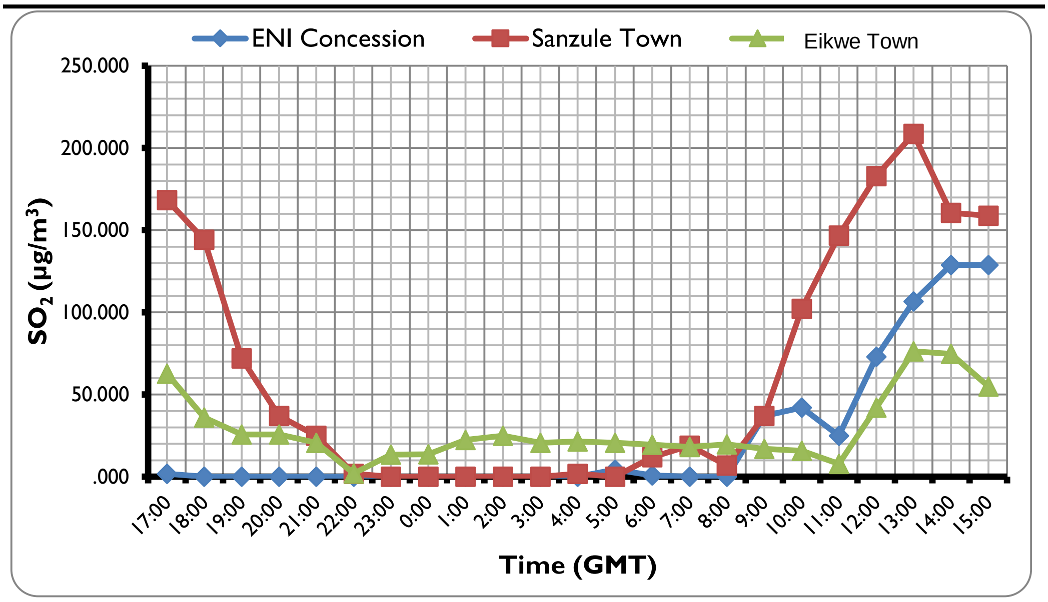
During the monitoring survey performed in October, 2014 (wet season), sulphur dioxide (SO_2) monitored levels for the three locations ranges between 0 – 231.79 µg/m^{3}with 24-hr averages of 65.93 µg/m^3, 30.49 µg/m^3 and 19.74 µg/m^3 for Sanzule Town, Ayibge Town and eni Concession respectively. The highest hourly SO_2 concentration of 208.61 µg/m^3 was recorded at the Sanzule town at 13:00 GMT. Contrary to previous assessment during the dry season, highest daily SO_2 levels were highest at Sanzule town.

Generally, SO_2 levels for all the monitored locations were low from 22:00 GMT to 8:00 GMT as seen in Figure B.17. The recorded 24-hr averages for all the locations were lower than the values obtained for the same locations during the dry season (March, 2014) monitoring: Eikwe Town (218.69 µg/m^3), Sanzule Town (78.65 µg/m^3) and eni Concession (130.34 µg/m^3).

All the recorded hourly and 24-hourly averages were within the regulatory Ghanaian limits of 900 µg/m^3 and 150 µg/m^3 respectively. The IFC 24-hour limit (20 µg/m^3) is respected only at eni Concession, although the monitored average level is close to the limit (19.74 µg/m^3).

The hourly variation in SO_2 levels recorded in October, 2014 for the three monitored locations is presented in Figure B.17.

Figure B.17 Variations in Hourly SO_2 Levels in the Monitored Locations during the Field Survey of October 2014 (Wet Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Particulate Matter (TSP & PM_{10})

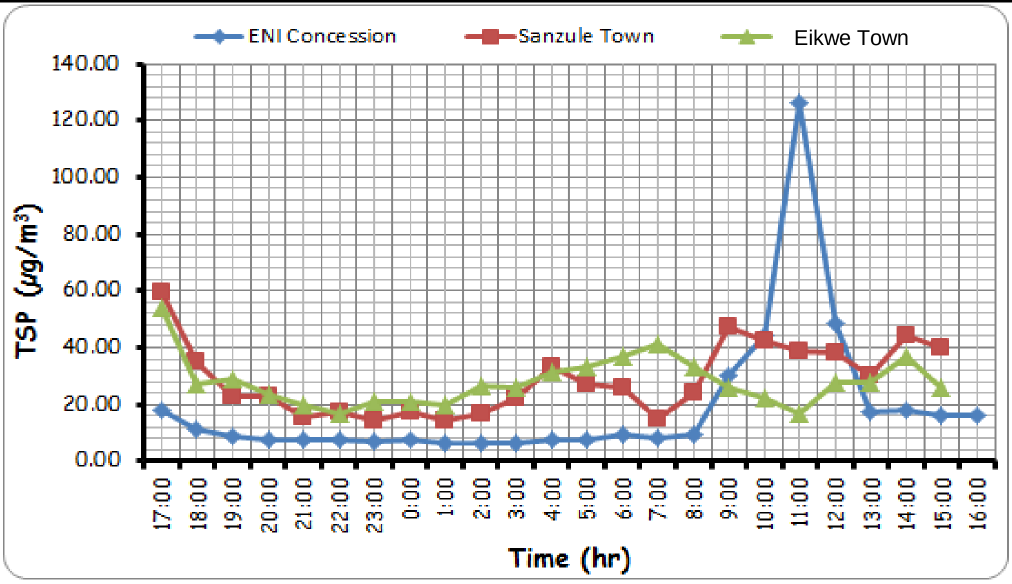
Particulate matter (PM) is a collective term used for every small solid and/or liquid particles found in the atmosphere. Tiny airborne particles or aerosols that are less than 100 micrometers (mm) are termed as total suspended particulate matter (TSP). Coarse particles (PM_{10}) are between 2.5 and 10 microns (µm) in diameter and arise primarily from natural processes, such as wind-blown dust or soil. PM and TSP result from natural or anthropogenic processes including pollen, salt spray, erosion, transportation, fuel combustion in stationary sources, industrial processes, land cleaning, wild fires and solid waste disposal (Vakeva et al. 1999, Adachi and Tainosho 2004). Several factors play vital roles in particulate matter concentrations in a particular location e.g. precipitation, temperature, humidity and wind speed and directions. The main hazard of particulate matter (fine particles) is respiratory irritation while TSP results in dust nuisance from soiling of clothes or building surfaces, reduce visibility and abrasive/corrosive surface deterioration of materials.

During the field survey performed in March, 2014 (dry season), recorded mean TSP values were 28.76 µg/m^3, 25.72 µg/m^3 and 19.04 µg/m^3 for Sanzule township, Eikwe town and eni Concession respectively. Fluctuation in hourly TSP varied in range 6.24-125.96 µg/m^3 with values well below EPA hourly limits (Figure B.18). The concentration of TSP was low at about 18:00 GMT and increased between 3:00-5:00 GMT. The distribution pattern showed increasing levels between 08:00-11:00 GMT for the eni Concession and Sanzule town. On the other hand the Eikwe town monitoring location showed decreasing TSP levels within the same period.

The trend observed for TSP was similar to that observed for PM_{10}, thus it is an indication that the PM_{10} is the major factor influencing TSP concentrations. The mean PM_{10} levels were highest at Eikwe town with 24.1 µg/m^3, followed by Sanzule town and eni Concession with 23.04 µg/m^3 and 14.68 µg/m^3 in that order (Figure B.19).

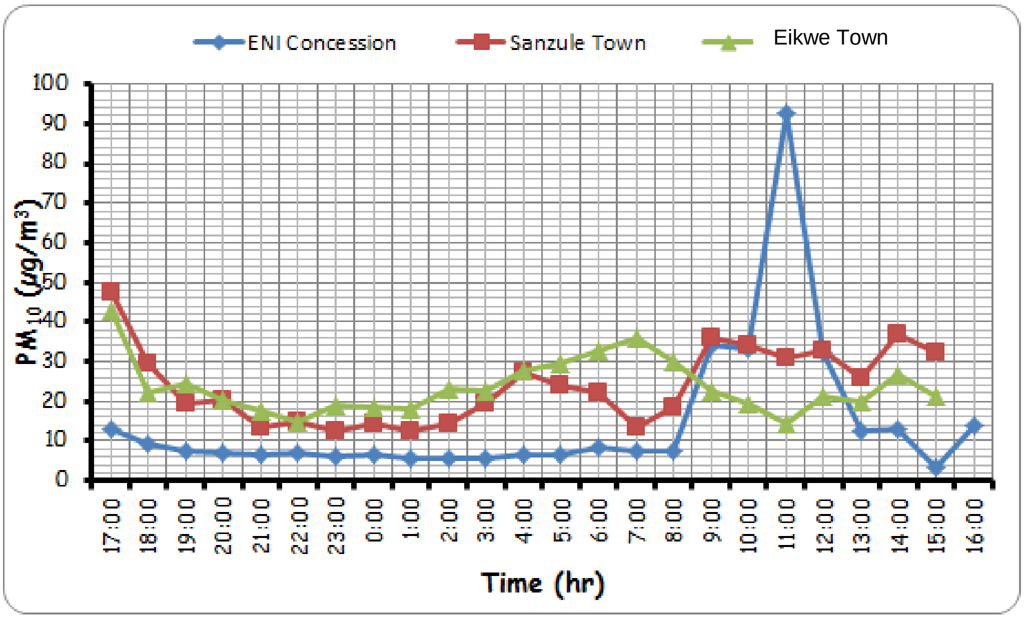
The daily average concentrations were below the Ghana EPA permissible limit, only at Sanzule town an exceedance of the IFC limit for PM_{10} was recorded. The relatively low particulate and suspended matter for the monitored locations may be due to natural phenomenon such as wind-blown dust, although road dust raised by road traffic may primarily correspond to that recorded for the Sanzule town.

Figure B.18 Variations in Hourly TSP Levels in the Monitored Locations during the Field Survey of March 2014 (Dry Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Figure B.19 Variations in hourly PM10 levels in the monitored locations during the field survey of March 2014 (Dry season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

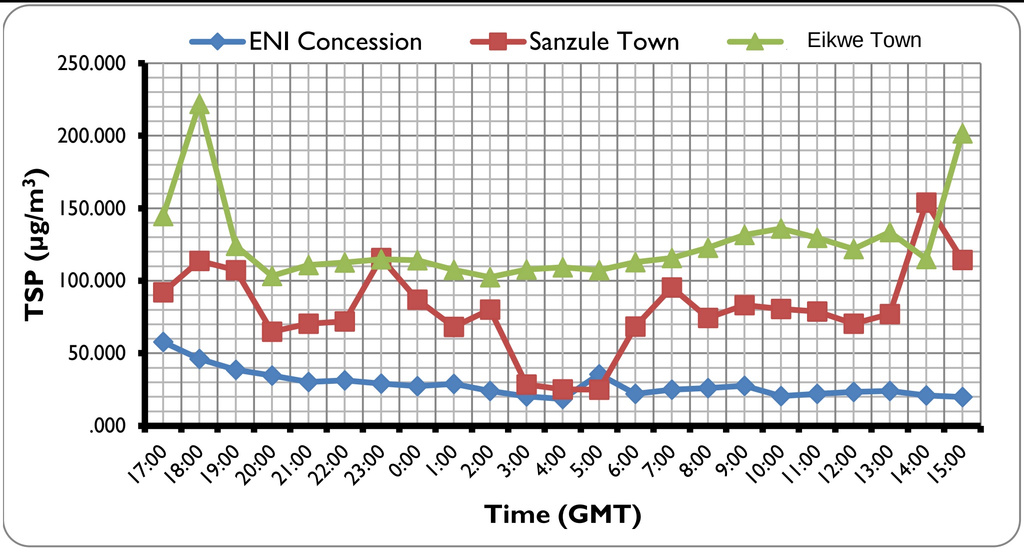
During the field survey performed in October, 2014 (wet season), the 24-hour TSP averages were 81.38 µg/m^3, 133.35 µg/m^3 and 28.77 µg/m^3 for Sanzule Town, Eikwe town and eni Concession respectively. The hourly TSP averages ranged from 24.88 to 153.93 µg/m^3 for the Sanzule Town, 102.43 to 221.82 µg/m^3 for Eikwe Town and 18.60 to 57.88 µg/m^3 for the eni concession. All the recorded averages were below the EPA regulatory limit of 230 µg/m^3 (Figure B.20).

The hourly TSP trends indicate uniform distribution for the eni Concession, relatively uniform distribution with a couple of spikes at Eikwe town, and highly fluctuating levels for the Sanzule Township. All the recorded 24-hour averages were higher than the averages for the dry season study. TSP levels in the monitoring locations can be attributed to the sandy nature of the area and smoking activities associated with the routine activities of the community members.

The 24-hour mean PM_{10} levels were 18.42 µg/m^3, 52.53 µg/m^3 and 84.52 µg/m^3 for the eni Concession, Sanzule town and Eikwe Town respectively. With the exception of Eikwe town which recorded an average exceeding the EPA guideline limit of 70 µg/m^3, the remaining locations were within the EPA permissible limit (Figure B.21). The IFC limit for PM_{10} (50 µg/m^3) instead was exceeded at Sanzule and Eikwe town.

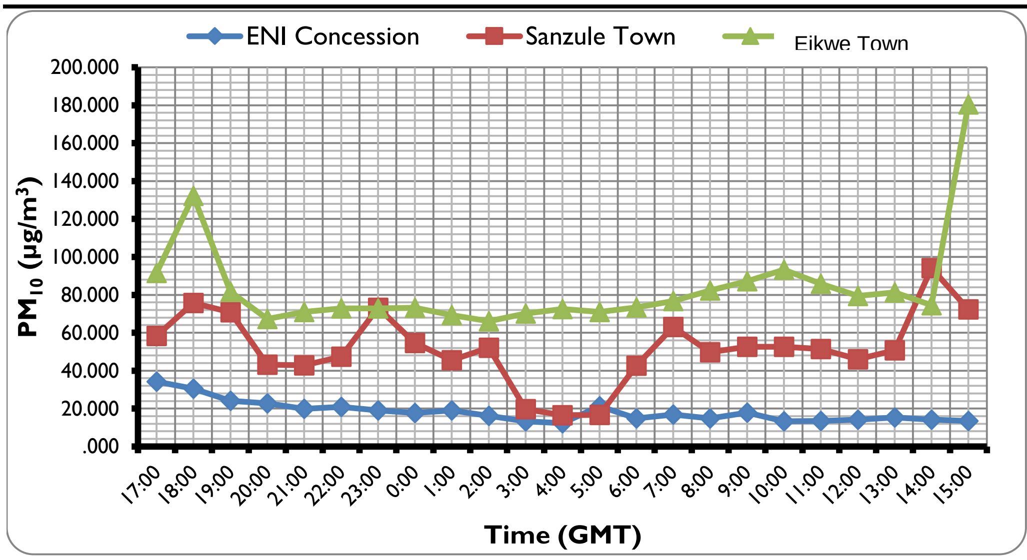
The trend observed for TSP was similar to that observed for PM_{10}, and it is an indication that the PM_{10} is the major contributor to the TSP concentrations within the monitored area. Also, the observed PM_{10} levels were higher for all locations compared to findings from the dry season assessment in March, 2014.

Figure B.20 Variations in Hourly TSP Levels in the Monitored Locations during the Field Survey of October 2014 (Wet Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Figure B.21 Variations in Hourly PM_{10} Levels in the Monitored Locations during the Field Survey of October 2014 (Wet Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Volatile Organic Compounds (VOCs)

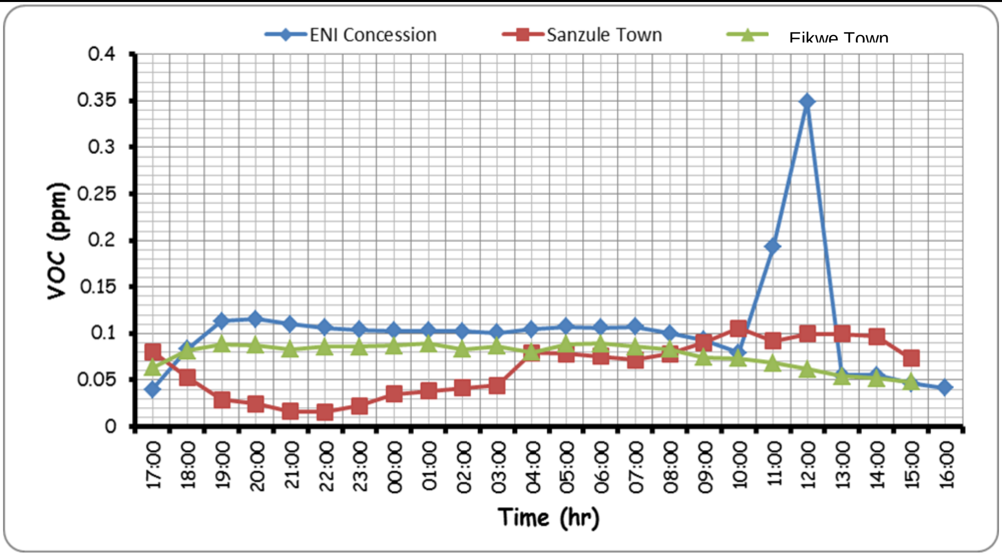
Volatile Organic Compounds (VOCs) are organic trace contaminants that can be readily separated from water into a gas phase by gas stripping. VOCs include benzene, toluene, ethylbenzene and xylene (BTEX).

Most of the VOCs are carcinogenic in nature. World Health Organization considers benzene as a Class 1 carcinogen. The Ghana EPA has no established permissible limit for VOCs.

These compounds are major constituents of petroleum products. VOCs come from either natural (biogenic) or anthropogenic sources. Biogenic VOC sources include coniferous trees and decaying vegetation. Petroleum and automobile emissions can be implicated for contributing massively to ambient volatile organic compound levels.

In March, 2014 (dry season), VOCs levels throughout the study area were low with mean 24-hour values of 0.06 ppm, 0.05 ppm and 0.07 ppm were recorded for Sanzule Township, Eikwe Town and eni Concession respectively. The hourly concentrations of VOCs were virtually stable in the study area except for recorded levels for the eni Concession which peaked at 12:00 GMT (Figure B.22).

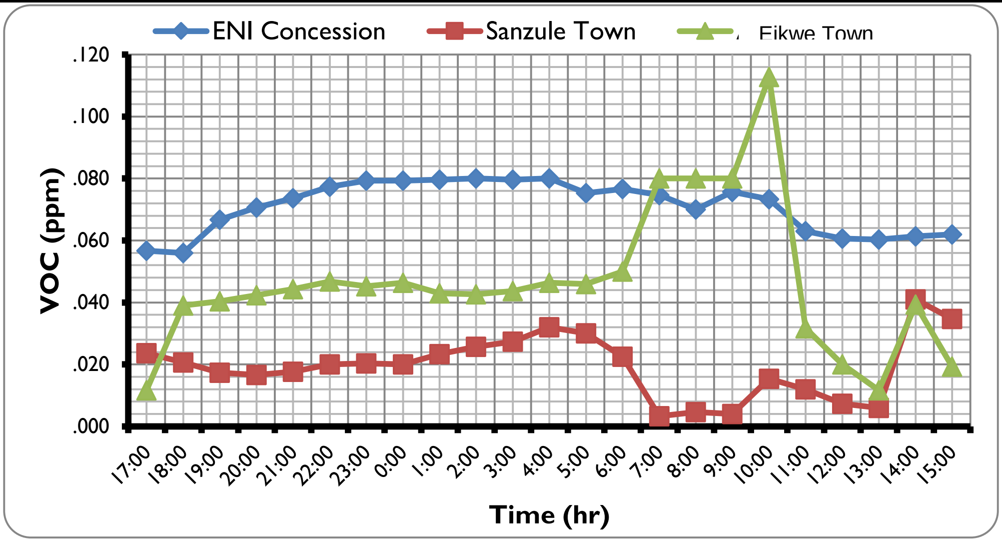
Figure B.22 Variations in Hourly VOCs Levels in the Monitored Locations during the Field Survey of March 2014 (Dry Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

In October, 2014 (wet season), VOCs levels throughout the study area were low with mean 24-hour values of 0.02 ppm, 0.04 ppm and 0.07 ppm recorded for Sanzule Town, Eikwe Town and eni Concession respectively. The hourly concentrations of VOCs were virtually stable in the study area except for the peak level recorded at Eikwe Town at 10:00 GMT (Figure B.23).

Figure B.23 Variations in Hourly VOCs Levels in the Monitored Locations during the Field Survey of October 2014 (Wet Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

The study area has no known anthropogenic sources, and given the spatial extent of low VOC levels throughout the study area, it is likely to be indicative of biogenic origin.

Carbon Dioxide (CO_2)

Carbon dioxide is one of the components of air. It is a by-product of respiration and complete burning of fossil fuels and organic materials. CO_2 is a useful gas to botanical life, as it is used by green plants in the presence of energy from the sun and water to synthesize carbohydrates. However, CO_2 is a greenhouse gas and has been established that atmospheric CO_2 levels contribute to global warming.

During the monitoring survey performed in March, 2014 (dry season), the recorded 24-hour average for CO_2 in Sanzule Township was 508293.6 µg/m^3, 496228.8 µg/m^3 for Eikwe Town and 523651.25 µg/m^3 for the proposed eni Concession.

The hourly variation in CO_2 levels recorded in March, 2014 for the three monitored locations is presented in

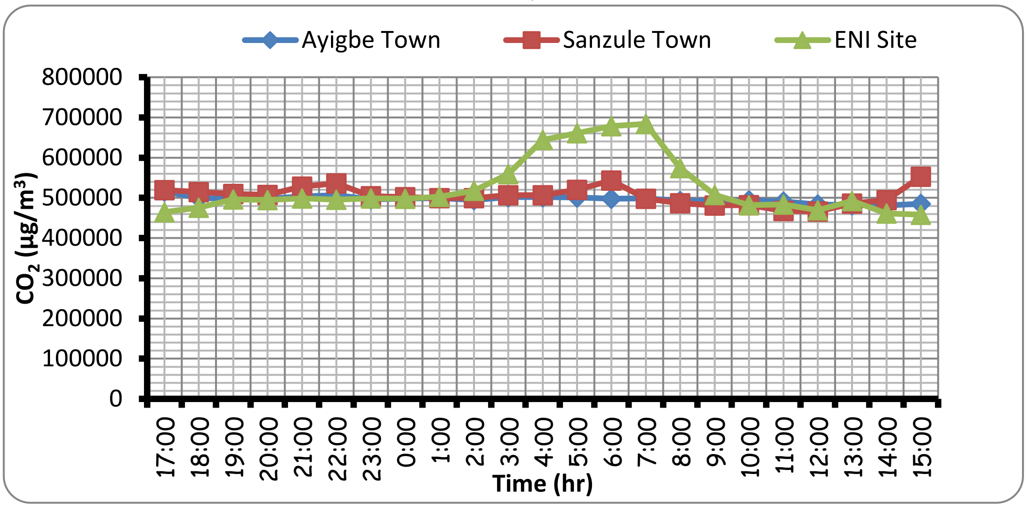
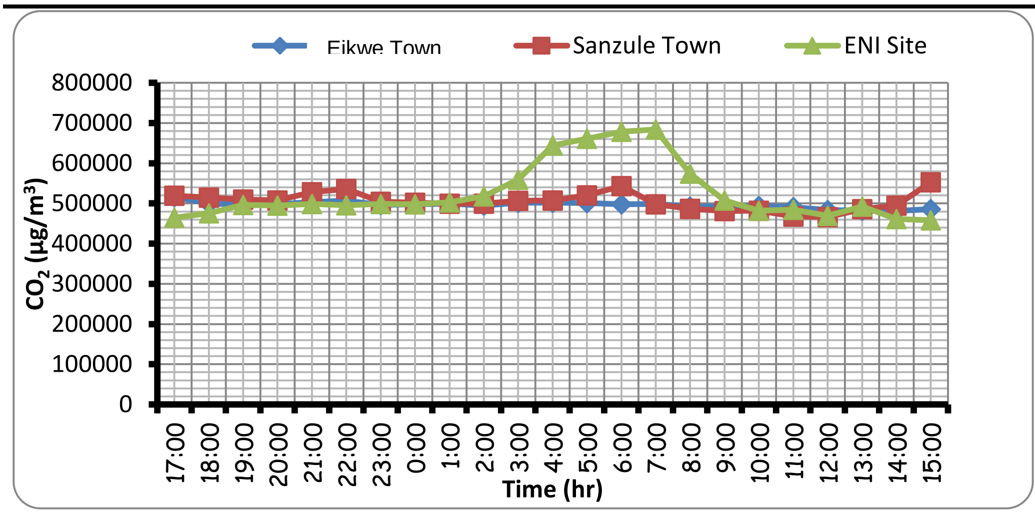


Figure B.24.

Figure B.24 Variations in Hourly CO_2 Levels in the Monitored Locations during the Field Survey of March 2014 (Dry Season)



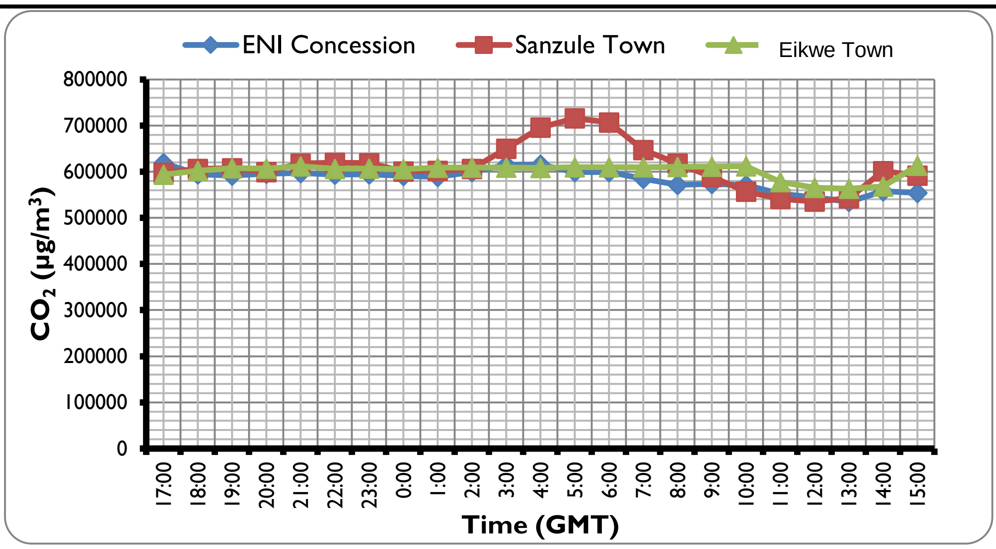
Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

During the monitoring survey performed in October, 2014 (wet season), the recorded 24-hour average for CO_2 were 542621.70 µg/m^3 for the eni Concession, 598222.89 µg/m^3 for Sanzule Town and 585411.40 µg/m^3 for Eikwe Town.

The recorded 24-hour CO_2 averages for all the locations were higher than the values obtained during the dry season assessment for the same locations. The hourly distributions revealed uniform trend with Sanzule Town peaking at 5:00 GMT as seen in Figure B.25. Remarkably, the period (1:00-9:00 GMT) of increasing CO_2 levels at Sanzule Town for this current assessment coincided with the period of increasing CO_2 observed for eni Concession in the previous assessment for dry season. It is an indication of the similarity in CO_2 sources within the two locations.

The hourly variation in CO_2 levels recorded in October, 2014 for the three monitored locations is presented in Figure B.25.

Figure B.25 Variations in Hourly CO2 Levels in the Monitored Locations during the Field Survey of October 2014 (Wet Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

There is no Ghana EPA or IFC/WB established guideline for CO_2, therefore levels were not compared. Nonetheless, the relatively high CO_2 levels can be attributed to burning activities in home since most of the residents typically use firewood as their source of energy for fish smoking, cooking and other domestic activities.

B.1.3 Light, Noise and Vibration

Urban noise pollution produces direct and cumulative adverse health effects by degrading residential, social, working, and learning environments with corresponding real (economic) and intangible (well-being) losses. The World Health Organization (WHO) Guidelines for Community Noise has documented seven categories of adverse health effects of noise pollution on humans: hearing impairment, interference with spoken communication, sleep disturbances cardiovascular disturbances, disturbances in mental health, impaired task performance and negative social behavior and annoyance reactions. Noise can produce a number of social and behavioural effects in residents, besides annoyance (for review see *Berglund & Lindvall 1995*). The social and behavioural effects are often complex, subtle and indirect. Many of the effects are assumed to be the result of interactions with a number of non-auditory variables. Social and behavioural effects include changes in overt everyday behaviour patterns (e.g. closing windows, turning TV and radio to louder levels, complaining to authorities); adverse changes in social behavior (e.g. aggression, unfriendliness, non-participation); adverse changes in social indicators (e.g. residential mobility, drug consumption, accident rates). Noise above 80 dBA is consistently associated with decreased helping behavior and increased aggressiveness.

Light, noise and vibration levels in the Project area are currently minimal due to the lack of industrial and other activities in the area. Current levels of noise are associated to domestic activities and natural sounds such as the ocean and waves.

The construction and operation of the ORF and onshore pipeline in the vicinity of Sanzule village will increase local light and noise levels and therefore this will need to be considered in the ESHIA.

The Ghana EPA has set the noise level for heavy industrial areas to be 70 dBA but residential areas range from 48 dBA (night-time) to 55 dBA (day-time). IFC/WB EHS Guideline, instead, sets a limit of 45 dBA for night time and 55 dBA for day time for residential areas.

Noise levels were measured using the ACO Pacific sound level meter which is integrated into the AQM for a real-time sound level measurement. The sound meter was calibrated with ACO Pacific Acoustic Calibrator (94dB@1kHz) prior to data collection at each sampling location.

Dry Season

The summary results of the noise levels recorded at the same sampling locations as the air quality during the field survey of March, 2014 are presented in Table B.6.

Variations in noise levels within the vicinity of the company were found in a range of 51.03 dBA to 62.83 dBA with a 24-hour mean of 53.33 dBA, 55.19 dBA and 59.86 for the eni site, Sanzule town and the Eikwe town respectively. Highest noise levels were recorded at Eikwe town probably originating from domestic activities.

Expectedly the eni Concession had relatively lower noise levels which most likely reflect the undeveloped/forested nature of the areas. Major source of noise within the eni Concession is noise associated with birds and wind assisted tree branch movements.

The results indicate that the average noise level at Sanzule and Eikwe town marginally exceeded the EPA permissible day-time noise level of 55 dBA and night time level of 48 dBA for residential area, and the IFC limits (55 dBA for day-time, 45 dBA for night time).

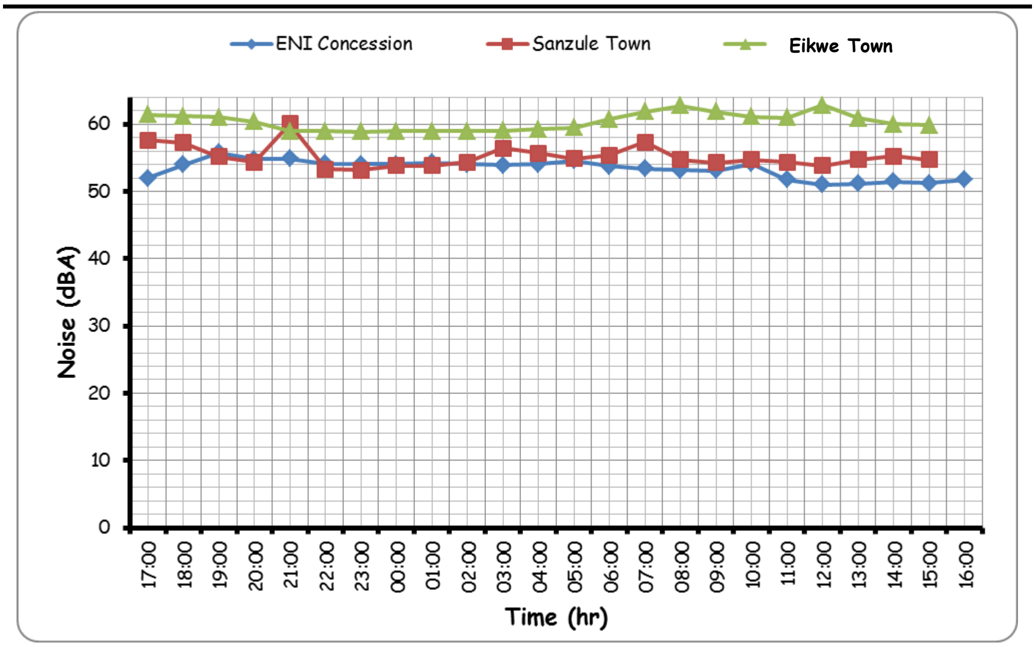
The hourly noise variation is presented in Figure B.26. Generally, the results indicate that the background noise levels at the locations were marginally high possibly due to domestic/human activities during the day. The increase in noise levels at Eikwe and the Sanzule town coincided with period of beach seine (fishing) activities. It was observed that the main sources of noise in the community were noise generated from vehicular movements, especially heavy truck movements along the road in proximity of the villages, beach seine activities, villages' activities (e.g., children playing, adults chatting, loud music/radio) and natural sources (e.g., sea waves breaking at the beach, winds).

Table B.6 Summary Statistics of Ambient Noise Results - Field Survey March 2014 (Dry Season)

Monitored Location	Measured Sound Pressure Level [dBA]							
	Average (Leq)	**Lmin**	**Lmax**	**Day Time**	**Night Time**	**LA_5**	**LA_{10}**	**LA_{50}**
Sanzule Town	55.19	53.15	60.07	55.07	55.19	53.0	53.4	54.5
Eikwe Town	59.86	51.62	62.83	60.48	59.49	58.7	58.8	59.7
eni Concession	53.33	51.03	55.79	52.31	54.37	50.9	51.2	53.7
EPA guideline	*55*			*55*	*48*			
IFC guideline				*55*	*45*			

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Figure B.26 Variations in Hourly Noise Levels in the Monitored Locations during the Field Survey of March 2014 (Dry Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014) (REF. 1).

Wet Season

The summary results of the noise levels recorded during the field survey of October, 2014 are presented in Table B.7.

In October 2014, variations in noise levels within the vicinity of the company were found in a range of 52.30 dBA to 73.30 dBA with a 24-hour mean of 58.39 dBA, 63.70 dBA, and 61.31 dBA for the eni Concession, Sanzule town and the Eikwe town respectively. Highest noise levels were recorded at Eikwe town probably originating from domestic activities.

Consistent with the previous assessment for dry season, highest noise level was recorded at Eikwe Town probably originating from domestic activities.

All the recorded averages (24-hour, day-time and night-time) well exceeded the EPA guideline and the IFC limits for residential areas. Also, all the recorded 24-hour averages were numerically higher than the values obtained during the March, 2014 study.

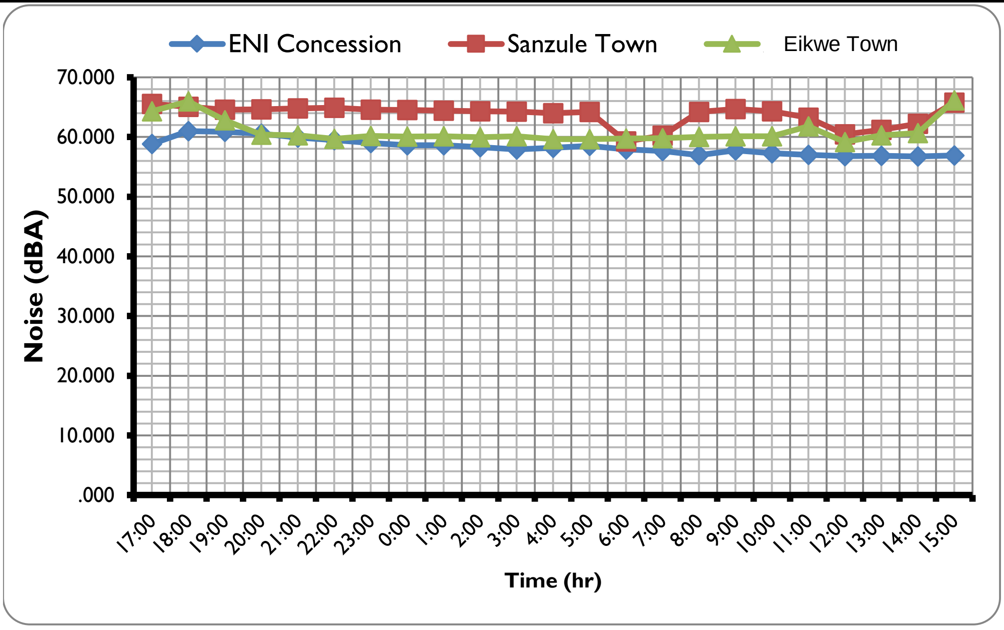
The hourly noise variation is presented in Figure B.27. Generally, the results indicate that the background noise levels at the locations were marginally high possibly due to domestic/human activities during the day. The main contribution to the noise levels at Eikwe and Sanzule came from fishing activities (beach seine), which together with vehicle movements, occasional music and sea waves breaking at the beach were the main noise sources observed in the vicinity of the settlements.

Table B.7 Summary Statistics of Ambient Noise Results - Field Survey October 2014 (Wet Season)

Monitored Location	**Measured Sound Pressure Level [dBA]**							
	Average (Leq)	**Lmin**	**Lmax**	**Day Time**	**Night Time**	**LA_5**	**LA_{10}**	**LA_{50}**
Sanzule Town	63.70	52.30	69.30	65.90	64.53	59.2	60.3	64.4
Eikwe Town	61.31	57.50	73.30	62.02	60.80	58.7	59.3	62.2
eni Concession	58.39	56.40	67.00	57.21	59.21	56.6	56.7	58.2
EPA guideline	*55*			*55*	*48*			
IFC guideline				*55*	*45*			

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

Figure B.27 Variations in Hourly Noise Levels in the Monitored Locations during the Field Survey of October 2014 (Wet Season)



Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014) (REF. 2).

B.2 ONSHORE GEOPHYSICAL AND CHEMICAL COMPONENT

B.2.1 Freshwater Resources

The physico-chemical sampling results for surface water are presented in the following tables.

Table B.8 Wet season physico-chemical characteristics of water samples

Surface (fresh) water		A. Temp	W. Temp	pH	Cond.	TDS	Salinity	DO	COD	BOD_5	TSS	Turbidity
		ºC	ºC		µS/cm	mg/L	‰	mg/L	mg/L	mg/L	mg/L	NTU
SW-AMA-UPP	**Surface**	35.56	25.94	6.58	36	23	0.01	3.31	<5	177	3.00	0.76
	Mid		26.7	6.56	36	23	0.01	2.72				
	Bottom		26.58	6.56	33	22	0.01	1.88				
SW-AMA-MID1	**Surface**	34.32	26.12	6.90	467	295	0.22	5.84	<5	183	9.00	8.95
	Mid		26.12	6.83	710	450	0.32	5.66				
	Bottom		26.03	6.80	3240	2115	1.80	4.07				
SW-AMA-MID2	**Surface**	31.18	26.02	6.94	3558	2349	1.88	5.97	<5	354	37.00	45.20
	Mid		27.58	6.88	39710	25830	24.96	7.66				
	Bottom		27.33	6.81	40050	26040	25.42	7.20				
SW-AMA-LOW	**Surface**	33.2	27.79	7.14	44610	27580	26.66	7.90	<.5	189	32.00	37.20
	Mid		27.81	7.14	42840	27800	26.81	8.14				
	Bottom		27.83	7.1	48855	30170	30.06	8.46				
SW-AMA-PIP		35.66	29.23	7.2	75	49	0.03	2.99	<5	64	10	56

Table B.9 Dry season physico-chemical characteristics of water samples

Location		pH	Temp (A)	Temp (W)	Conductivity	Salinity	Turbidity	TSS	TDS	DO	BOD_5	COD
Surface Water			**ºC**	**ºC**	**µS/cm**	**0/00**	**NTU**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
AMA Upstream	S	6.8	29.1	28.97	3651	1.63	5.46	24	2197	1.32	95	425
	M	6.52	NV	28.7	11952	6.31	NV	NV	7256	0.23	NV	NV
	B	6.53	NV	27.72	11955	6.31	NV	NV	7256	0.82	NV	NV
AMA Midstream 1	S	6.55	30.11	30.03	18082	9.58	0.82	1	10700	2.08	90.6	6400
	M	6.58	NV	29.81	20570	11.1	NV	NV	12250	1.91	NV	NV
	B	6.59	NV	29.87	21642	11.75	NV	NV	12890	2.5	NV	NV
AMA Midstream 2	S	6.7	29.13	31.04	26981	14.57	4.94	79	15720	1.91	82.4	5200
	M	6.69	NV	29.31	27022	15.14	NV	NV	16230	5.38	NV	NV
	B	6.66	NV	29.17	26433	14.88	NV	NV	15980	1.83	NV	NV
AMA Downstream	S	6.61	31.66	30.43	25119	13.58	1.915	33	14770	5.26	78	3500
	M	6.69	NV	30.21	25491	13.81	NV	NV	15080	4.9	NV	NV
	B	6.68	NV	29.98	18796	10.78	NV	NV	12160	4.92	NV	NV

Table B.10 Wet season concentrations of nutrients in water samples

Surface (fresh) water	Phosphates	Nitrate	Silicate
	mg/L	mg/L	mg/L
SW-AMA-UPP	4.00	2.50	12.90
SW-AMA-MID1	0.18	1.60	13.40
SW-AMA-MID2	0.14	1.20	21.90
SW-AMA-LOW	0.06	2.20	19.40
SW-AMA-PIP	0.23	1.56	13.7

Table B.11 Dry season concentrations of nutrients in water samples

Surface (fresh) water	Phosphate	Nitrate	Silicates
	mg/L	mg/L	mg/L
AMA Upstream	0.21	5.8	0.54
AMA Midstream 1	0.29	13.4	2.8
AMA Midstream 2	0.21	5.6	0.86
AMA Downstream	0.17	13.65	1.4

Table B.12 Wet season concentrations of oil & grease and Total Petroleum Hydrocarbons

Surface (fresh) water	Oil & Grease	TPH
	ppm	Ppm
SW-AMA-UPP	<2	<2
SW-AMA-MID1	<2	<2
SW-AMA-MID2	<2	<2
SW-AMA-LOWER	<2	<2
SW-AMA-PIPELINE	<2	<2

Table B.13 Dry season concentrations of oil & grease and Total Petroleum Hydrocarbons

Surface (fresh) water	Oil & Grease	TPH
	ppm	Ppm
AMA Upstream	1	0
AMA Midstream 1	2	0
AMA Midstream 2	0	0
AMA Downstream	1	0

Table B.14 Dry season concentrations of Faecal Coliform and Total Coliform

Surface Water	Total Coliform (cfu/100ml)	Faecal Coliform (cfu/100ml)
DOL 1 (Ground water)	0	0
ENI 1 (Ground water)	3	0
AYI 1 (Ground water)	1023	2
WHO GUIDELINE	**0**	**0**
GHANA STANDARD	**0**	**0**

B.2.2 Groundwater

The physico-chemical sampling results for groundwater are presented in the following tables.

Table B.15 Wet season concentrations of nutrients in water samples

Groundwater	Nitrate	T. Phosphorus	Silicate
	mg/L	**mg/L**	**mg/L**
GW-1A	3.99	0.04	8.50
GW-1B	7.59	0.04	7.50
GW-2A	11.59	0.05	6.50
GW-2B	11.79	0.03	6.50
GW-3A	10.19	0.07	8.00
GW-3B	8.99	0.07	8.5
GW-ANOR (A)	7.79	0.04	6.50
GW-ANOR (B)	6.99	0.03	8.00
GW-BAKU (A)	3.49	0.03	9.50
GW-BAKU (B)	3.99	0.05	8.50
GW-EIK (A)	16.99	0.04	17.50
GW-EIK (B)	10.59	0.04	16
GW-BKT (A)	14.99	0.7	9.5
GW-BKT (B)	8.99	0.7	10.5

Table B.16 Dry season concentrations of nutrients in water samples

Location	Phosphate	Nitrate	Silicates
Groundwater	mg/L	mg/L	mg/L
DOL1	0.18	7.4	NA
ENI1	0.22	9.5	NA
AYI1	0.49	45	NA

Table B.17 Wet season concentrations of oil & grease and Total Petroleum Hydrocarbons

Groundwater	Oil & Grease	TPH
	ppm	ppm
GW-1A	<2	<2
GW-1B	<2	<2
GW-2A	<2	<2
GW-2B	<2	<2
GW-3A	<2	<2
GW-3B	<2	<2
GW-ANOR (A)	<2	<2
GW-ANOR (B)	<2	<2
GW-BAKU (A)	<2	<2
GW-BAKU (B)	<2	<2
GW-EIK (A)	<2	<2
GW-EIK (B)	<2	<2
GW-BKT (A)	<2	<2
GW-BKT (B)	<2	<2

Table B.18 Dry season concentrations of oil & grease and TPH's

Location	O&G	TPH
Ground Water	ppm	ppm
DOL1	0	0
ENI1	0	0
AYI1	0	0

Table B.19 Dry season concentrations of Faecal Coliform and Total Coliform

Groundwater	Total Coliform (cfu/100ml)	Faecal Coliform (cfu/100ml)
DOL 1 (Ground water)	0	0
ENI 1 (Ground water)	3	0
AYI 1 (Ground water)	1023	2
WHO GUIDELINE	**0**	**0**
GHANA STANDARD	**0**	**0**

Table B.20 Wet season physico-chemical characteristics of water samples

Groundwater	A. Temp	W. Temp	pH	Cond.	TDS	Salinity	DO	COD	BOD_5	TSS	Turbidity
	ºC	ºC		µS/cm	mg/L	‰	mg/L	mg/L	mg/L	mg/L	NTU
GW-1A	35.56	28.29	6.35	60	40	0.02	5.84	<5	54	0.00	0.52
GW-1B		28.36	6.20	50	30	0.02	6.07	<5	50	0.00	0.59
GW-2A	35.43	27.59	5.19	146	90	0.06	3.93	<5	61	3.25	0.33
GW-2B		27.54	5.33	146	90	0.06	4.80	<5	76.7	4.00	0.40
GW-3A	34.78	27.89	8.21	726	450	0.33	3.12	<5	93.6	4.33	0.88
GW-3B		27.43	8.19	728	452	0.34	3.87	<5	86.5	1	0.51
GW-ANOR (A)	34.28	28.04	7.00	284	180	0.13	5.35	<5	102	1.00	0.79
GW-ANOR (B)		27.88	7.08	283	180	0.13	5.24	<5	24	0.00	0.72
GW-BAKU (A)	34.66	27.72	5.41	87	60	0.04	3.74	<5	128.8	1.00	0.32
GW-BAKU (B)		27.74	5.41	88	50	0.04	3.77	<5	129.2	0.33	0.42
GW-EIK (A)	33.58	27.17	7.45	378	240	0.17	5.07	<5	22	13.25	13.16
GW-EIK (B)		26.94	7.36	381	239	0.17	3.86	<5	62	51.75	13.53
GW-BKT (A)	34.68	29.83	7.82	349	208	0.15	4.62	<5	47	3	0.53
GW-BKT (B)		30.49	7.81	352	207	0.15	5.03	<5	69.8	1	2.96

Table B.21 Dry season physico-chemical characteristics of water samples

Ground Water	pH	Temp (A)	Temp (W)	Conductivity	Salinity	Turbidity	TSS	TDS	DO	BOD_5	COD
		°C	°C	µS/cm	0/00	NTU	mg/L	mg/L	mg/L	mg/L	
DOL1	5.47	28.65	29.39	32	0.01	0.89	25	49.6	3.96	87.8	
ENI1	5.76	31.39	30.68	64	0.03	0.86	1	66.6	4.02	75.2	
AYI1	7.26	30.45	29.12	1924	0.89	1.1	33	2035	3.87	94.6	

B.3 Flora and Fauna

B.3.1 Flora

Table B.22 Flora sampling locations and description (wet season) – concession Area

SAMPLE 1	SAMPLE 2	SAMPLE 3
Coconut plantation with secondary thicket	Coconut farm with secondary thicket	Swamp forest / Raphia hookeri
Lat 4°58.034	Cassava farm / groundnut	Lat 04°57.932
Long 002°26.538	Lat 4°57.982	Long 002°26.864
Triclisia patens	Long 002°26.887	*Carapa procera*
Elaeis guineensis	*Baphia nitida*	*Raphia hookeri*
Dracaena arborea	*Waltheria indica*	*Anthocleista djalonensis*
Psydrax subcordata	*Voacanga africana*	*Lygodium microphyllum*
Hypselodelphys violaceae	*Rauvolfia vomitoria*	*Cleistopholis patens*
Acridocarpus smeathmanii	*Triumfetta cordifolia*	*Cyrtosperma senegalensis*
Cnestis ferruginea	*Baphia pubescens*	*Cola sp.*
Tetracera alnifolia	*Mangifera indica*	*Psychotria sp.*
Carapa procera	*Blighia sapida*	*Crinum ornatum*
Baphia nitida	*Dissotis rotundifolia*	
Pycnocoma macrophylla	*Macaranga barteri*	
Trichilia prieureana	*Scleria verrucosa*	
Sterculia tragacantha	*Selaginella myosorus*	
Spondias mombin	*Cnestis ferruginea*	
Funtumia africana	*Acridocarpus smeathmanii*	
Funtumia elastica	*Cassytha filiformis*	
Newbouldia laevis	*Flagellaria guineensis*	
Seleginella myosorus	*Albizia ferruginea*	

SAMPLE 1	**SAMPLE 2**	**SAMPLE 3**
Smilax kraussiana	*Croton lobatus*	
Flagellaria guineensis	*Solenostemon mannii*	
Griffonia simplicifolia		
Acacia kamerunensis		
Baissea multiflora		
Agelea trifolia		
Albizia adianthifolia		

SAMPLE 4	**SAMPLE 5**
Strand vegetation	Lat 4°57.522
Coconut plantation	Long 002°26.884
Lat 04°57.482	*Eclipta prostrata*
long 002°26.891	*Asystasia calycina*
Remirea maritima	*Aframomum sp.*
Asystasia calycina	*Cyrtosperma senegalensis*
Ipomoea pes-caprae	*Raphia hookeri*
Passiflora foetida	*Ficus sp.*
Stachytarpheta indica	*Elaeis guineensis*
Triumfetta rhomboidea	*Phyllanthus muellerianus*
Desmodium adscendens	*Pneumatopteris afer*
Solenostemon monostachyus	*Fuirena umbellata*
Diodia vaginalis	*Desmodium adscendens*

Table B.23 Wet season floristic composition and frequency distribution of species in AoI

SPECIES LIST	FAMILY	LIFE FORM	ECOLOGICAL GUILD	STAR RATING	IUCN STATUS
Acacia kamerunensis	Mimosaceae	Climber	NPLD	Green	NA
Acridocarpus smeathmanii	Malpighiaceae	Climber	NE	Green	NA
Aframomum sp.	Zingiberaceae	Herb	NF/WP	NE	NA
Agelea trifolia	Connaraceae	Herb	NE	NE	NA
Albizia adianthifolia	Mimosaceae	Tree	NPLD	Green	LC
Albizia ferruginea	Mimosaceae	Tree	NPLD	Scarlet	V
Alchornea cordifolia	Euphorbiaceae	Tree	Pioneer	Green	NA
Anthocleista djalonensis	Loganiaceae	Tree	Pioneer	Green	NA
Asystasia calycina	Acanthaceae	Shrub	Pioneer	Green	NA
Baissea multiflora	Apocynaceae	Climber	NPLD	Green	NA
Bambusa vulgaris	Gramineae	Tree	Swamp	Green	NA
Baphia nitida	Papilionaceae	Tree	SB	Green	LC
Baphia pubescens	Papilionaceae	Tree	Pioneer	Green	NA
Blighia sapida	Sapindaceae	Tree	NPLD	Green	NA
Carapa procera	Meliaceae	Tree	SB	Green	NA
Cassytha filiformis	Lauraceae	Climber	NE	NE	NA
Chromolaena odorata	Compositae	Shrub	NE	NE	NA
Cleistopholis patens	Annonaceae	Tree	Pioneer	Green	NA
Cnestis ferruginea	Connaraceae	Climber	Pioneer	Green	NA
Cocos nucifera	Palmae	Tree	NF/SP	NE	NA
Cola sp.	Sterculiaceae	Tree	NF/SP	NE	NA
Combretum racemosum	Combretaceae	Climber	Pioneer	Green	NA
Crinum ornatum	Amaryllidaceae	Herb	Swamp	Green	NA
Croton lobatus	Euphorbiaceae	Shrub	NF/WP	NE	NA
Cyrtosperma senegalensis	Araceae	Herb	NE	Green	NA
Desmodium adscendens	Papilionaceae	Shrub	NE	Green	LC
Dichapetallum madagascariensis	Dichapetalaceae	Tree	SB	Green	NA
Diodia vaginalis	Rubiaceae	Herb	Pioneer	NE	NA
Diospyros monbutensis	Ebenaceae	Tree	SB	Green	NA
Dissotis rotundifolia	Melastomataceae	Shrub	Pioneer	Green	NA

SPECIES LIST	**FAMILY**	**LIFE FORM**	**ECOLOGICAL GUILD**	**STAR RATING**	**IUCN STATUS**
Dracaena arborea	Agavaceae	Tree	Pioneer	Green	NA
Eclipta prostrata	Compositae	Shrub	NF/WP	NE	DD
Elaeis guineensis	Palmae	Tree	Pioneer	Pink	NA
Ficus sp.	Moraceae	Tree	Pioneer	Green	NA
Flagellaria guineensis	Flagellariaceae	Climber	Pioneer	Green	NA
Fuirena umbellata	Cyperaceae	Herb	NF/WP	NE	LC
Funtumia africana	Apocynaceae	Tree	NPLD	Green	NA
Funtumia elastica	Apocynaceae	Tree	NPLD	Pink	NA
Griffonia simplicifolia	Caesalpiniaceae	Climber	NPLD	Green	NA
Hallea stipulosa	Rubiaceae	Tree	Swamp	Red	V
Harungana madagascariensis	Guttiferae	Tree	Pioneer	Green	NA
Hyparrhenia mutica	Gramineae	Herb	NE	NE	NA
Hypselodelphys violaceae	Marantaceae	Climber	Pioneer	Green	NA
Ipomoea involucrata	Convolvulaceae	Climber	NF/WP	NE	NA
Ipomoea pes-caprae	Convolvulaceae	Climber	NF/WP	NE	NA
Remirea maritima	Cyperaceae	Herb	NF/WP	NE	NA
Laccosperma opacum	Palmae	Climber	NPLD	Pink	NA
Lonchocarpus sericeus	Papilionaceae	Tree	NE	NE	NA
Lygodium microphyllum	Pteridaceae	Climber	NE	Green	LC
Macaranga barteri	Euphorbiaceae	Tree	Pioneer	Green	NA
Mangifera indica	Anacardiaceae	Tree	NF/SP	NE	DD
Morinda morindoides	Rubiaceae	Climber	NPLD	Green	NA
Nephrolepis biserrata	Pteridaceae	Herb	NE	Green	NA
Newbouldia laevis	Bignoniaceae	Tree	Pioneer	Green	NA
Oldenlendia corymbosa	Rubiaceae	Shrub	NF/WP	NE	NA
Paspalum conjugatum	Gramineae	Herb	NF/WP	NE	LC
Passiflora foetida	Passifloraceae	Climber	NF/WP	NE	NA
Phyllanthus muellerianus	Euphorbiaceae	Climber	Pioneer	Green	NA
Pneumatopteris afer	Pteridaceae	Herb	NE	Green	NA
Psychotria sp.	Rubiaceae	Shrub	NF/WP	NE	NA
Psydrax subcordata	Rubiaceae	Tree	Pioneer	Green	NA
Pterocarpus santalinoides	Papilionaceae	Tree	Swamp	Green	LC

SPECIES LIST	FAMILY	LIFE FORM	ECOLOGICAL GUILD	STAR RATING	IUCN STATUS
Pycnanthus angolensis	Myristicaceae	Tree	NPLD	Pink	NA
Pycnocoma macrophylla	Euphorbiaceae	Shrub	SB	Green	NA
Raphia hookeri	Palmae	Tree	Pioneer	NE	NA
Rauvolfia vomitoria	Apocynaceae	Tree	Pioneer	Green	NA
Richardia brasiliensis	Rubiaceae	Herb	NE	NE	NA
Scleria verrucosa	Cyperaceae	Herb	Pioneer	Green	NA
Selaginella myosorus	Pteridaceae	Herb	NE	Green	NA
Smilax kraussiana	Smilacaceae	Climber	Pioneer	Green	NA
Solanum verbascifolium	Solanaceae	Tree	Pioneer	Green	NA
Solenostemon monostachyus	Lamiaceae	Shrub	NF/WP	NE	NA
Spathodea campanulata	Bignoniaceae	Tree	Pioneer	Green	NA
Spondias mombin	Anacardiaceae	Tree	NE	Green	NA
Sporobolus pyramidalis	Gramineae	Herb	NF/WP	NE	NA
Sporobolus virginicus	Gramineae	Herb	NF/WP	NE	NA
Stachytarpheta indica	Verbenaceae	Shrub	NF/WP	NE	NA
Sterculia tragacantha	Sterculiaceae	Tree	Pioneer	Green	NA
Syzygium guineense	Myrtaceae	Tree	NE	Blue	NA
Tetracera alnifolia	Dilleniaceae	Climber	NE	Green	NA
Trichilia prieureana	Meliaceae	Tree	NPLD	Green	NA
Triclisia patens	Menispermaceae	Climber	NE	Green	NA
Triumfetta cordifolia	Tiliaceae	Tree	NF/SP	NE	NA
Triumfetta rhomboidea	Tiliaceae	Shrub	NE	NE	NA
Voacanga africana	Apocynaceae	Tree	Pioneer	Green	NA
Waltheria indica	Sterculiaceae	Shrub	NF/WP	NE	NA

Table B.24 Continued: floristic composition and frequency distribution of species AoI (wet season)

SPECIES LIST	P 1	P 2	P 3	P 4	P 5	S 1	S 2	S 3	S 4	S 5
Acacia kamerunensis	0	0	0	0	0	1	0	0	0	0
Acridocarpus smeathmanii	0	0	0	1	0	1	1	0	0	0
Aframomum sp.	0	0	0	0	0	0	0	0	0	1
Agelea trifolia	0	0	0	0	0	1	0	0	0	0
Albizia adianthifolia	0	0	0	0	0	1	0	0	0	0
Albizia ferruginea	0	0	1	0	0	0	1	0	0	0
Alchornea cordifolia	1	1	1	1	1	0	0	0	0	0
Anthocleista djalonensis	1	0	1	0	0	0	0	1	0	0
Asystasia calycina	0	0	0	0	1	0	0	0	1	1
Baissea multiflora	0	0	0	0	0	1	0	0	0	0
Bambusa vulgaris	0	0	1	0	0	0	0	0	0	0
Baphia nitida	0	1	0	1	1	1	1	0	0	0
Baphia pubescens	0	1	0	1	0	0	1	0	0	0
Blighia sapida	0	0	0	0	0	0	1	0	0	0
Carapa procera	0	0	1	0	0	1	0	1	0	0
Cassytha filiformis	0	0	0	0	0	0	1	0	0	0
Chromolaena odorata	0	0	0	0	0	0	0	1	0	0
Cleistopholis patens	1	0	0	0	0	0	0	1	0	0
Cnestis ferruginea	0	0	0	0	0	1	1	0	0	0
Cocos nucifera	0	0	0	0	1	0	0	0	0	0
Cola sp.	0	0	0	0	0	0	0	1	0	0
Combretum racemosum	0	0	0	0	1	0	0	0	0	0
Crinum ornatum	0	0	0	0	0	0	0	1	0	0
Croton lobatus	0	0	0	0	0	0	1	0	0	0
Cyrtosperma senegalensis	0	0	1	0	0	0	0	1	0	1
Desmodium adscendens	0	0	0	0	0	0	0	0	1	1
Dichapetallum madagascariensis	0	1	0	0	0	0	0	0	0	0
Diodia vaginalis	0	0	0	0	0	0	0	0	1	0
Diospyros monbutensis	0	1	0	0	0	0	0	0	0	0
Dissotis rotundifolia	0	0	0	0	1	0	1	0	0	0

SPECIES LIST	P 1	P 2	P 3	P 4	P 5	S 1	S 2	S 3	S 4	S 5
Dracaena arborea	0	0	0	0	0	1	0	0	0	0
Eclipta prostrata	0	0	0	0	0	0	0	0	0	1
Elaeis guineensis	0	1	1	0	1	1	0	0	0	1
Ficus sp.	0	0	0	0	0	0	0	0	0	1
Flagellaria guineensis	0	0	0	0	0	1	1	0	0	0
Fuirena umbellata	1	0	0	1	0	0	0	0	0	1
Funtumia africana	0	0	0	0	0	1	0	0	0	0
Funtumia elastica	0	0	0	0	0	1	0	0	0	0
Griffonia simplicifolia	0	0	0	0	0	1	0	0	0	0
Hallea stipulosa	1	0	0	0	0	0	0	0	0	0
Harungana madagascariensis	0	1	0	0	0	0	0	0	0	0
Hyparrhenia mutica	0	1	0	0	1	0	0	0	0	0
Hypselodelphys violaceae	0	0	0	0	0	1	0	0	0	0
Ipomoea involucrata	0	0	1	0	1	0	0	0	0	0
Ipomoea pes-caprae	0	0	0	1	0	0	0	0	0	0
Remirea maritima	0	0	0	0	0	0	0	0	1	0
Laccosperma opacum	0	1	1	0	0	0	0	0	0	0
Lonchocarpus sericeus	0	0	0	1	0	0	0	0	0	0
Lygodium microphyllum	0	0	0	0	0	0	0	1	0	0
Macaranga barteri	0	0	0	0	0	0	1	0	0	0
Mangifera indica	0	0	0	0	1	0	1	0	0	0
Morinda morindoides	0	1	0	0	0	0	0	0	0	0
Nephrolepis biserrata	0	1	0	0	1	0	0	0	0	0
Newbouldia laevis	0	0	0	0	0	1	0	0	0	0
Oldenlendia corymbosa	0	0	0	0	1	0	0	0	0	0
Paspalum conjugatum	0	0	0	1	0	0	0	0	0	0
Passiflora foetida	0	0	0	0	0	0	0	0	1	0
Phyllanthus muellerianus	0	0	0	0	0	0	0	0	0	1
Pneumatopteris afer	0	0	0	0	0	0	0	0	0	1
Psychotria sp.	1	0	0	0	0	0	0	1	0	0
Psydrax subcordata	0	0	0	0	0	1	0	0	0	0
Pterocarpus santalinoides	0	0	1	0	0	0	0	0	0	0

SPECIES LIST	P 1	P 2	P 3	P 4	P 5	S 1	S 2	S 3	S 4	S 5
Pycnanthus angolensis	1	0	0	0	0	0	0	0	0	0
Pycnocoma macrophylla	0	0	0	0	0	1	0	0	0	0
Raphia hookeri	1	0	0	0	0	1	0	0	0	1
Rauvolfia vomitoria	0	0	1	0	0	0	1	0	0	0
Richardia brasiliensis	0	0	0	0	1	0	0	0	0	0
Scleria verrucosa	0	1	0	0	0	0	1	0	0	0
Selaginella myosorus	0	1	0	0	1	0	1	0	0	0
Smilax kraussiana	0	0	0	0	0	1	0	0	0	0
Solanum verbascifolium	0	0	0	1	0	0	0	0	0	0
Solenostemon monostachyus	0	1	0	0	0	0	1	0	0	0
Spathodea campanulata	0	0	0	0	1	0	0	0	0	0
Spondias mombin	0	0	0	0	0	1	0	0	0	0
Sporobolus pyramidalis	0	1	0	0	0	0	0	0	0	0
Sporobolus virginicus	0	0	0	1	0	0	0	0	0	0
Stachytarpheta indica	0	0	0	0	0	0	0	0	1	0
Sterculia tragacantha	0	0	0	0	0	1	0	0	0	0
Syzygium guineense	0	1	0	1	0	0	0	0	0	0
Tetracera alnifolia	0	0	0	0	0	1	0	0	0	0
Trichilia prieureana	0	0	0	0	0	1	0	0	0	0
Triclisia patens	0	0	0	0	0	1	0	0	0	0
Triumfetta cordifolia	0	0	0	0	0	0	1	0	0	0
Triumfetta rhomboidea	0	0	0	0	1	0	0	0	1	0
Voacanga africana	0	0	0	0	0	0	1	0	0	0
Waltheria indica	0	0	0	0	1	0	1	0	0	0
	8	16	11	11	17	25	19	9	7	11

Note: P1-5 and S1-5 refer to the sampling locations

Table B.25 Sample plots location and description (dry and wet season)

SAMPLE CODES	LOCATION (Long / Lat)	DESCRIPTION
S 1	N 04°58’09.05” W 002°27’11.9”	Secondary Thicket
S 2	N 04°58’07.9” W 002°27’08.3”	Undergrowth of Coconut plantation
S 3	N 04°57’58.6” W 002°26’53.0”	Farmland (Cleared area in coconut plantation with pineapple and rubber cultivated)
S 4	N 04°57’56.2” W 002°26’51.2”	Fresh water swamp with raphia
S 5	N 04°58’01.0” W 002°26’32.6”	Secondary Thicket (Abandoned coconut plantation)
S 6	N 04°57’49.5” W 002°27’06.2”	Swamp forest
S 7	N 04°57’51.1” W 002°26’57.2”	Oil palm / Coconut plantation (cleared area) / Thicket clump
S 8	N 04°57’50.7” W 002°26’28.2”	Abandoned coconut plantation / Secondary forest

Table B.26 Location and description of transect plots (10 x 10 m) (dry and wet season)

TRANSECT CODES	LOCATION (Long / Lat)	DESCRIPTION
T 1	N 04°57’29.3” W 022°26’54.4”	Strand
T 2	N 04°57’30.3” W 002°26’54.3”	Coconut
T 3	N 04°57’31.1” W 002°26’54.3”	Coconut
T 4	N 04°57’31.6” W 002°26’54.2”	Swamp
T 5	N 04°57’32.4” W 002°26’54.1”	Thicket
T 6	N 04°57’33.1” W 002°26’54.1”	Swamp forest / Thicket

Table B.27 Checklist of vascular plant species recorded at the study area (wet season)

Species list	Family	Life form	Ecological Guild	Star Rating	IUCN Threatened Status	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	T 1	T 2	T 3	T4	T 5	T6
Abrusprecatorious	Papilionaceae	Climber	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Acridocarpusalternifolius	Malpighiaceae	Climber	NPLD	Green	NA	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Acridocarpussmeathmaniii	Malpighiaceae	Climber	NE	Green	NA	0	0	1	0	1	0	0	1	0	0	0	0	0	0
Adenialobata	Passifloraceae	Climber	Pioneer	Green	NA	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Aframomumelliotii	Zingiberaceae	Herb	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Ageleanitida	Connaraceae	Climber	NE	NE	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Albiziaadianthifolia	Mimosaceae	Tree	NPLD	Green	LC	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Albiziaferruginea	Mimosaceae	Tree	NPLD	Scarlet	V	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Albiziazygia	Mimosaceae	Tree	NPLD	Green	NA	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Alchorneacordifolia	Euphorbiaceae	Tree	Pioneer	Green	NA	1	1	1	1	1	1	0	1	0	0	0	1	0	1
Alstoniaboonei	Apocynaceae	Tree	Pioneer	Green	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Alternantherasessilis	Amaranthaceae	Shrub	NF/WP	NE	LC	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Anchomanesdifformis	Araceae	Herb	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Anthocleistanobilis	Loganiaceae	Tree	Pioneer	Green	NA	1	1	0	1	1	1	0	0	0	0	0	0	0	0
Aspilia Africana	Compositae	Climber	NF/WP	NE	NA	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Asystasiacalycina	Acanthaceae	Shrub	Pioneer	Green	NA	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Baphianitida	Papilionaceae	Tree	SB	Green	LC	1	1	1	0	1	0	1	0	0	0	0	0	0	1

Species list	Family	Life form	Ecological Guild	Star Rating	IUCN Threatened Status	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	T 1	T 2	T 3	T4	T 5	T6
Baphiapubescens	Papilionaceae	Tree	Pioneer	Green	NA	1	1	1	0	1	0	1	1	0	0	0	0	0	0
Blighiasapida	Sapindaceae	Tree	NPLD	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Blighiawelwitschii	Sapindaceae	Tree	NPLD	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombaxbuonopozense	Bombacaceae	Tree	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Borreriascabra	Rubiaceae	Shrub	Pioneer	Green	NA	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Brideliaferruginea	Euphorbiaceae	Tree	NF/SP	NE	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Brideliamicrantha	Euphorbiaceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Buchholziacoriacea	Capparaceae	Tree	SB	Green	NA	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Byrsocarpuscoccineus	Connaraceae	Shrub	Pioneer	Green	NA	1	0	1	0	1	0	1	0	0	0	0	0	0	0
Canariumschweinfurthii	Burseraceae	Tree	Pioneer	Pink	NA	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Carpolobialutea	Polygalaceae	Shrub	SB	Green	NA	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Cassythafiliformis	Lauraceae	Climber	NE	NE	NA	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Ceibapentandra	Bombacaceae	Tree	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Chromolaenaodarata	Compositae	Shrub	Pioneer	Green	NA	1	1	1	0	1	0	1	1	0	0	0	0	0	0
Cleistopholis patens	Annonaceae	Tree	Pioneer	Green	NA	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Cnestisferruginea	Connaraceae	Climber	Pioneer	NE	NA	1	1	1	0	1	0	0	1	0	0	0	0	0	0
Coffeaafzelii	Rubiaceae	Climber	SB	Blue	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Coffeamacrochlamys	Rubiaceae	Shrub	NE	Gold	V	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cola millenii	Sterculiaceae	Tree	NPLD	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Combretumracemosum	Combretaceae	Climber	Pioneer	Green	NA	1	1	1	0	0	0	1	1	0	0	0	0	0	0
Commelinaafricana	Commelinaceae	Herb	Pioneer	Green	LC	0	0	1	0	0	0	0	0	1	0	1	0	0	0
Commelinaerecta	Commelinaceae	Herb	Pioneer	Green	LC	1	0	0	0	0	0	0	0	1	1	0	0	0	0
Crinum jagus	Amaryllidaceae	Herb	Swamp	Blue	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Crotalaria retusa	Papilionaceae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Croton lobatus	Euphorbiaceae	Shrub	NF/WP	NE	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cyperusrotundus	Cyperaceae	Herb	NF/WP	NE	LC	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Cyrtospermasenegalense	Araceae	Herb	NE	Green	LC	0	0	0	1	0	1	0	0	0	0	0	1	1	1
Dalbergiahostilis	Papilionaceae	Climber	NPLD	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dalbergiasaxatilis	Papilionaceae	Climber	NE	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Deinbolliapinnata	Sapindaceae	Tree	NPLD	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Desmodiumadscendens	Papilionaceae	Shrub	NE	Green	LC	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Desmodiumgangeticum	Papilionaceae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichapetallumangolense	Dichapetalaceae	Climber	NPLD	Green	NA	0	0	1	0	0	0	1	1	0	0	0	0	0	0
Dichapetalumpallidum	Dichapetalaceae	Climber	SB	Green	NA	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Diocleareflexa	Papilionaceae	Climber	Pioneer	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Diospyrosmonbuttensis	Ebenaceae	Tree	SB	Green	NA	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Dissotisgrandiflora	Melastomataceae	Herb	Pioneer	NE	NA	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Dissotisrotundifolia	Melastomataceae	Shrub	Pioneer	Green	NA	0	0	1	0	1	0	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Dracaena arborea	Agavaceae	Tree	Pioneer	Green	NA	1	0	1	0	1	0	0	1	0	0	0	0	0	0
Ecliptaprostrata	Compositae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Elaeisguineensis	Palmae	Tree	Pioneer	Pink	NA	1	1	1	0	1	0	0	1	0	0	0	0	0	0
Ficus sp.	Moraceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Flacourtiaflavescens	Flacourtiaceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Flagellariaguineensis	Flagallariaceae	Climber	Pioneer	Green	NA	0	1	1	0	1	0	1	1	0	0	0	0	0	0
Funtumiaafricana	Apocynaceae	Tree	Pioneer	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Glyphaeabrevis	Tiliaceae	Tree	SB	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Griffoniasimplicifolia	Caesalpiniaceae	Climber	NPLD	Green	NA	1	1	1		1	0	0	0	0	0	0	0	0	0
Halleastipulosa	Rubiaceae	Tree	Swamp	Red	V	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Harunganamadagascariensis	Guttiferae	Tree	Pioneer	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Heisteriaparvifolia	Olacaceae	Tree	SB	Green	NA	1	1	1	1	1	0	0	1	0	0	0	0	0	0
Holarrhena floribunda	Apocynaceae	Tree	Pioneer	Green	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Homaliumletestui	Flacourtiaceae	Tree	NPLD	Green	NA	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Hoslundiaopposita	Labiatae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Hugoniarufipilis	Linaceae	Climber	NPLD	Blue	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ipomoea asarifolia	Convolvulaceae	Climber	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ipomoea mauritana	Convolvulaceae	Climber	NF/WP	NE	NA	0	1	0	0	0	1	0	0	0	0	1	0	0	0
Ipomoea pes-caprae	Convolvulaceae	Climber	NE	NE	NA	0	0	0	0	0	0	0	0	1	1	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Ipomoea surattensis	Convolvulaceae	Climber	NF/WP	NE	NA	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Kyllingapumila	Cyperaceae	Herb	NF/WP	NE	NA	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Landolphiadulcis	Apocynaceae	Climber	NPLD	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Lanneaacida	Anacardiaceae	Tree	NF/SP	NE	NA	1	0	1	0	1	0	1	1	0	0	0	0	0	0
Lanneawelwitschii	Anacardiaceae	Tree	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lygodiummicrophyllum	Fern	Herb	NE	Green	LC	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Macarangahurifolia	Euphorbiaceae	Tree	Pioneer	Green	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Macarangabarteri	Euphorbiaceae	Tree	Pioneer	Green	NA	0	1	0	0	1	0	0	1	0	0	0	0	0	0
Mallotusoppositifolius	Euphorbiaceae	Tree	SB	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Mangiferaindica	Anacardiaceae	Tree	NF/SP	NE	DD	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Manihotesculenta	Euphorbiaceae	Shrub	NE	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Manniophytonfulvum	Euphorbiaceae	Climber	NPLD	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Manoteslongiflora	Connaraceae	Climber	NE	Green	NA	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Margaritariadiscoidea	Euphorbiaceae	Tree	Pioneer	Green	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mariscuslongibracteatus	Cyperaceae	Herb	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mezoneuronbenthamianum	Caesalpiniaceae	Climber	Pioneer	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Microdesmispuberula	Pandaceae	Tree	SB	Green	NA	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Millettiabarteri	Papilionaceae	Climber	Swamp	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Millettiazechiana	Papilionaceae	Tree	Pioneer	Green	LC	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Monodoratenuifolia	Annonaceae	Tree	Pioneer	Green	NA	1	0	0	0	1	0	0	0	0	0	0	1	1	1
Morindalucida	Rubiaceae	Tree	Pioneer	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Morindamorindoides	Rubiaceae	Climber	NPLD	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Mussaendaerythrophylla	Rubiaceae	Climber	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nephrolepisbiserrata	Fern	Herb	NE	Green	NA	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Newbouldialaevis	Bignoniaceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Oplismenusburmanii	Gramineae	Herb	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ourateasulcata	Ochnaceae	Shrub	SB	Green	NA	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Pandanus candelabrum	Pandaceae	Tree	Swamp	Blue	NA	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Parkiabicolor	Mimosaceae	Tree	NPLD	Green	LC	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Paullina pinnata	Sapindaceae	Climber	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pentaclethramacrophylla	Mimosaceae	Tree	NPLD	Green	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pentodonpentandrus	Rubiaceae	Shrub	NF/WP	NE	LC	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Perotisindica	Gramineae	Herb	Pioneer	NE	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Phyllanthusniruroides	Euphorbiaceae	Herb	NE	NE	NA	0	1	0	0	0	1	0	0	0	0	1	1	1	1
Pneumatopterisafer	Fern	Herb	NE	Green	NA	0	0	0	1	0	0	0	0	0	0	0	1	0	1
Premnaquadrifolia	Verbanaceae	Climber	Pioneer	Blue	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Psychotriayapoensis	Rubiaceae	Shrub	NE	NE	NA	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Pycnanthusangolensis	Myristicaceae	Tree	NPLD	Pink	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Species list	Family	Life form	Ecological Guild	Star Rating	IUCN Threatened Status	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	T 1	T 2	T 3	T4	T 5	T6
Rafiahookeri	Palmae	Tree	Swamp	Green	NA	0	0	0	1	0	1	0	0	0	0	0	0	1	1
Rauvolfiacumminsii	Apocynaceae	Shrub	SB	Blue	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Rauvolfiavomitoria	Apocynaceae	Tree	Pioneer	Green	NA	1	1	1	0	1	0	0	1	0	1	1	0	0	0
Sansevierialiberica	Agavaceae	Herb	NE	Blue	NA	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Scleriaboivinii	Cyperaceae	Herb	Pioneer	Green	NA	1	0	1	1	1	1	1	1	0	0	0	0	0	0
Scleriaverticellata	Cyperaceae	Herb	Pioneer	Green	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Selaginellamyosorus	Fern	Herb	NE	Green	NA	1	1	1	0	1	0	1	1	0	0	0	0	0	0
Setariabarbata	Gramineae	Herb	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Sidalinifolia	Malvaceae	Herb	NE	NE	NA	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Smeathmanniapubescens	Passifloraceae	Tree	SB	Green	NA	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Smilax kraussiana	Smilacaceae	Climber	Pioneer	Green	NA	1	1	1	1	1	0	0	1	0	0	0	0	0	0
Solenangisscandens	Orchidaceae	Herb	NE	Green	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solenostemonmonostachyus	Labiatae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Spermacoceverticillata	Rubiaceae	Shrub	NE	NE	NA	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sporoboluspyramidalis	Gramineae	Herb	NF/WP	NE	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Stachytaphetaindica	Verbanaceae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sterculiaoblonga	Sterculiaceae	Tree	NPLD	Green	NA	1	1	1	0	1	0	0	1	0	0	0	0	0	0
Sterculiatragacantha	Sterculiaceae	Tree	Pioneer	Green	NA	1	1	1	0	0	0	1	1	0	0	0	0	0	0
Symphoniaglobulifera	Guttiferae	Tree	Swamp	Green	NA	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Syzygiumguineense var. littorale	Myrtaceae	Tree	NE	Blue	NA	1	0	1	0	1	0	0	0	1	1	1	0	0	1
Tabanaemontanacrassa	Apocynaceae	Tree	SB	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Talinumtriangulare	Portulaceae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Tetraceraalnifolia	Dilleniaceae	Climber	NE	Green	NA	1	1	0	0	1	1	0	0	0	0	0	0	0	0
Tetraceradinklagii	Dilleniaceae	Climber	NE	Blue	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Tristemmahirtum	Melastomataceae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Triumfettacordifolia	Tiliaceae	Shrub	NF/WP	NE	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Triumfettarhomboidea	Tiliaceae	Shrub	NE	NE	NA	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Uapacatogoensis	Euphorbiaceae	Tree	NF/WP	NE	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Uvariaafzelii	Annonaceae	Climber	NPLD	Green	NA	1	0	1	0	1	0	0	0	0	0	0	0	0	0
Uvariachamae	Annonaceae	Climber	NE	Blue	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitexdoniana	Verbanaceae	Tree	NF/SP	NE	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Voacangaafricana	Apocynaceae	Tree	Pioneer	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Waltheriaindica	Sterculiaceae	Shrub	NF/WP	NE	NA	1	0	1	0	0	0	1	1	0	0	0	0	0	0
Xylopiarubescens	Annonaceae	Tree	Swamp	Gold	NA	0	1	0	0	1	1	0	0	0	0	0	0	0	0
Xylopiastaudtii	Annonaceae	Tree	SB	Green	NA	1	0	0	1	0	0	0	1	0	0	0	0	0	0
Zanthoxylumzanthoxyloides	Rutaceae	Tree	NF/SP	NE	NA	0	1	0	0	0	0	0	0	0	1	0	0	0	0
						66	54	43	21	38	24	18	30	9	12	10	8	5	10

Table B.28 Checklist of vascular plant species recorded at the study area (dry season)

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Abrusprecatorious	Papilionaceae	Climber	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Acridocarpusalternifolius	Malpighiaceae	Climber	NPLD	Green	NA	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Acridocarpussmeathmaniii	Malpighiaceae	Climber	NE	Green	NA	0	0	1	0	1	0	0	1	0	0	0	0	0	0
Adenialobata	Passifloraceae	Climber	Pioneer	Green	NA	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Aframomumelliotii	Zingiberaceae	Herb	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Ageleanitida	Connaraceae	Climber	NE	NE	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Albiziaadianthifolia	Mimosaceae	Tree	NPLD	Green	LC	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Albiziaferruginea	Mimosaceae	Tree	NPLD	Scarlet	V	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Albiziazygia	Mimosaceae	Tree	NPLD	Green	NA	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Alchorneacordifolia	Euphorbiaceae	Tree	Pioneer	Green	NA	1	1	1	1	1	1	0	1	0	0	0	1	0	1
Alstoniaboonei	Apocynaceae	Tree	Pioneer	Green	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Alternantherasessilis	Amaranthaceae	Shrub	NF/WP	NE	LC	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Anchomanesdifformis	Araceae	Herb	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Anthocleistanobilis	Loganiaceae	Tree	Pioneer	Green	NA	1	1	0	1	1	1	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Aspilia Africana	Compositae	Climber	NF/WP	NE	NA	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Asystasiacalycina	Acanthaceae	Shrub	Pioneer	Green	NA	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Baphianitida	Papilionaceae	Tree	SB	Green	LC	1	1	1	0	1	0	1	0	0	0	0	0	0	1
Baphiapubescens	Papilionaceae	Tree	Pioneer	Green	NA	1	1	1	0	1	0	1	1	0	0	0	0	0	0
Blighiasapida	Sapindaceae	Tree	NPLD	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Blighiawelwitschii	Sapindaceae	Tree	NPLD	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombaxbuonopozense	Bombacaceae	Tree	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Borreriascabra	Rubiaceae	Shrub	Pioneer	Green	NA	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Brideliaferruginea	Euphorbiaceae	Tree	NF/SP	NE	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Brideliamicrantha	Euphorbiaceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Buchholziacoriacea	Capparaceae	Tree	SB	Green	NA	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Byrsocarpuscoccineus	Connaraceae	Shrub	Pioneer	Green	NA	1	0	1	0	1	0	1	0	0	0	0	0	0	0
Canariumschweinfurthii	Burseraceae	Tree	Pioneer	Pink	NA	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Carpolobialutea	Polygalaceae	Shrub	SB	Green	NA	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Cassythafiliformis	Lauraceae	Climber	NE	NE	NA	0	0	1	0	0	0	1	0	0	0	0	0	0	0

Species list	Family	Life form	Ecological Guild	Star Rating	IUCN Threatened Status	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	T 1	T 2	T 3	T4	T 5	T6
Ceibapentandra	Bombacaceae	Tree	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Chromolaenaodarata	Compositae	Shrub	Pioneer	Green	NA	1	1	1	0	1	0	1	1	0	0	0	0	0	0
Cleistopholis patens	Annonaceae	Tree	Pioneer	Green	NA	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Cnestisferruginea	Connaraceae	Climber	Pioneer	NE	NA	1	1	1	0	1	0	0	1	0	0	0	0	0	0
Coffeaafzelii	Rubiaceae	Climber	SB	Blue	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Coffeamacrochlamys	Rubiaceae	Shrub	NE	Gold	V	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cola millenii	Sterculiaceae	Tree	NPLD	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Combretumracemosum	Combretaceae	Climber	Pioneer	Green	NA	1	1	1	0	0	0	1	1	0	0	0	0	0	0
Commelinaafricana	Commelinaceae	Herb	Pioneer	Green	LC	0	0	1	0	0	0	0	0	1	0	1	0	0	0
Commelinaerecta	Commelinaceae	Herb	Pioneer	Green	LC	1	0	0	0	0	0	0	0	1	1	0	0	0	0
Crinum jagus	Amaryllidaceae	Herb	Swamp	Blue	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Crotalaria retusa	Papilionaceae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Croton lobatus	Euphorbiaceae	Shrub	NF/WP	NE	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cyperusrotundus	Cyperaceae	Herb	NF/WP	NE	LC	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Cyrtospermasenegalense	Araceae	Herb	NE	Green	LC	0	0	0	1	0	1	0	0	0	0	0	1	1	1

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Dalbergiahostilis	Papilionaceae	Climber	NPLD	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dalbergiasaxatilis	Papilionaceae	Climber	NE	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Deinbolliapinnata	Sapindaceae	Tree	NPLD	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Desmodiumadscendens	Papilionaceae	Shrub	NE	Green	LC	0	1	0	0	0	0	0	0	1	0	1	0	0	1
Desmodiumgangeticum	Papilionaceae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichapetallumangolense	Dichapetalaceae	Climber	NPLD	Green	NA	0	0	1	0	0	0	1	1	0	0	0	0	0	0
Dichapetalumpallidum	Dichapetalaceae	Climber	SB	Green	NA	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Diocleareflexa	Papilionaceae	Climber	Pioneer	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Diospyrosmonbuttensis	Ebenaceae	Tree	SB	Green	NA	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Dissotisgrandiflora	Melastomataceae	Herb	Pioneer	NE	NA	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Dissotisrotundifolia	Melastomataceae	Shrub	Pioneer	Green	NA	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Dracaena arborea	Agavaceae	Tree	Pioneer	Green	NA	1	0	1	0	1	0	0	1	0	0	0	0	0	0
Ecliptaprostrata	Compositae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Elaeisguineensis	Palmae	Tree	Pioneer	Pink	NA	1	1	1	0	1	0	0	1	0	0	0	0	0	0
Ficus sp.	Moraceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Flacourtiaflavescens	Flacourtiaceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Flagellariaguineensis	Flagallariaceae	Climber	Pioneer	Green	NA	0	1	1	0	1	0	1	1	0	0	0	0	0	0
Funtumiaafricana	Apocynaceae	Tree	Pioneer	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Glyphaeabrevis	Tiliaceae	Tree	SB	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Griffoniasimplicifolia	Caesalpiniaceae	Climber	NPLD	Green	NA	1	1	1		1	0	0	0	0	0	0	0	0	0
Halleastipulosa	Rubiaceae	Tree	Swamp	Red	V	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Harunganamadagascariensis	Guttiferae	Tree	Pioneer	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Heisteriaparvifolia	Olacaceae	Tree	SB	Green	NA	1	1	1	1	1	0	0	1	0	0	0	0	0	0
Holarrhena floribunda	Apocynaceae	Tree	Pioneer	Green	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Homaliumletestui	Flacourtiaceae	Tree	NPLD	Green	NA	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Hoslundiaopposita	Labiatae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Hugoniarufipilis	Linaceae	Climber	NPLD	Blue	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ipomoea asarifolia	Convolvulaceae	Climber	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ipomoea mauritana	Convolvulaceae	Climber	NF/WP	NE	NA	0	1	0	0	0	1	0	0	0	0	1	0	0	0
Ipomoea pes-caprae	Convolvulaceae	Climber	NE	NE	NA	0	0	0	0	0	0	0	0	1	1	0	0	0	0

Species list	Family	Life form	Ecological Guild	Star Rating	IUCN Threatened Status	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	T 1	T 2	T 3	T4	T 5	T6
Ipomoea surattensis	Convolvulaceae	Climber	NF/WP	NE	NA	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Kyllingapumila	Cyperaceae	Herb	NF/WP	NE	NA	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Landolphiadulcis	Apocynaceae	Climber	NPLD	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Lanneaacida	Anacardiaceae	Tree	NF/SP	NE	NA	1	0	1	0	1	0	1	1	0	0	0	0	0	0
Lanneawelwitschii	Anacardiaceae	Tree	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lygodiummicrophyllum	Fern	Herb	NE	Green	LC	0	1	0	1	0	1	0	0	0	0	0	0	0	0
Macarangahurifolia	Euphorbiaceae	Tree	Pioneer	Green	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Macarangabarteri	Euphorbiaceae	Tree	Pioneer	Green	NA	0	1	0	0	1	0	0	1	0	0	0	0	0	0
Mallotusoppositifolius	Euphorbiaceae	Tree	SB	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Mangiferaindica	Anacardiaceae	Tree	NF/SP	NE	DD	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Manihotesculenta	Euphorbiaceae	Shrub	NE	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Manniophytonfulvum	Euphorbiaceae	Climber	NPLD	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Manoteslongiflora	Connaraceae	Climber	NE	Green	NA	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Margaritariadiscoidea	Euphorbiaceae	Tree	Pioneer	Green	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mariscuslongibracteatus	Cyperaceae	Herb	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Mezoneuronbenthamianum	Caesalpiniaceae	Climber	Pioneer	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Microdesmispuberula	Pandaceae	Tree	SB	Green	NA	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Millettiabarteri	Papilionaceae	Climber	Swamp	Green	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Millettiazechiana	Papilionaceae	Tree	Pioneer	Green	LC	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Monodoratenuifolia	Annonaceae	Tree	Pioneer	Green	NA	1	0	0	0	1	0	0	0	0	0	0	1	1	1
Morindalucida	Rubiaceae	Tree	Pioneer	Green	NA	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Morindamorindoides	Rubiaceae	Climber	NPLD	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Mussaendaerythrophylla	Rubiaceae	Climber	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nephrolepisbiserrata	Fern	Herb	NE	Green	NA	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Newbouldialaevis	Bignoniaceae	Tree	Pioneer	Green	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Oplismenusburmanii	Gramineae	Herb	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ourateasulcata	Ochnaceae	Shrub	SB	Green	NA	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Pandanus candelabrum	Pandaceae	Tree	Swamp	Blue	NA	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Parkiabicolor	Mimosaceae	Tree	NPLD	Green	LC	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Paullina pinnata	Sapindaceae	Climber	Pioneer	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Pentaclethramacrophylla	Mimosaceae	Tree	NPLD	Green	NA	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pentodonpentandrus	Rubiaceae	Shrub	NF/WP	NE	LC	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Perotisindica	Gramineae	Herb	Pioneer	NE	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Phyllanthusniruroides	Euphorbiaceae	Herb	NE	NE	NA	0	1	0	0	0	1	0	0	0	0	1	1	1	1
Pneumatopterisafer	Fern	Herb	NE	Green	NA	0	0	0	1	0	0	0	0	0	0	0	1	0	1
Premnaquadrifolia	Verbanaceae	Climber	Pioneer	Blue	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Psychotriayapoensis	Rubiaceae	Shrub	NE	NE	NA	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Pycnanthusangolensis	Myristicaceae	Tree	NPLD	Pink	NA	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Rafiahookeri	Palmae	Tree	Swamp	Green	NA	0	0	0	1	0	1	0	0	0	0	0	0	1	1
Rauvolfiacumminsii	Apocynaceae	Shrub	SB	Blue	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Rauvolfiavomitoria	Apocynaceae	Tree	Pioneer	Green	NA	1	1	1	0	1	0	0	1	0	1	1	0	0	0
Sansevierialiberica	Agavaceae	Herb	NE	Blue	NA	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Scleriaboivinii	Cyperaceae	Herb	Pioneer	Green	NA	1	0	1	1	1	1	1	1	0	0	0	0	0	0
Scleriaverticellata	Cyperaceae	Herb	Pioneer	Green	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Selaginellamyosorus	Fern	Herb	NE	Green	NA	1	1	1	0	1	0	1	1	0	0	0	0	0	0

Species list	**Family**	**Life form**	**Ecological Guild**	**Star Rating**	**IUCN Threatened Status**	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**	**S 6**	**S 7**	**S 8**	**T 1**	**T 2**	**T 3**	**T4**	**T 5**	**T6**
Setariabarbata	Gramineae	Herb	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Sidalinifolia	Malvaceae	Herb	NE	NE	NA	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Smeathmanniapubescens	Passifloraceae	Tree	SB	Green	NA	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Smilax kraussiana	Smilacaceae	Climber	Pioneer	Green	NA	1	1	1	1	1	0	0	1	0	0	0	0	0	0
Solenangisscandens	Orchidaceae	Herb	NE	Green	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solenostemonmonostachyus	Labiatae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	1	0	0	0	0
Spermacoceverticillata	Rubiaceae	Shrub	NE	NE	NA	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sporoboluspyramidalis	Gramineae	Herb	NF/WP	NE	NA	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Stachytaphetaindica	Verbanaceae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Sterculiaoblonga	Sterculiaceae	Tree	NPLD	Green	NA	1	1	1	0	1	0	0	1	0	0	0	0	0	0
Sterculiatragacantha	Sterculiaceae	Tree	Pioneer	Green	NA	1	1	1	0	0	0	1	1	0	0	0	0	0	0
Symphoniaglobulifera	Guttiferae	Tree	Swamp	Green	NA	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Syzygiumguineense var. littorale	Myrtaceae	Tree	NE	Blue	NA	1	0	1	0	1	0	0	0	1	1	1	0	0	1
Tabanaemontanacrassa	Apocynaceae	Tree	SB	Green	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Talinumtriangulare	Portulaceae	Shrub	NF/WP	NE	NA	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Species list	Family	Life form	Ecological Guild	Star Rating	IUCN Threatened Status	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	T 1	T 2	T 3	T4	T 5	T6
Tetraceraalnifolia	Dilleniaceae	Climber	NE	Green	NA	1	1	0	0	1	1	0	0	0	0	0	0	0	0
Tetraceradinklagii	Dilleniaceae	Climber	NE	Blue	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Tristemmahirtum	Melastomataceae	Shrub	NF/WP	NE	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Triumfettacordifolia	Tiliaceae	Shrub	NF/WP	NE	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Triumfettarhomboidea	Tiliaceae	Shrub	NE	NE	NA	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Uapacatogoensis	Euphorbiaceae	Tree	NF/WP	NE	NA	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Uvariaafzelii	Annonaceae	Climber	NPLD	Green	NA	1	0	1	0	1	0	0	0	0	0	0	0	0	0
Uvariachamae	Annonaceae	Climber	NE	Blue	NA	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitexdoniana	Verbanaceae	Tree	NF/SP	NE	NA	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Voacangaafricana	Apocynaceae	Tree	Pioneer	Green	NA	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Waltheriaindica	Sterculiaceae	Shrub	NF/WP	NE	NA	1	0	1	0	0	0	1	1	0	0	0	0	0	0
Xylopiarubescens	Annonaceae	Tree	Swamp	Gold	NA	0	1	0	0	1	1	0	0	0	0	0	0	0	0
Xylopiastaudtii	Annonaceae	Tree	SB	Green	NA	1	0	0	1	0	0	0	1	0	0	0	0	0	0
Zanthoxylumzanthoxyloides	Rutaceae	Tree	NF/SP	NE	NA	0	1	0	0	0	0	0	0	1	0	0	0	0	0
						66	54	43	21	38	24	18	30	9	12	10	8	5	10

B.3.2 Fauna

Table B.29 Wildlife species observed in AoI (dry season)

COMMON NAME	SCIENTIFIC NAME	NUMBERS RECORDED	IUCN STATUS	NATIONAL PROTECTION STATUS
Mammals, Squirrels and Rats				
Rope Squirrel	*Funisciurus pyrropus*	1	LC	Schedule III
Giant Gambian Rat**	*Cricetomys gambianus*	1	LC	Schedule III
Cane Rat / Grasscutter**	*Thryonomys swinderianus*	6	LC	Schedule III
Giant Forest Squirrel**	*Protoxerus stageri*	2	LC	Schedule III
Reptiles				
Black snake (Juvenile)	*Unidentified*	1	Unknown	Unknown
Birds				
Black Kite	*Milvus migrans parasites*	13	LC	Schedule I
Pied Crow	*Corvus albus*	7	LC	
African Pied Hornbill	*Tockus fasciatus*	4	LC	
Hooded Vulture	*Necrosyrtes monachus*	2	EN	
Shining Blue kingfisher	*Alcedo quadribrachys*	3	LC	
Red-Billed Dwarf Hornbill	*Tockus camurus*	5	LC	
Fire-Bellied Woodpecker	*Dendropicos pyrrhogaster*	2	LC	
Black Headed Oriole	*Oriolus brachyrhynchus*	1	LC	
Vieillot's Black Weaver **	*Ploceus nigerrimus*	120	LC	Schedule II

COMMON NAME	SCIENTIFIC NAME	NUMBERS RECORDED	IUCN STATUS	NATIONAL PROTECTION STATUS
Village Weaver**	*Ploceus cucullatus*	500	LC	Schedule II
Yellow-Mantled Weaver**	*Ploceus tricolor*	150	LC	Schedule II
Senegal Coucal	*Centropus grillii*	2	LC	Schedule I
Whimbrel	*Numenius phaeopus*	1	LC	
Western Reef Heron	*Egretta gularis*	2	LC	
Cattle egret	*Bubulcus ibis*	5	LC	

** Numbers estimated for observed population; *(LC= Least Concern; EN= Endangered)*

Table B.30 Small mammal capture checklist (wet season)

Species	Common Name	No. of Captures	% Occurrence
Mus musculoides	Pygmy Mouse	4	**50.0**
Praomys tullbergi	Soft-furred Mouse	3	**37.5**
Mastomys erythroleucus	Multimammate Mouse	1	**12.5**
Total Captures		**8**	**100**
No. of Species		**3**	

Table B.31 Other small mammals (rodents) recorded using oher methods (wet season)

Species	Common Name	Recording Method	Conservation Significance	
			Global (IUCN)	Ghana
Cricetomys gambianus	Giant Pouched Rat	DO/Int	LC	S2
Euxerus erythropus	Striped Ground Squirrel	DO/Int	LC	S2
Atherurus africanus	Brush- tailed Porcupine	DO/Int	LC	S2
Anomalurus beecrofti	Beecroft’s Flying Squirrel	DO/Int		S1
Epixerus ebii	Red-headed Forest Squirrel	DO/Int		S1

Table B.32 Checklist of large mammals recorded in the Western region

Common Name	Scientific Name	Conservation Significance	
		IUCN	National
PHOLIDOTA			
Manidae			
Giant pangolin	*Smutsia gigantean*	NT	S1
Long-tailed pangolin	*Manis tetradactyla*	LC	SI
Tree pangolin	*Phataginus tricuspis*	NT	SI
PRIMATES			
Galagonidae			
Senegal bushbaby (galago)	*Galago senegalensis*	LC	S1
Loridae			
Bosman’s potto	*Perodicticus potto*	LC	S1
Cercopithecidae			
Mona monkey	*Cercopithecus mona*		S2

Common Name	Scientific Name	Conservation Significance	
		IUCN	**National**
Spot-nosed monkey	*Cercopithecus petaurista*	LC	S2
Black-and-white colobus monkey	*Colobus polykomos*		S1
CARNIVORA			
Herpestidae			
Slender mongoose	*Herpestes sanguineus*	LC	S2
Marsh mongoose	*Atilax paludinosus*	LC	S2
Common cuisimanse	*Crossarchus obscurus*	LC	S2
Viverridae			
African civet	*Civettictis civetta*	LC	S2
African palm civet	*Nandinia binotata*	LC	S2
Common genet	*Genetta genetta*	LC	S2
Blotched genet	*Genetta tigrina*	LC	S2
ARTIODACTYLA			
Tragulidae			
Water Chevrotain	*Hyemoschus aquaticus*	LC	S2
Bovidae			
Royal Antelope	*Neotragus pygmaeus*	LC	S2
Maxwell's duiker	*Philantomba maxwellii*	LC	S2
Black duiker	*Cephalophus niger*	LC	S2
Bushbuck	*Tragelaphus scriptus*	LC	S2
HYRACOIDEA			
Tree Hyrax	*Dendrohyrax dorsalis*	NT	S2

IUCN = IUCN Conservation Status, **LC** = Least Concern, NT = Vulnerable,
National = National Protection Status: **First Schedule** = SI, **Second Schedule** = S2

Table B.33 Checklist of herpetofaunal species recorded and their conservation significance

Species	Common Name	Conservation Significance	
		IUCN	National
HERPETOFAUNA	**Reptiles/Amphibians**		
AMPHIBIA			
Phrynobatrachidae			
Phrynobatrachus latifrons	Ahl's River Frog	LC	
Bufonidae			
Amietophrynus maculates	Flat-backed Toad	LC	
Dicroglossidae			
Hoplobatrachus occipitalis	Crowned Bullfrog	LC	
Arthroleptidae			
Arthroleptis poecilonotus	West African Screeching Frog	LC	
Ptychadenidae			
Ptychadena bibroni	Broad-banded Grass Frog	LC	
Reptilia			
Chelonia	**Tortoises/Turtles/Terrapins**		
Pelomedusidae			
Pelomedusa subrufa	Marsh Terrapin		
Pelusios gabonensis	Gaboon Terrapin		S2
Squamata: *Lacertilia*	**Lizards**		
Agamidae			
Agama agama	Agama Lizard	LC	
Scincidae			

Species	Common Name	Conservation Significance	
		IUCN	National
Panaspis togoensis	Red-tailed Skink	LC	
Trachylepis perotettii	Orange-flanked Skink	LC	
Trachylepis affinis	Senegal Mabuya	LC	
Gekkonidae			
Hemidactylus brookii	Brook's House Gecko	LC	
Chamaeleonidae			
Chamaeleo gracilis	Graceful Chameleon		S2
Varanidae			
Varanus niloticus	Nile Monitor	LC	S1
Squamata: *Serpentes*	**Snakes**		
Boidae			
Python regius	Royal Python		
Python sebae	African Python	LC	S2
Colubridae			
Thelothornis kirtlandii	Twig Snake	LC	S5
Philothamnus semivariegatus	Green Tree Snake	LC	S5
Psammophis phillipsi	Olive Sand Snake	LC	S5
Boiga blandingii	Brown Tree Snake		
Grayia smythii	Water Snake		
Dasypeltis scabra	Egg-eating Snake		
Thelothornis kirtlandii	Twig Snake		
Elapidae			
Dendroaspis viridis	Green Mamba	LC	S5
Naja melanoleuca	Black Cobra	LC	S5
Viperidae			
Causus maculates	Night Adder	LC	S5
Bitis gabonica	Gaboon Viper		
Bitis nasicornis	Rhinoceros Viper		
Number of Species	**19**		

IUCN = IUCN Conservation Status, **LC** = Least Concern, NT = Vulnerable,
National = National Protection Status: **First Schedule** = SI, **Second Schedule** = S2

Table B.34 Checklist of avifaunal species recorded and their conservation significance (wet season)

Family	Common Name	Scientific Name	IUCN Status
Accipitridae	Yellow Bill Kite	*Milvus migrans parasites*	
	Hooded Vulture	*Necrosyrtes monachus*	EN
	African Goshawk	*Accipiter tachiro*	LC
Alcedinidae	Woodland Kingfisher	*Halcyon senegalensis*	LC
	Malachite Kingfisher	*Alcedo cristata*	
	Blue Breasted Kingfisher	*Halcyon malimbica*	LC
Apopidae	African Palm Swift	*Cypsiurus parvus*	LC
	Common Swift	*Apus apus*	LC
Ardeidae	Grey Heron	*Ardea cinerea*	LC
	Black Headed Heron	*Ardea melanocephala*	LC
	Intermediate Egret	*Egretta intermedia*	
Bucerotidae	African Pied Hornbill	*Torkus fasciatus*	
	White crested Hornbill	*Tropicranus albicristatus*	
Cisticolidae	Grey Backed Camaroptera	*Camaroptera brachyuran*	
	Twany-Flanked Prinia	*Prinia subflava*	LC
	Whistling Cisticola	*Cisticola lateralis*	LC
	Red Faced Cisticola	*Cisticola erythrops*	LC
Columbidae	Tambourine Dove	*Turtur tympanistria*	LC
	Laughing Dove	*Streptopelia senegalensis*	LC
	Red Eyed Dove	*Streptopelia semitorquata*	LC
	African Green Pigeon	*Treron calvus*	LC
Corvidae	Pied Crow	*Corvus albus*	LC

Family	Common Name	Scientific Name	IUCN Status
Cuculidae	Senegal Coucal	*Centropus senegalensis*	LC
	Klass's cuckoo	*Chrysococcyx klass*	
Estrildidae	Bronze Mannikin	*Spermestes cucullatus*	
	Orange Cheeked Waxbill	*Estrilda melpoda*	LC
	Bar Breasted Firefinch	*Lagonosticta rufopicta*	LC
	Blue Billed Firefinch	*Lagonosticta rubricata*	LC
	Western Bluebill	*Spermophaga haematina*	LC
Malaconotidae	Yellow Crowned Gonolek	*Laniarius barbarous*	
Meropidae	Rosy Bee-Eater	*Merops malimbicus*	LC
	White Throated Bee-Eater	*Merops albicollis*	LC
	Little Bee-Eater	*Merops pusillus*	LC
Motacillidae	African Pied Wagtail	*Motacilla aguimp*	LC
Musophagidae	Western Grey Plantain Eater	*Crenifer piscator*	
Nectariniidae	Green Headed Sunbird	*Cyanomitra verticalis*	
	Olive Sunbird	*Cyanomitra olivacea*	
	Copper Sunbird	*Cinnyris cupreus*	
Passeridae	Northern Grey Headed Sparrow	*Passer griseus*	LC
Picidae	Gabon Wood Pecker	*Dendropicos gabonensis*	LC
Platysteiridae	Common Wattle Eye	*Platysterira cyanea*	
Ploceidae	Village Weaver	*Ploceus cucullatus*	LC
	Black necked Weaver	*Ploceus nigricollis*	LC
	Northern Red Bishop	*Euplectus franciscanus*	
Pycnonotidae	Little Greenbul	*Andropadus virens*	LC
	Yellow Whiskered Greenbul	*Andropadus latirostris*	LC
	Grey Headed Bristlebill	*Bleda canicapillus*	LC
	Common Bulbul	*Pycnonotus barbatus*	LC

Family	Common Name	Scientific Name	IUCN Status
Scolopacidae	Little Stint	*Calidris minuta*	LC
Sturnidae	Splendid Glossy Starling	*Lamprotornis splendidus*	LC
Sylviidae	Green Hylia	*Hylia prasina*	LC
Turdidae	African Thrush	*Tardus pelios*	

EN- Endangered; LC- Least Concern; Empty cells- Data deficient

Table B.35 Relative Abundance of 10 Most Dominant Bird Species Recorded (wet season report)

Common names	Scientific name	Species Encounter	Relative Abundance %
Common Swift	*Apus apus*	63	19.0
Village Weaver	*Ploceus cucullatus*	53	16.0
African Palm Swift	*Cypsiurus parvus*	34	10.3
Orange Cheeked Waxbill	*Estrilda melpoda*	26	7.9
Red Eyed Dove	*Streptopelia semitorquata*	20	6.0
Little Bee-Eater	*Merops pusillus*	19	5.7
Pied Crow	*Corvus albus*	17	5.1
Common Bulbul	*Pycnonotus barbatus*	16	4.8
Yellow Bill Kite	*Milvus migrans parasites*	15	4.5

Table B.36 Species of Value for Local Livelihood and Economy (wet season report)

COMMON NAME	SCIENTIFIC NAME	VALUE FOR LOCAL LIVELIHOOD AND ECONOMY
Mammals		
Giant Forest Squirrel*	*Protoxerus stangeri*	Selling price: GH₵ 10.00
Rope Squirrel	*Funisciurus pyrropus*	Selling price: GH₵ 10.00

COMMON NAME	**SCIENTIFIC NAME**	**VALUE FOR LOCAL LIVELIHOOD AND ECONOMY**
Long tailed pangolin	*Uromanis tetradactyla*	Selling price: GHȻ 15.00
Royal Antelope	*Neotragus pygmaeus*	Selling price: GHȻ 25.00
Maxwell’s Duiker	*Cephalophus maxwelli*	Selling price: GHȻ 80.00
Ogilby’s Duiker	*Cephalophus ogilbyi*	Selling price: GHȻ 80.00
Black Duiker	*Cephalophus niger*	Selling price: GHȻ 80.00
Bushbuck	*Tragelaphus scriptus*	Selling price: GHȻ 300.00
Afrian Bush-Tailed Porcupine	*Atherurus africanan*	Rarely sold for money but is usually hunted for food. It is however not a preferred meat source by most people.
Giant Gambian Rat*	*Cricetomys gambianus*	Selling price: GHȻ 12.00
Cane Rat / Grasscutter*	*Thryonomys swinderianus*	Selling price: GHȻ 100.00
African Civet	*Viverra civetta*	Selling price: GHȻ 100.00
Egyptian Mongoose	*Herpestes ichneumon*	Selling price: GHȻ 25.00
Tree Dassie	*Dendrohyrax arboreus*	Selling price: GHȻ30.00
Black-and-White Colobus	*Colobus vellerosus*	Selling price: GHȻ 40.00
Olive Colobus	*Colobus (Procolobus) verus*	Selling price: GHȻ 40.00
Potto	*Perodicticus potto*	Selling price: GHȻ 80.00
Red River Hog	*Potamochoerus porcus pictus*	Selling price: GHȻ 120.00
Reptiles		
Nile Monitor	*Varanus niloticus ornatus*	Selling price: GHȻ 20.00

COMMON NAME	SCIENTIFIC NAME	VALUE FOR LOCAL LIVELIHOOD AND ECONOMY
African Python	*Python sebae*	Selling price: GH₵ 30.00
Black cobra	*Naja melanoleuca*	Not eaten or sold. Not a target for hunting.
Dwarf Crocodile	*Osteolaemus tetraspis*	Selling price: GH₵ 20.00
Nile Crocodile	*Crocodylus niloticus*	Selling price: GH₵ 50.00
Bell’s Hinged Tortoise	*Kinixys belliana nogueyi*	Selling price: GH₵ 5.00
Home’s Hinged Tortoise	*Kinixys homeana*	Selling price: GH₵ 5.00
West-African Mud Turtle	*Pelusios castaneus*	Selling price: GH₵ 2.00
Birds		
Black Kite	*Milvus migrans parasites*	Mainly as a sources of food.
Pied Crow	*Corvus albus*	Mainly as a sources of food.
African Pied Hornbill	*Tockus fasciatus*	Mainly as a sources of food.
Hooded Vulture	*Neophron nonachus*	None
Shining Blue kingfisher	*Alcedo quadrabrachys*	Mainly as a sources of food.
Red-Billed Dwarf Hornbill	*Tockus camurus*	Mainly as a sources of food.
Fire-Billed Woodpecker	*Mesopicos pyrrhogaster*	None
Black Headed Oriole	*Oriolus brachyrhynchus*	
Vieillot's Black Weaver	*Centropus grillii*	None
Vieillot's Black Weaver	*Ploceus nigerrimus*	None
Village Weaver	*Ploceus cucullatus*	None

COMMON NAME	SCIENTIFIC NAME	VALUE FOR LOCAL LIVELIHOOD AND ECONOMY
Yellow-Mantled Weaver	*Ploceus tricolor*	None
Whimbrel	*Numenius phaeopus*	May be used as a source of food. But not usually hunted.
Western Reef Heron	*Egretta gularis*	May be used as a source of food. But not usually hunted.
Cattle egret	*Bubulcus ibis*	None

Appendix B.2

B.4 SOCIAL AND HEALTH

Table B.37 Characteristics of the Ngalikpole Community

Characteristic	Description
History	Ngalikpole is believed to be one of the oldest communities in the Ellembelle District. The community was established around the 1400's by a woman named Kyeremadi. The people settled here to undertake fishing, farming and making sponge from tree barks as a packaging material for export. A third successor to the stool was called Ngale Ezoma Kpole, who was a herbalist. She prepared herbal medicine for women and helped many women to conceive and bear children. Over time, women who wanted to conceive came to the community for the herbal preparation. They would say they were going to Ngale Ezoma Kpole for herbal medicine. Hence, the community came to be known as Ngalikpole
Landscape/location	The topography of Ngalikpole is flat and sandy, with a long stretch of sandy beach. It is bordered in the west by Ngalichi in the, east by Eikwe, and in the north by Akpandue, A.B. Bokazo and Aloakpole.
Demographics	The community could not give an estimate of the total population size but reported an estimated total of 100 households. Residents are mainly from the Nzema, Ahanta, Fante and Ewe ethnic groups. The community consists of approximately 60 percent male and 40 percent females. The community has a young population, with an estimated 53 percent of the population being 18 years or younger. The economically active population (i.e. 18 to 59 years) makes up approximately 35 percent of the population.
Livelihood and Occupation	The economy of the area is largely based on fishing. Over 70 percent of the population are engaged in fishing activities, though some are also engaged in farming. Farmers have smallholdings due to scarcity of land. The slash and burn method is a common practice of land preparation in the community. The major cash crops grown are coconut and oil palm. Food crops such as cassava and maize are grown extensively both for subsistence and for cash. Petty trading, baking, poultry farming and piggery are the other forms of livelihood activities undertaken by the community.
Education and Skills	Overall, education levels in the community are considered to be low. It was reported that about a quarter of the adult population could not read or write. About 80 percent of the adult inhabitants of the community are unskilled.

Characteristic	Description
Social and health Infrastructure	Apart from a small kindergarten, the town does not have a primary school or JHS. Children attend school either at Ngalichi or Eikwe. Most of the houses are constructed of concrete walls and corrugated aluminium roofing. The community has no health post or clinic. One traditional birth attendant assists women to deliver their baby during an emergency. The town has one VIP toilet facility. Most inhabitants resort to open defecation. There are two waste disposal sites for the community. A borehole serves as the main source of potable water for the entire community. Motorbikes, taxis and mini-buses are the main means of transportation for the community.

Table B.38 Characteristics of the Ngalichi Community

Characteristics	Description
History	It is believed that the earliest settlers migrated from Shama and settled at Kprusi in the Ahanta West District before finally migrating to the present day Ngalichi.
Landscape/ location	Ngalichi is largely a rural community. The topography of the community is generally flat with a long stretch of open sandy beach. Bekuand Ngalikpole bound it on the west and east respectively. Akpandu and A.B. Bokazo communities lie to the north of Ngalichi.
Demographics	The population of the community is estimated to be 1100, which is made up of both Nzemas, and few Fantes. There are approximately 180 houses and an average household size of 6.1. The native Nzemas are both fishermen and farmers whilst the few Fantes are solely fishermen residing along the beach. The population increases during the major fishing season when migrant fishermen arrive from other inland communities.
Livelihood and occupation	Livelihood activities include fishing, fish mongering, farming, and informal trading. Farming is not lucrative in the area because their land is as fertile in comparison to surrounding communities. In addition, a small number of community members are formally employed with the Ghana Education Service.
Education and skills	Educational standards as well as the literacy rate were reported to be low.
Social and health Infrastructure	The community has a basic KG school with teachers' accommodation. Majority of the teaching staff in the school are untrained. The housing units in this town are predominantly constructed from mud and thatch roofed. Ngalichi has no health post. Medical care is accessed mainly form Eikwe Hospital. The community has no toilet facility. There is one functioning borehole and three hand-dug wells. The community has created a dumping site, although dumping solid waste in open spaces is very common in the community. The major cause of the unsanitary conditions in the community is lack of toilet and waste disposal facilities.

Table B.39 Characteristics of the Beku Community

Characteristic	Description
History	Beku is one of the oldest communities in the Ellembelle district. It is believed that that the original inhabitants migrated from Effiduase in the Ashanti to Beku in the 17th century. According to the Chief, when one of the two women who originally settled died, the sole survivor lamented that " bako ye ya" (meaning it is painful to be alone) hence the name Beku. People in Beku were originally salt producing people and had direct trade relations with the Europeans. Moreover, due to its natural harbour, the community served as the main route to Tarkwa and Prestea where mining and timber business were carried out.
Landscape/ location	Beku is located on a flat open sandy beach. The community is bound to the west by Anonki, to the East by Ngalechi and to the north by Menzezor and Aloakpole.
Demographics	There are three main ethnic groups in the community, namely Nzemas, Fantes and Ewes. The community has estimated its population at around 1,170 with the native Nzemas representing over 80% of the population. The Nzemas are both farmers and fishermen while the Fantes and the Ewes are predominantly fishermen. There are estimated to be approximately 120 houses in the community (which suggests a high average household size if the population estimate is accurate).
Livelihood and occupation	Fishing (70%), farming (20%) and petty trading (8%) are the prominent livelihood activities undertaken in the community. Crops cultivated by farmers include coconuts, oil palm, pineapple, cassava, maize, and vegetables. Teaching and nursing were cited as options for formal employment taken by some community members. People reported to spending their income mainly on food, education and health. It was reported by some informants that women earn more than men (however this is not openly admitted among men). During the lean fishing season youth leave the village in search of work in Takoradi, Tarkwa and other large surrounding towns.
Education and Skills	There is a generally low education level in the community which is attributed to poverty and lack of funding for schools. A large percentage of pupils tend to drop out of school to fish as they enter the Junior secondary school. There is no difference between boys and girls in terms of enrolment and the majority of pupils begin school at the correct age.
Social and health Infrastructure	The village does not have a public school and has one private kindergarten. The community shares both Primary and Junior High with Ngalichi community, which is a kilometre away. Houses are mainly built with mud and raffia and roofed with thatch. There are no health facilities, toilets or potable water facilities in the community.
Cultural Heritage	Ngoane Azale and Korazo crocodile ponds lie on the western and eastern edges of the community. According to the locals, these ponds are gods and serve as habitat for crocodiles.

Table B.40 Characteristics of Anochi Community

Characteristic	Description
History	According to oral narrations, the earlier settlers migrated from Wassa Akropong. They were led by Anoekyi who later became the chief of the village. They were salt miners who had direct trade relations with European traders at Atuabo and Ahonlezo now Asamdasuazo. A second group who migrated from Kumasi in the Ashanti Region later joined them in the area, farming the land and later attempting to claim the Anochi land as theirs. A dispute ensued and after a decision from the Awulae in Atuabo (in the 1950s) the descendants of the original salt miners were granted title. A descendant of the original woman who came to the area was declared Chief and his name was Anochi.
Landscape/ Location	Anochi is a small coastal community with a relatively flat land surface with no significant hills. Atuabo borders the community on the west, with Beku to the east and Mezozo to the north. The coastal strip is characterized by open sandy beach of about 120 meters. The western and eastern edges of the community are covered with coconut plantations.
Demographics	The town has about 182 houses and an estimated population of 1100 people with larger proportion of females. It is also noted that there numerous single headed households in the village. There predominantly Nzemas and Ahantas people in the community, although are also Fantis and Ewes residing in the community.
Livelihood and occupation	Fishing, farming, petty trading, charcoal production and baking are the main economic activities undertaken. Crops include coconut, oil palm, groundnut and maize. In general the community has low-income levels. On key reason for this is the lack of access to markets for their crops and informal trading goods. Since the Ghana Gas project has been constructed there has been a reported reduction in farming as the project encroached on some of their farmlands. About 60% are estimated to be in fishing, 30% in farming and 10% in other services. Fishermen operate in Jawe Walfe and as far abroad as Cote d'Ivoire. There is limited formal employment, although some community members are employed with the Ghana Education Service (although they are not necessarily professionals). The inhabitants of Anochi spend the greater part of their income on food and children's school fees.
Education and Skills	There are generally low levels of educational attainment, usually terminating at the Junior high school level or at best senior high school.
Social and Health Infrastructure	There is no health centre in the community and villagers must travel to Eikwe for medical care. There is, however, one traditional birth attendant in the community.

Table B.41 Characteristics of Asemde-Sauzo

Characteristic	Description
History	Asemda-Suazo was named after the Nana Asemda who first settled there and initially named Bosomle-Bo or "home of the gods". The place later served as a place of refuge for people from Atuabo and Anochi during times of war, and was referred to as Atuabo-Ahonlenzo or "the heart of Atuabo.
Demographics	The community has estimated its population at 639 made up of approximately 35 houses giving a very high average household size.
Livelihood and occupation	The main land use is farming making up 80% of the village area. Buildings make 15 % and the least 5 % for other uses. The majority of households are engaged in production of local gin known as akpeteshie. The two other main economic activities are fishing and farming followed by livestock rearing. Types of crops cultivated include; maize, cassava, okra, and pineapple. In addition, the women indicated that they sell a large proportion of crops. Teachers and workers at Ghana Gas are the main formal employees in the community. The men indicated that out-migration was more significant than in-migration. This is a result of the limited employment opportunities as many people leave in search of work. Moreover, a large percentage of the youth have left for the city in search of work.
Education and Skills	The majority of families indicated that they do send their children to school. There is junior school enrolment at the basic level; however pupils tend to drop out as they enter the Junior high school.
Social and health Infrastructure	The community has two functioning boreholes and 2 wells which they use as their water source. The village does not have a public toilet facility or designated place for refuse disposal. Only three houses have private toilet facilities. There is no health centre in the community and villagers must travel to Eikwe for medical care. Electricity is used for lighting while fuel wood and charcoal are the main sources of fuel for cooking. According to the inhabitants; the narrow cul-de-sac roads leading to the village tend to be swampy and virtually impassable by a vehicle during heavy downpours.

LEGEND

EXISTING FACILITIES

- GHANA NATIONAL GAS COMPANY CENTRAL PROCESSING FACILITY (GNGC CPF)
- GNGC SALES GAS PIPELINE
- JUBILEE OFFSHORE PIPELINE

PROJECT COMPONENTS

- CONCESSION AREA
- ONSHORE RECEIVING FACILITY (ORF)
- PLANNED ONSHORE PIPELINE
- PLANNED OFFSHORE PIPELINE
- DIRECT AREA OF INFLUENCE
- COMMUNITY WITHIN DIRECT AREA OF INFLUENCE
- NEIGHBOURING COMMUNITY
- COMMUNITY OUTSIDE DIRECT AREA OF INFLUENCE
- DISTRICT BOUNDARY

Coordinate System: WGS 1984 UTM Zone 30N
Proiezione: Transverse Mercator
Datum: WGS 1984

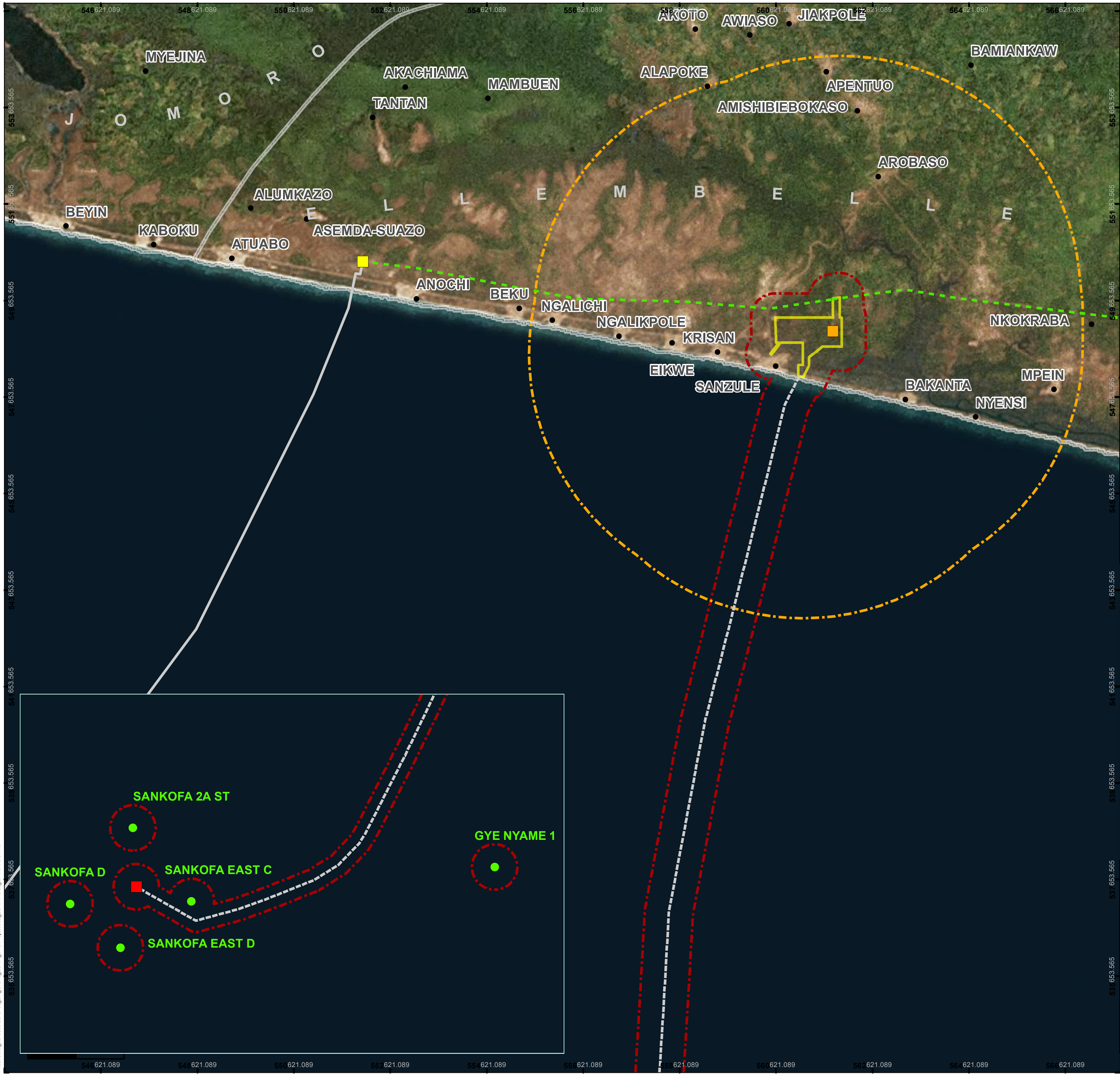
Environmental Resources Management

ERM

Project	ESHIA for the OCTP Phase II Development Project Ghana	
Annex: C	Social & Healthl Areas of Influence	
Scale 1:65,000	Project Number 0272709	Client eni Ghana
Revision 01	Date Mar 2015	
Size A3 / Layout -	Drawn by MAR / PjM -	File 01_SocialAoI_A3

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

PROJECTION: WGS 1984 UTM Zone 30N



LEGEND

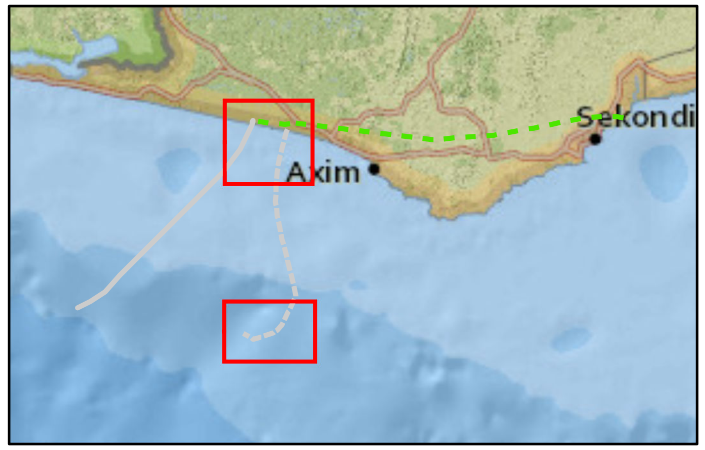
EXISTING FACILITIES

- GHANA NATIONAL GAS COMPANY CENTRAL PROCESSING FACILITY (GNGC CPF)
- GNGC SALES GAS PIPELINE
- JUBILEE OFFSHORE PIPELINE

PROJECT COMPONENTS

- PROJECT COMPONENTS
- ONSHORE RECEIVING FACILITY (ORF)
- FLOATING PRODUCTION STORAGE AND OFFLOADING (FPSO) VESSEL
- WELL LOCATION
- OPTIONAL ONSHORE PIPELINE
- PLANNED OFFSHORE PIPELINE
- AREA OF INTEREST FOR SURFACE WATER, SEDIMENT QUALITY, PROTECTED AREAS AND AVIFAUNA
- AREA OF INTEREST FOR OTHER BIOPHYSICAL ASPECTS
- SETTLEMENT
- DISTRICT BOUNDARY

Coordinate System: WGS 1984 UTM Zone 30N
Proiezione: Transverse Mercator
Datum: WGS 1984



ERM Environmental Resources Management

Project: ESHIA for the OCTP Phase II Development Project Ghana

Annex: C — Environmental Areas of Influence

Scale	Project Number	Client
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Revision: 02	Date: Mar 2015	
Size: A3 / Layout: -	Drawn by: MAR / PjM: -	File: 02_EnvironAoIs

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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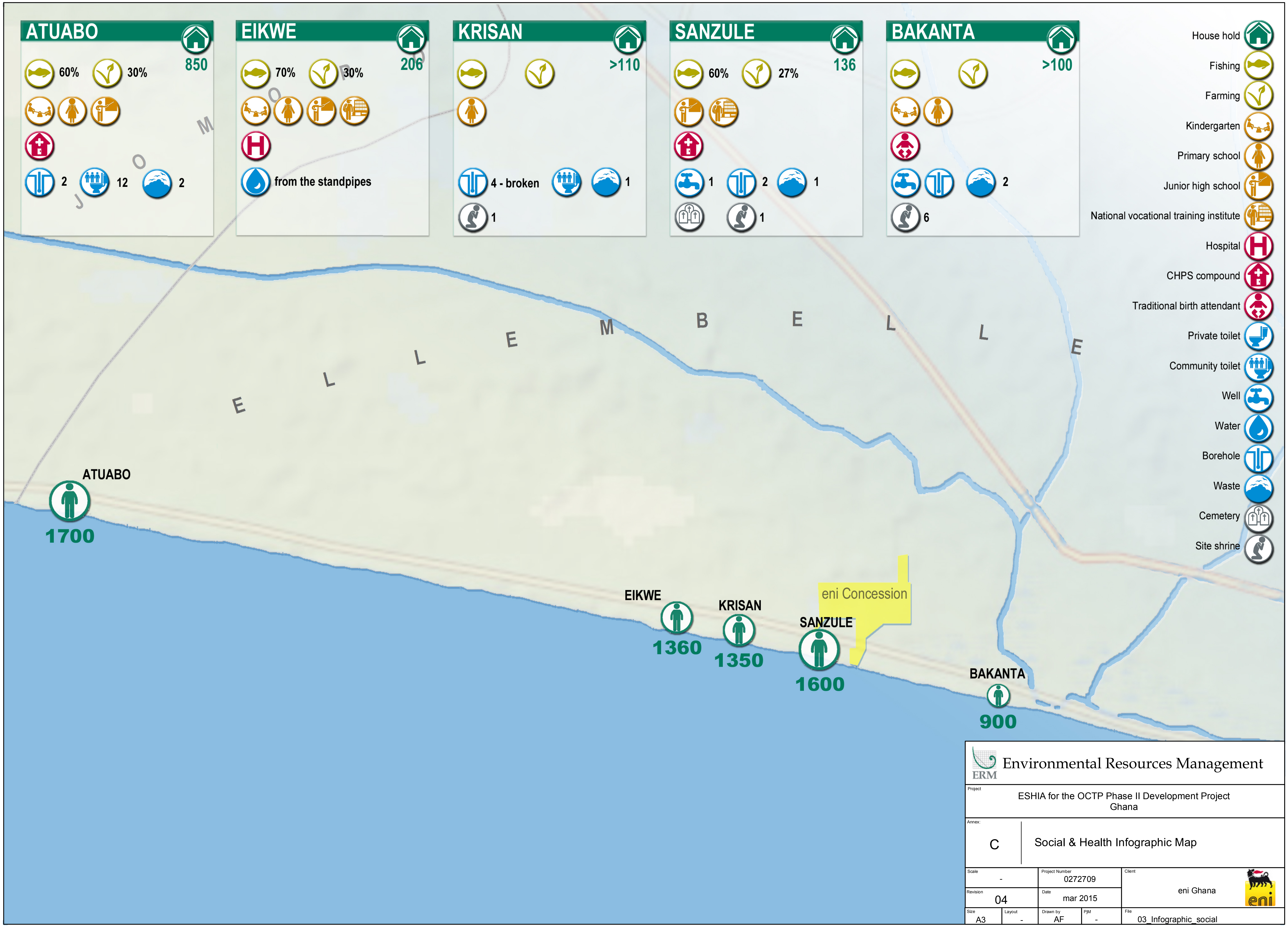
PROJECTION: WGS 1984 UTM Zone 30N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30%
2
12
2
EIKWE
206
70%
30%
from the standpipes
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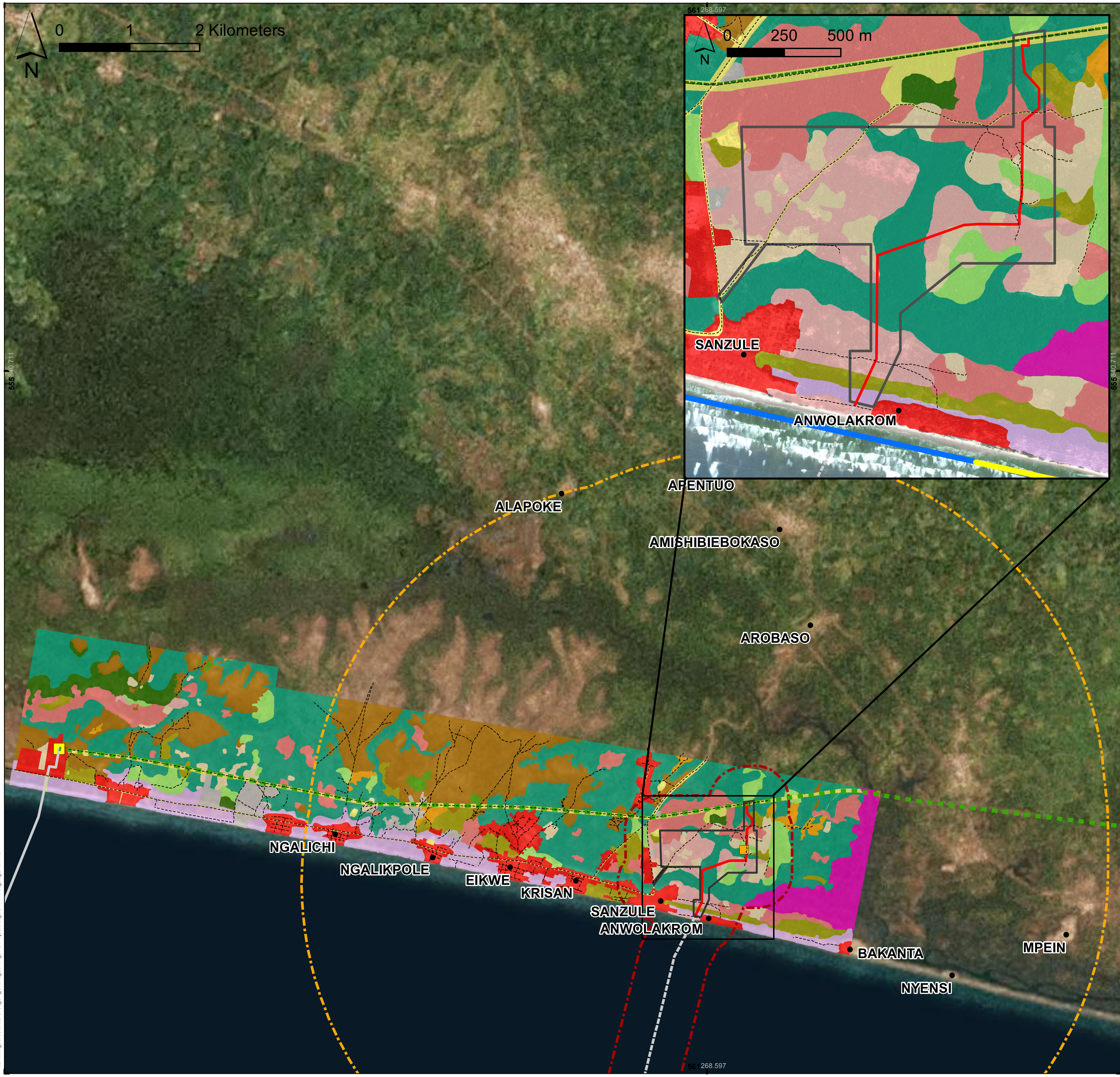
4 - broken
1
1
SANZULE
136
60%
27%
1
2
1
1
BAKANTA
>100
2
6
House hold
Fishing
Farming
Kindergarten
Primary school
Junior high school
National vocational training institute
Hospital
CHPS compound
Traditional birth attendant
Private toilet
Community toilet
Well
Water
Borehole
Waste
Cemetery
Site shrine
JOMORO
ELLEMBELLE
ATUABO
1700
EIKWE
1360
KRISAN
1350
SANZULE
1600
eni Concession
BAKANTA
900
Environmental Resources Management
ERM
Project
ESHIA for the OCTP Phase II Development Project
Ghana
Annex:
C
Social & Health Infographic Map
Scale
-
Project Number
0272709
Client
eni Ghana
Revision
04
Date
mar 2015
Size
A3
Layout
-
Drawn by
AF
PM
-
File
03_Infographic_social



LEGEND

GHANA NATIONAL GAS COMPANY CENTRAL PROCESSING FACILITY

EXISTING FACILITY

GNGC SALES GAS PIPELINE

JUBILEE OFFSHORE PIPELINE

PROJECT COMPONENTS

ONSHORE RECEIVING FACILITY (ORF)

CONCESSION AREA

PLANNED ONSHORE PIPELINE

PLANNED OFFSHORE PIPELINE

AOI FOR SURFACE WATER, SEDIMENT QUALITY, PROTECTED AREAS AND AVIFAUNA

AREA OF INTEREST FOR OTHER BIOPHYSICAL ASPECTS

VEGETATION MAP

BARE SOIL

BUILT GROUND

COASTAL COCONUT PALM PLANTATIONS

DEFORESTED AREA

DEGRADED COCONUT PALM PLANTATIONS

DEGRADED VEGETATION

INLAND COCONUT PALM PLANTATIONS

MIXED FOREST, COCONUTS PALM PLANTATIONS

MIXED VEGETATION, FOREST, PALMS AND GRASSLAND

SAVANNA PATCH WITH GRASS AND SEDGES

SAVANNA WITH PATCH OF FOREST AND PALMS

SMALL PATCH OF FOREST

SWAMP AND MANGROVE FOREST

WET EVERGREEN FOREST

WET EVERGREEN FOREST WITH PALMS

SETTLEMENT WITHIN AREA OF INFLUENCE

ROAD NETWORK

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984

Revision	Date	Description	Checked by
00	xx-xx-xxxx	xx-xx-xxxx	Xxx

Environmental Resources Management

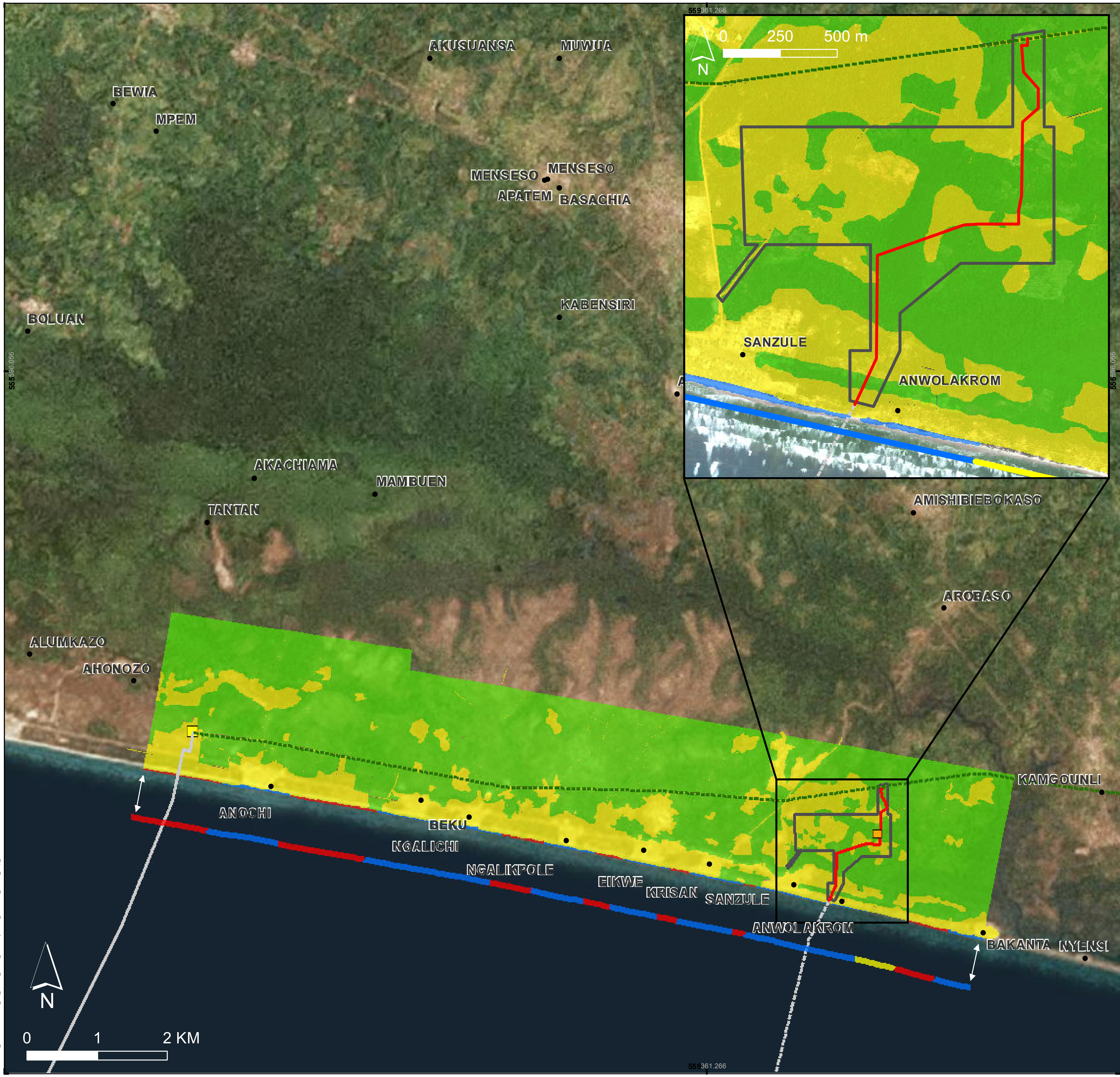
Project: ESHIA for the OCTP Phase II Development Project Ghana

Annex: C — Land Cover

Scale	Project Number	Client
1:55,000	0272709	eni Ghana
Revision: 03	Date: Apr 2015	
Size: A3 / Layout: - / Drawn by: MAR / PjM: -		File: 05_LC_EAoI

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

PROJECTION: WGS 1984 UTM Zone 30N



LEGEND

EXISTING FACILITIES

- EXISTING FACILITIES
- GNGC SALES GAS PIPELINE
- JUBILEE OFFSHORE PIPELINE

PROJECT COMPONENTS

- CONCESSION AREA
- ONSHORE RECEIVING FACILITY (ORF)
- PLANNED ONSHORE PIPELINE
- PLANNED OFFSHORE PIPELINE

COAST SENSITIVITY

- CRITICAL
- MODIFIED
- POTENTIAL CRITICAL

HABITAT SENSITIVITY

- MODIFIED
- NATURAL
- POTENTIAL
- CRITICAL
- SETTLEMENT

Coordinate System: WGS 1984 UTM Zone 30N
Proiezione: Transverse Mercator
Datum: WGS 1984

Revision	Date	Description	Checked by
00	xx-xx-xxxx	xx-xx-xxxx	Xxx

Environmental Resources Management

Project: ESHIA for the OCTP Phase II Development Project
Ghana

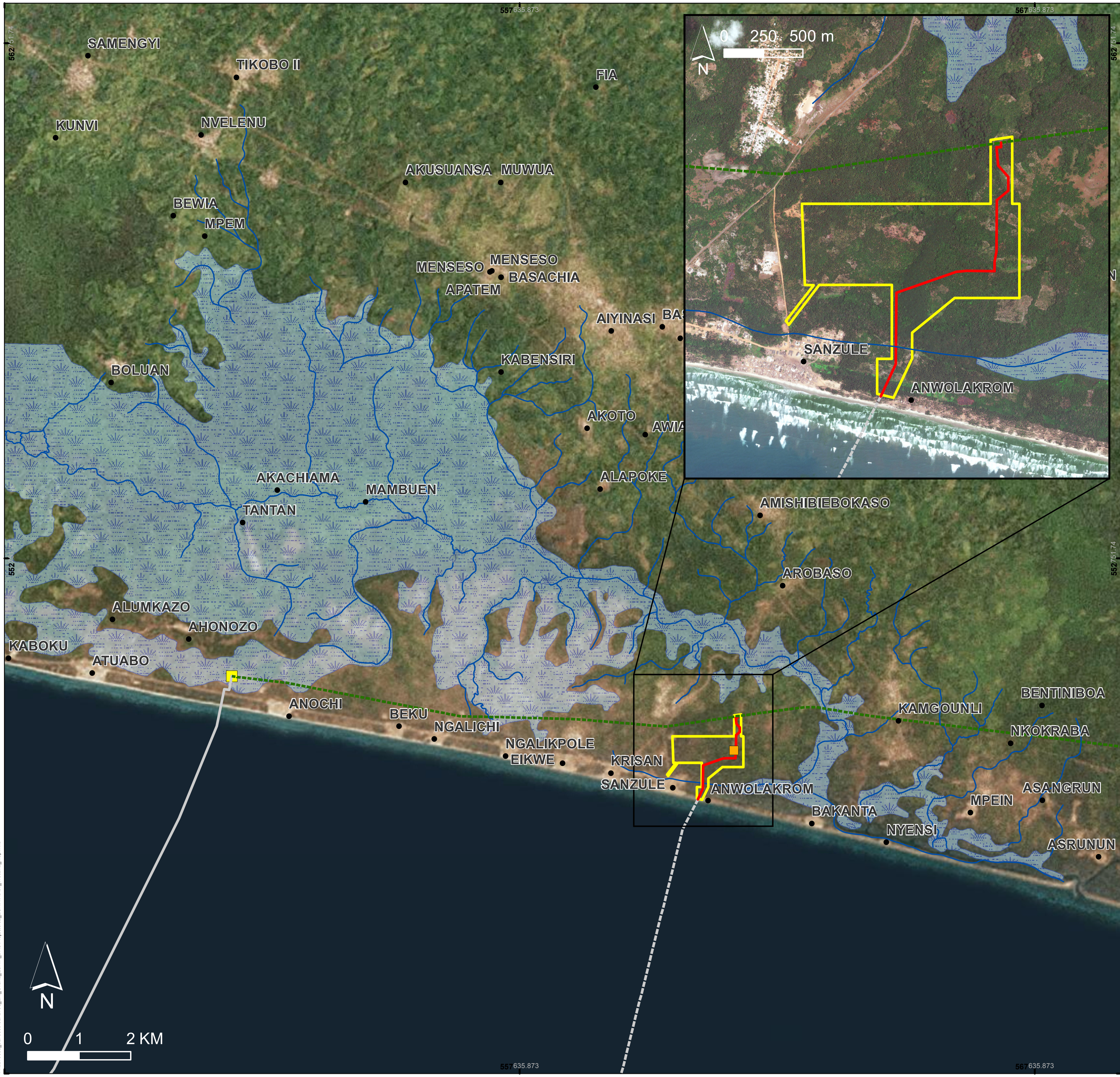
Annex: C — Habitat Sensitivity

Scale	Project Number	Client
1:55 000		eni Ghana
Revision: 05	Date: apr 2015	

Size	Layout	Drawn by	PjM	File
A3	-	MAR	-	06_Habitat_Map_without table

PROJECTION: WGS 1984 UTM Zone 30N

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.



LEGEND

EXISTING FACILITIES

- EXISTING FACILITIES
- GNGC SALES GAS PIPELINE
- JUBILEE OFFSHORE PIPELINE

PROJECT COMPONENTS

- CONCESSION AREA
- ONSHORE RECEIVING FACILITY (ORF)
- PLANNED ONSHORE PIPELINE
- PLANNED OFFSHORE PIPELINE

MAPPING FROM SATELLITE IMAGERY

- WETLAND
- RIVER NETWORK

Coordinate System: WGS 1984 UTM Zone 30N
Proiezione: Transverse Mercator
Datum: WGS 1984

Revision	Date	Description	Checked by
00	xx-xx-xxxx	xx-xx-xxxx	Xxx

ERM Environmental Resources Management

Project: ESHIA for the OCTP Phase II Development Project Ghana

Annex: C — Wetland Extent

Scale	Project Number	Client
1:75,000		eni Ghana

Revision	Date
06	Apr 2015

Size	Layout	Drawn by	PM	File
A3	-	MAR	-	07_Wetland_Map

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

PROJECTION: WGS 1984 UTM Zone 30N

Annex D
Terms of Reference of the EIA

ABSTRACT

This Annex includes the Termes of References for the EIA report, as defined within the Scoping Report submitted to EPA in December 2014.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Marzo 2015	03	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
27-02-2015	02	Issued for submission to Authorities	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
23-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
26-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

TABLE OF CONTENTS

LIST OF TABLES

D. TERMS OF REFERENCE FOR EIA

D.1.1 INTRODUCTION

This chapter provides the proposed Terms of Reference for the EIA and is structured as follows.

- Steps that will be carried out to complete the EIA process;
- Baseline studies;
- Stakeholder engagement;
- Structure of the EIA Report (or ESHIA); and
- Schedule for the EIA process.

D.1.2 STEPS TO COMPLETE THE EIA PROCESS

Following submission of the Scoping Report to EPA, the EIA team will undertake the following tasks.

- The Project description will be updated and finalised as further details become available from the Project's technical team. The EIA team will work with the technical team to confirm parameters for the modelling studies and impact assessment;
- Baseline data collection and specialist studies (including modelling studies) will be completed and reported in an environmental social baseline and health chapter as part of the EIA Report (see Section D.D.1.3 below);
- Impact assessment will be undertaken to determine significance ratings according to predefined impact assessment methodology. The proposed impact assessment methodology is attached in Chapter 10 and more in detail in Annex G
- Mitigation and monitoring measures will be developed and an Environmental, Social and Health Management Plan (ESHMP) will be prepared as part of the EIA;
- Stakeholder engagement will continue throughout the EIA process (see Section D.1.3.2 below); and
- The EIA Report will be submitted for regulator review and public comment.

D.1.3 PROPOSED BASELINE STUDIES

During the EIA, available public, scientific and statistic information will be collated and reviewed and studies will be undertaken to provide additional information on the current environmental socio-economic and health baseline conditions against which the identified potential impacts will be assessed. In addition to further desktop research, specialist studies will also be undertaken to assess key issues identified during coping. Specialists with qualifications in the particular resource area and knowledgeable of the local conditions will contribute to gather additional and specific information. The scope of these specialist studies are described in Table D.0.1.

D.1.3.1 Environmental Baseline

Determination of the existing environmental conditions will cover both the wet and the dry seasons to accurately characterize the Project setting (Table D.0.1). Dry season field surveys were undertaken in March and April 2014. The wet season field surveys were carried out in November-December 2014. Supplemental field surveys will be conducted if required.

D.1.3.2 Socio-economic and Health Baseline

Socio-economic and health baseline information will be collected using a range of methods, including review of secondary data and supplemented with primary data collection through key informant and focus group interviews within the communities located within the selected direct area of influence (see Chapter 4 of the Report): Sanzule, Bakanta, Krisan, Eikwe, Ngalekpole, Ngaliki, Beku, Anochi, Asemdasuazo and Atuabo. Selected key informants in the Extended Area of Influence will also be interviewed.

Baseline surveys will be used to ground-truth available secondary data and characterise the communities, as well as to contextualise the socio-economic, socio-cultural, political and health environment as well as overall quality of life. The data collection process will focus on gathering information based around several data categories as outlined in Table D.0.1.

The data collection work will focus on providing a description of the socio-economic status and health condition of potentially affected communities and stakeholders. Findings of the consultation process will also inform the assessment of socio-economic, cultural and health impacts.

Table D.0.1 Overview of Scope of Baseline Studies

Resource	Potential Area of Influence	Approach	Parameters
		Environmental Baseline Studies	
Terrestrial Soils and Geology	Soils in the immediate area of the proposed sites (Project footprint)	A specialist will undertake a study of: • soil physico-chemical characteristics; • regional geology; • existing soil contamination; • soil capability for agricultural use • land use (present and historic). Investigation will include observations, test pits (for soil profiling), and laboratory analysis of three to four surface soil samples on and around the Project site for each season. An additional four samples (30 cm deep – 0-15 cm and 15-30 cm depths) were taken along the pipeline ROW during the wet season.	For field and laboratory testing of soil samples: • grain size • total organic carbon • hydrocarbons (TPH and PAHs) • oil and grease • heavy metals
Freshwater Sediments	Freshwater sediment characteristics and benthic community composition	A specialist will describe the physico -chemical characteristics of the freshwater sediments. Investigation will include sampling at a minimum of four locations along the Amansuri River where also water quality sampling will take place (see below) for both seasons. Two additional samples were taken during the wet season within seasonally inundated areas along the pipeline ROW, as identified. This will include also an investigation of macro invertebrate community.	For field and laboratory testing of freshwater sediment samples: • grain size • total organic carbon • hydrocarbons (TPH and PAHs) • oil and grease • heavy metals • macrobenthos
Surface water	Surface water bodies within the zone of influence (mainly Amansuri River)	A specialists will carry out a study to: • determine surface water conditions; • determine quality of surface • identify public and private surface water use sources	For field and laboratory testing of surface water samples: • temperature, pH, salinity and turbidity • biological oxygen demand (BOD) • chemical oxygen demand (COD) • dissolved and suspended solids

Resource	**Potential Area of Influence**	**Approach**	**Parameters**
		in the potential area of influence. Investigation will include observations as well as laboratory and field analysis of samples from three to four sampling points at Amansuri River. Sample locations will be selected to represent the surface water bodies identified, including different locations in the Amansuri river (upstream midstream, and downstream on the river mouth).	• total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs) • oil and grease • heavy metals • microbiology • nutrients • chlorophyll a • phytoplankton and zooplankton
Geohydrology	Groundwater within the zone of hydrological influence, both shallow and deep	A specialist will carry out a study to: • determine groundwater characteristics and conditions; • determine quality of groundwater with respect to use for process water and potable water; and • identify public and private water use sources (e.g. boreholes, shallow wells) in the potential area of influence. Investigation will include analysis of three samples from existing community boreholes or shallow wells in Sanzule community and one sample in Bakanta and available desktop and secondary information.	For field and laboratory testing of groundwater samples: • temperature, pH, salinity and dissolved oxygen • BOD • turbidity and conductivity • dissolved and suspended solids • hydrocarbons • heavy metals • microbiology • nutrients
Terrestrial Ecology	Terrestrial species within the footprint of the Project as well as in the defined area of influence (including ORF site and pipeline RoW).	An ecologist will conduct a survey of the terrestrial environment to: • describe the existing vegetation and habitat types • identify plants and wildlife.	Based on desktop study and field survey comprising 20 m radius sweeps for flora and random blocks along selected transects for mammals and birds): • habitat type (including classifccation in line with IFC PS 6 categories) • plant types and distribution • animal types and distribution • sensitive habitats • threatened or protected species

Resource	Potential Area of Influence	Approach	Parameters
Marine and Intertidal Ecology	Marine species that potentially occur in the Project area	An ecologist will conduct a survey of the intertidal and nearshore environment to: • describe the existing habitats • identify plant, algae and wildlife • identify turtle nesting locations • ghost crabs abundance. For the marine environment, fauna will be identified using desktop information and interviews with local people knowledgeable of the marine environment (e.g. fishermen).	Based on desktop study and field survey: • habitats • marine vegetation types and distribution • animal types and distribution • sensitive habitats • threatened or endangered species • beach profile
Marine Water Quality	Near shore environment Offshore area	A specialist will describe the physico-chemical characteristics of the marine water at the proposed Project site (pipeline landfall area) based on water quality sampling at one location close to the beach. Water quality data from the offshore part of the project (well locations and subsea facilities) was already gathered during the Phase I of the project by means of an oceanographic campaign.	The nearshore water quality laboratory sampling will include: • temperature, pH, salinity and dissolved oxygen • BOD • turbidity and conductivity • total suspended solids, total dissolved solids • TPH • oil and grease • heavy metals • microbiology • nutrients (nitrates, orthophosphates and silicates) • phytoplankton and zooplankton • chlorophyll a
Marine Sediment	Marine sediment characteristics and benthic composition of both offshore and nearshore areas of the project area of influence.	A specialist will describe the physico-chemical characteristics of the marine sediment at the proposed Project sites, based on existing available data from OCTP Phase I (Along subsea facilities) and from direct sampling on the intertidal area.	Based on data available from Phase I of OCTP development Project, for offshore Western Ghana along the project footprint. Sampling will be done within the intertidal area in Sanzule beach to determine the sediment size distribution and

Resource	Potential Area of Influence	Approach	Parameters
			other physical and chemical characteristics as follows: • grain size • total organic carbon • TPH and PAH • oil and grease • heavy metals • macrobenthos
Noise	Existing background noise levels at sensitive receptors	A specialist will conduct a study of ambient noise levels. The study will identify locations of sensitive receptors. Study will include collection of background noise levels at three locations around the Project site (Sanzule, Ayigbe and proposed ORF area during both dry and wet seasons). Additional samples during the wet season were taken along the pipeline ROW (one season). All noise sampling is to be conducted over a 24 h period so as to include day and the night time measurements.	To determine existing background noise levels, acoustical measurements will be collected using a Type I or Type II integrating sound level meter on both day and night time.
Air Quality	Air quality near the proposed ORF site and along the pipeline route	A specialist will conduct a study to determine the status of local air quality using existing monitoring data and by conducting 24 h measurements during dry and wet seasons on the ORF site (3 sampling points) and on one season along the pipeline route (4 sampling points). The study will include confirmation of regional wind patterns as well as any localised patterns. Investigation will include analysis of three sampling points around the Project site (Sanzule, Ayigbe and proposed ORF area). Additional samples during the wet season were taken along the pipeline ROW (one season). All air quality sampling is to be conducted over a 24 h period.	Based on desktop study and field survey including sampling and analysis. The following parameters will be described: • meteorological parameters • suspended particulate matter (TSP and PM10) • carbon dioxide (CO_2) • sulphur dioxide (SO_2) • nitrogen dioxide (NO_2) • volatile organic carbons

Resource	Potential Area of Influence	Approach	Parameters
Fisheries	Understanding local fishing activities, species, fishing areas and livelihoods of nearshore beach seine fisheries at Sanzule and Bakanta	The fishing areas, patterns and species will be identified using desktop information and interviews with fishermen in the directly affected communities (Sanzule and Bakanta).	• species fished • catches • catch per unit effort (CPUE)
Social and Health Baseline Studies			
Administrative Structure	10 potentially impacted Communities within the Direct Area of Influence (1) Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine the administrative and government structures at a national, regional, district level, as well traditional administrative structures within local communities within the potential area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	• formal and traditional administrative structures • traditional authorities
Land Tenure and Land use	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine the land tenure and land use within the area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities.	• land use • land and sea tenure • traditional land title • settlement patterns and mapping
Historical,	10 potentially impacted	A specialist team will conduct a study to determine the	• history of the potentially impacted villages project area

(1) 10 communities were surveyed during the baselie data gatehering based on Area of Influence defined ihn relation to the location of both ORF and possible optional pipeline. Optional pipeline is no longer a consideration meaning only 5 communitiesare now described in detail in the baseline.

Resource	Potential Area of Influence	Approach	Parameters
Cultural and Macroeconomic Context	Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	historical, cultural and macroeconomic context within the area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	of influence • festivals and cultural practices • sites and customs of cultural, religious and historical significance (including especially cemeteries) • recreational facilities • marine and terrestrial cultural heritage • macro-economy of Ghana , Western Region and Ellembelle District
Demographic Profile and Migration patterns	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine the demographic profile of the area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	• population and population growth • urban and rural population trends • age and gender distribution • ethnicity, language and religion • migration patterns
Gender issues Vulnerable Groups	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine the gender profile of the area of influence and identify and understand charactersitics of potentially vulnerable groups. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	• regulatory context pertaining to protection of rights of women, elderly, children and people living with disabilities • child and forced labour incidence and trends • baseline characteristics contributing to vulnerability in specific groups e.g. ○ Subsistence farmers, fishers and migrant fishing communities ○ Elderly ○ Children ○ People living with disabilities
Education	10 potentially impacted Communities within the Direct Area of Influence	A specialist will conduct a study to determine education levels and service provision in the area of influence. The study will include both desktop research and primary	• education indicators including attainment, enrolment, literacy, teacher pupil ratio, drop-out rates and patterns • education facilities and services (public and private schools and vocational training centres/tertiary

Resource	Potential Area of Influence	Approach	Parameters
	Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	institutions) • conditions of facilities, availability of equipment, supplies, teaching staff and skills training.
Economic Activity and Livelihoods including fisheries	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine economic activity and livelihoods in the area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence. The fishing areas, patterns and species will be identified using desktop information and interviews with fishermen in the directly affected communities.	• means of livelihood, economic base • income distribution • occupations and employment • alternative economic activities to fishing including Farming, Oil and Gas, Informal Economy, Mining and Minerals, Tourism • fishing livelihoods and economic importance of the offshore/ aquatic ecosystem • species fished • fishing grounds • patterns and trends in fish catch • seasonal fishing activities
Utilities and Social Infrastructure	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine utilities and social Infrastructure in the potential area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	• road infrastructure and transport • telecommunications • water and sanitation • energy • waste disposal
Marine Infrastructure	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district	A specialist will conduct a study to determine marine infrastructure in the area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of	• ports and harbours • pipelines and cables • shipping and navigation • oil and gas

Resource	**Potential Area of Influence**	**Approach**	**Parameters**
	assemblies) within the Extended Area of Influence	influence.	
Public Safety and Security	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine safety and security in the area of influence. This will include both the onshore and offshore areas. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	• political stability • road safety • maritime safety • crime, policing
Worker Health, Safety and Security	Project workers at the onshore and offshore locations.	A specialist will conduct a study to determine worker health safety and security. The study will include both desktop research and will be based on studies and plans provided by the Project's technical team.	• worker occupational health and safety • worker and asset security (from crime, vandalism, piracy)
Health Baseline	10 potentially impacted Communities within the Direct Area of Influence Selected locations (e.g. towns, regional administrations, district assemblies) within the Extended Area of Influence	A specialist will conduct a study to determine health status and health facilities, capacity and conditions in the area of influence. The study will include both desktop research and primary data collection (community surveys, focus group discussions, and key informant interviews) in the potentially impacted communities and wider area of influence.	• health institutional framework • health policy and programmes • national health accounts • the health care system • health infrastructure, services and resources • maternal and child health • life style behaviours • morbidity and mortality
Cumulative Impacts	Cumulative impacts of this project on the Direct Area of Influence. Cumulative impacts with other projects along the coastline from Atuabo to	The Project is being developed in a coastal region already affected by a number of existing projects as well as a number of planned projects. The cumulative effect of the Project will be evaluated considering the following which are known to be in development or that could reasonably be expected to be developed: • eni Ghana Oil Development (phase 1);	The following categories of cumulative impacts will be addressed in the EIA: • livelihoods and fishing; • biodiversity; • environmental quality; • coastal processes; and socio-economic effects;

Resource	Potential Area of Influence	Approach	Parameters
	Sanzule.	• Jubilee Field Development (in operation since 2014); • TEN Development (proposed, EIA under evaluation); • GNGC Gas Plant at Atuabo and Pipeline (phase 1 in operation, phase 2 under construction). • Lornho Oil Service Port at Atuabo (proposed, EIA under evaluation).	• community health

D.1.3.3 Baseline Reporting

Following completion of the baseline studies, the EIA team will report the findings in the EIA Report. This will provide a description of the existing environmental social and health conditions in the main EIA Report supported by more detailed information in annexes as required. The aim of the baseline reporting will be to provide sufficient information to undertake the following:

- Identify the key environmental social and health conditions in areas potentially affected by the Project and highlight those that may be vulnerable to aspects of the Project;
- Describe their characteristics (nature, condition, quality, extent, etc) now and in the future in the absence of the Project; and
- Provide sufficient data to inform judgments about the importance, value and sensitivity/ vulnerability or resources and receptors to allow the prediction and evaluation of potential impacts.

D.1.3.4 Quantitative Specialist Studies

Quantitative studies will be undertaken to support the prediction of risks and impacts. These studies will include the following.

- Air Quality: atmospheric emissions modelling to show the changes in air quality as a results of the emissions from the operation of the ORF; and
- Noise: using modelled noise emissions resulting from the construction and operation of the onshore pipeline and the ORF to understand the noise impacts on the local communities and natural environment;
- Oil Spills: the dispersion of oil from an accidental release of oil from the FPSO will be modelled to determine the fate of the oil in the environment, especially the locations where the oil might reach the coastline.

D.1.3.5 Fisheries Impact Assessment

Section 93 of the Fisheries Act stipulates that if a proponent plans to undertake an activity which is likely to have a substantial impact on the fisheries resources, the Fisheries Commission will be informed of such an activity prior to commencement and a Fisheries Impact Assessment (FIA) be prepared and submitted to the Commission. The Commission may require information from the proponent on the likely impact of the activity on the fishery resources and possible means of preventing or minimising adverse impacts.

As such, the Fisheries Commission has been consulted as a key stakeholder in the EIA and potential impacts on fisheries resources will be assessed as part of the OCTP Phase 2 NAG development EIA. In addition, a fish catch study has been undertaken in two seasons (April and October 2014) and two locations (Sanzule and Bakanta). See Chapter 7 for details.

A FIA will be produced integrating the two development phases of the project. The fisheries study will provide a more localised baseline on fish ecology and fisheries activities against which potential fisheries impacts can be assessed. Potential impacts that will be assessed are outlined in Chapter 10 and Annex G, and the ESHMP in Chapter 12 will describe eni Ghana’s commitment to develop a Fishermen Management Plan and a Fisheries Monitoring Program.

The FIA will be summarized in a standalone report. The results will also be included in the EIA Report.

D.1.4 IMPACT ASSESSMENT METHODOLOGY

Potential impacts generated by the Project activities on the various environmental, social and health components will be identified, as described below and in line with the preliminary assessment carried out at this stage of the EIA process in the Section D.1.4 of this Report. This Section will also define the methodology/approach of mitigation measures of the identified potential impacts. The assessment approach generally involves matching the various activities of the proposed Project with the components of the existing biophysical and anthropic environment.

D.1.4.1 Potential Impacts Identification and Characterization

The environmental, social and health impacts potentially generated by the Project will be identified via the elaboration of impact pathways. An impact pathway is substantially a process tool which allows for the identification of the main impacts on the surrounding physical environment and the host communities' society, economy and health, induced during the execution of the project, from the initial phase, through to Operation and Production, and ultimately Decommissioning.

The process begins with an impact identification matrix, which involves the listing of the main project activities carried out during the various project phase on one side and on the other the baseline biophysical and anthropic profile components (i.e. environmental, socio-economic and health components) so as to highlight the relationships between project activities and potential direct impacts.

Characterization refers to the types of impact generated by the Project; i.e. any project can generate a wide range of potential impacts, some of which will be direct, whilst others will be more complex and difficult to identify (see Table D.0.2).

Table D.0.2 Types of impact

Direct (or primary)	Impacts that result from a direct interaction between a planned project activity and the receiving natural or human environment.
Indirect	Impacts that follow on from the primary interactions between the project and its natural and human environment as a result of subsequent interactions.
Cumulative	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the project.
Perceived	Changes that may be unconnected to, but blamed on, the project. These are usually identified and assessed through stakeholder engagement and consultation.

Once the direct impacts are established, the next step is to complete the impact pathway by determining the indirect impacts of these direct changes to the environmental, social and health components, as well as any subsequent cumulative and perceived impacts.

Potential impacts identified in the Scoping phase, as reported in Section D.1.4 of the present Report, will be characterized in detail during the EIA development and then evaluated as described in the following Paragraph.

D.1.4.2 Impacts Evaluation

Once identified, the significance of the potential impacts will be assessed in order to determine requirements for impact mitigation (or enhancement of benefits) and management measures to be implemented during the Project. The description of the impact assessment methodology is reported in Annex E. Impacts identified will be ranked accordingly and a consistent terminology will be adopted in order to allow the establishment of a detailed EIA Action Plan (including mitigation, management and monitoring measures).

D.1.4.3 Impact Mitigation

A set of mitigation measures will be identified for each environmental, social and health component and for each project phase, in order to avoid or minimize as much as reasonably practicable negative impacts, while enhancing those that are positive, based on the impact evaluation conducted in the previous stage of the EIA development. The identification of appropriate mitigation measures will be done following the hierarchy criteria illustrated in the Table below:

Table D.0.3 Mitigation Hierarchy Criteria

MITIGATION HIERARCHY CRITERIA	ACTION
Avoid at source (*Minimisation*)	Re-design the project in order to remove the potential impact due to the project's feature (e.g. re-routing a pipeline, relocating facilities, etc.).
Reduce on site (*End-of-pipe*)	Design control systems to minimize impacts (e.g. wastewater treatment, NOx reduction technology).
Reduce off site	Implement off-site measures in order to reduce those impacts that cannot be eliminated with end-of-pipe treatments (e.g. soundproof equipment at a nearby residences, visual screening by planting of hedges).
Restore	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 (e.g. for BES in a like-for-like biological offset attaining ecological no net loss).
Net positive outcomes	Make a positive contribution to Biodiversity conservation and/or improvement of Ecosystem Services and communities' development.

D.1.4.4 Monitoring Plan

A Monitoring Plan will be carried out to ensure that all mitigation measures included in the EIA will be implemented throughout the lifecycle of the Project and to evaluate their effectiveness, providing specific information on the characteristics and functioning of environmental and social and health variables in space and time. It will be aligned with the requirements established under Ghanian Legislation and International Standards (IFC, Equator Principles).

The Environmental Social and Health Monitoring Plan will address all the Project activities that have been identified to have potentially significant impacts on the environment social and health aspects, during both normal operations and upset conditions.

Monitoring frequency will be such as to guarantee the provision of representative data for the parameter being monitored. The list of parameters to be monitored per relative Project phase (drilling, operations, etc.) will be identified on the basis of the outcomes of the environmental social and health impact assessment.

Monitoring data will be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Moreover, as per required by Ghanaian law, monthly monitoring results will be submitted to the EPA using the EPA reporting format for the oil and gas sector or other internationally recognized reporting format.

The Monitoring Plan will also foresee the relevant provisions for an environmental authority to conduct routine inspections, investigations, audits, etc. of the project facilities.

D.1.4.5 Environmental, Social and Health Management Plan

The ESHMP will clearly specify guidelines for ensuring conformance of project implementation with procedure, practices and recommendations outlined in the EIA reports. It will be implemented throughout the lifecycle of the project to guarantee that impacts are properly managed. As a minimum it will include guidelines for:

- Ensuring conformance of detailed engineering design with design concept;
- The OCTP Development project implementation program;
- Achieving the objectives and commitment of the OCTP Development project;
- Responsibilities and accountability throughout project implementation;
- Procedures for dealing with changes and modification of the project;
- Corrective action which will be employed should the need arise;
- Inspection, auditing and monitoring of all phases of the project; and
- Decommissioning and abandonment of the project.

D.1.4.6 Quality Assurance/Quality Control

eni Ghana's QA/QC protocol will be strictly adhered to, knowing that data acquired is critical to the preparation of meaningful and acceptance EIA report.

D.1.4.7 Decommissioning and Remediation Plan

Appropriate measures for the restoration of the environment after decommissioning/ abandonment of the OCTP Development project will be provided in Chapter 11.

The plan will also focus on the social and economic effects of project closure. The EIA will include an exit strategy addressing how social and economic benefits, deriving from the project, can be sustainable. In case they are not sustainable, the strategy will address also how the impact of losing the socio-economic benefits will be mitigated.

D.1.5 STAKEHOLDER ENGAGEMENT

D.1.5.1 Objectives of Consultations

The objectives of consultation with stakeholders are to:

- Promptly identify issues/concerns to avoid conflict in the future.
- Gain consensus on potential impacts identified and to proffer mitigative measures before the project gets underway.
- Avoid any misunderstanding about the project development and for stakeholders to be jointly and severally acquainted with the project.
- Ensure that any apprehension and fears expressed by stakeholders about the project, nature, scale and impact of the operation have been addressed.
- Collate all comments and recommendations of all stakeholders for incorporation into the EIA report as appropriate.
- Consult with host communities and minutes of such consultation incorporated into the EIA report.
- Consolidate information into the stakeholder register.

Participation will be undertaken for consultations with community leaders, youth and women groups, and other stakeholders for the purpose of consolidating baseline data as well as information on potentially affected communities' concerns regarding the project.

D.1.5.2 Stakeholder Identification and Analysis

The range of relevant stakeholders will be identified, i.e. those individuals, groups or communities who are directly or indirectly affected by the project, as well as those who may have interests in the project and/or the ability to influence its outcome, either positively or negatively. Stakeholder identification will be consolidated in this phase, given the completion of the screening and scoping phase.

On the basis of initial stakeholder consultation results (i.e. from screening and scoping), stakeholders must now be assessed into the stakeholder register as per the eni Upstream Stakeholder Engagement Operating Instructions.

In the stakeholder register, the Stakeholder Assessment Matrix has to be completed with:

- the level of stakeholders' power on the Project (Low-Medium-High);
- stakeholders' disposition/attitude towards the project (Positive – Negative – Neutral).

In the stakeholder register, the Stakeholder Risk Matrix must also be completed with:

- the degree of the impact
- the probability of its occurrence

eni's Stakeholder Engagement department will provide the eni Upstream Stakeholder Engagement Operating Instruction and the stakeholder register format to be completed.

D.1.5.3 Stakeholder Engagement Activities

Having completed scoping consultation, as described in Chapter 6, further consultation will be undertaken as follows:

- Disclosure of the Scoping Report;
- Engagement during Baseline Studies; and
- Disclosure of the EIA Report and Public Hearings.

The following sections describe these consultation activities.

D.1.5.4 Disclosure of the Scoping Report

This Scoping Report will be submitted to the EPA for review.

The Scoping Report will be disclosed by EPA to Ministries and by eni Ghana to other stakeholders subsequent to the EPA's approval. An advertisement announcing the release of the Scoping Report for comment will be published. Copies of the Scoping Report will also be placed at central locations for public review. Copies of the Scoping Report will likely be placed at the following locations (subject to EPA advice):

- EPA library, Accra;
- Sekondi Public Library;
- Ellembelle District Assembly offices, Western Region; and
- With Paramount Chief at Atuabo.

Upon approval of the Scoping Report the EPA will issue a letter to inform the Project that the process can proceed to the EIA phase. The letter will also include any comments on the Scoping Report and proposed Terms of Reference for the EIA.

D.1.5.5 Engagement during Baseline Studies

Further, local level scoping engagement activities will be undertaken during the socio-economic and health baseline studies. These interactions will involve focus group discussions and key informant interviews at the 10 communities located within the Direct Area of Influence, and selected key informants across 6 districts in the Extended Area of Influence.

Focus group discussions will be undertaken with women's groups, leaders and men, and fishermen groups. A structured social and health questionnaire will be used. Key informant interviews will engage representative individuals for health, education, and tourism.

The aim of these consultations will be data collection for the socio-economic and health baseline, and stakeholder views and concerns will continue to be gathered during these engagements.

D.1.5.6 Disclosure of the EIA Report and Public Hearings

Disclosure of the Draft EIA Report/ EIA will provide detailed information about the proposed Project activities, an assessment of the potential impacts and the planned mitigation and monitoring measures. The EIA Report/ EIA will be issued to EPA and advertised. Copies of the EIA Report/ EIA will be made available at a number of locations for public review and comment. The EIA Report/ EIA will include a non-technical summary which will present the EIA findings in a non-technical format. eni Ghana will support the distribution process as required and directed by the EPA.

Given the nature and scale of the proposals it is expected that Public Hearings will be held. These will be organised by the EPA and attended by eni Ghana and members of the EIA team as required. EPA may grant provisional approval for commencement of the Project following review and the Public Hearing.

The comments received on the EIA Report/ EIA from EPA will be addressed and a Final EIA Report/ EIA will be submitted to EPA.

D.1.6 OUTLINE STRUCTURE OF THE EIA REPORT/ EIA

An outline of the proposed contents of the main volume of the EIA Report is provided in this Annex. The proposed contents follow previous EPA guidance on EIA Report/ EIA structure. The content may altered slightly during the evolution of the Project or based on the findings of on-going consultation, however it is anticipated that the contents of the EIA Report/ EIA will align broadly within the suggested framework.

D.1.7 POTENTIAL SCHEDULE FOR THE EIA PROCESS

A provisional schedule for the EIA is provided in Table D.0.4.

Table D.0.4 EIA Schedule

Milestone	**Approximate date**
Register Phase 2 Development Project EIA with EPA	November 2014
Perform baseline data collection	November - December 2014
Submit Scoping Report /TOR to EPA	December 2014
Receive acceptance of TOR from EPA	December 2014
Officially commence EIA as per accepted TOR	December 2014
Submission of Final Draft EIA to Authorities	February 2015
Submission of Final EIS to Authorities	July 2015
Receive Environmental Permit for Project	July 2015

Annex E
Issues Trail from Scoping Consultation

ABSTRACT

This Annex includes main issues and comments raised during the Scoping consultation. Each issue and comment is taken into account and answered within the present EIS.

July 2015	06	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
April 2015	04	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
March 2015	03	Interim Draft Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
27-02-2015	02	Issued for submission to Authorities	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
23-02-2015	01	Issued for comments	ERM	eni SEQS/SAL	G. Nicotra
26-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Nana Kofi Adu-Nsiah	Accidents	Disposal of chemicals, oil, and hazardous waste into the sea has the potential to cause marine pollution.	Risks and impacts associated with hazardous materials storage and handling will be evaluated in the ESHIA.
17-Dec-14	Western Regional Fisheries Commission (WRFC)	Mr. Alex Sarbah	Accidents	There is a concern about the effects of leakage of gas and the likely impact on the health of fish, fishermen and the communities.	The ESHIA will evaluate the risk of gas leakage and potential effects on the environment.
08-dic-14	Sekondi-Takoradi Metropolitan Assembly	Mr. Henry Owusu	Accidents	Plans must be put in place to mitigate a potential oil spill.	The ESHIA will evaluate risks of accidents and potential impacts. The Project will develop an emergency response plan to include accidental spills.
08-dic-14	Nzema East Municipal Assembly	Mr. Dominc Boadu-Ayebato Mr. Isaac Kwakye Mr. Kwabena Kesseh Mr. John Tetteh Doku Mr. Emmanuel Azuma Mr. Kingsley Ofori Mr. Eric Yeboah	Accidents	Unforseen events that could cause environmental damage.	The ESHIA will evaluate risks of accidents and potential impacts. The Project will develop an emergency response plan.
08-dic-14	Chief Fisherman of Upper Axim (Ahanta West DA)	Mr. Nana Etwe Azane Mr. C.K.Attah Mr. Kofi Yankey Uncle Kwabena Mason Uncle Ebukobo	Accidents	Concern over accidental damage to gas pipeline and possible gas leakage.	The ESHIA will evaluate risks of accidents and potential impacts. The Project will develop an emergency response plan.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
08-dic-14	Chief Fisherman of Upper Axim (Ahanta West DA)	Mr. Nana Etwe Azane Mr. C.K.Attah Mr. Kofi Yankey Uncle Kwabena Mason Uncle Ebukobo	Accidents	Fishermen are concern about impacts of unplanned events (accidents).	The ESHIA will evaluate risks of accidents and potential impacts. The Project will develop an emergency response plan.
08-Dec-14	EPA (Western Region)	Mr. Shine Fiagome Mr. Hakim Seidu	Aircraft Safety, Biodiversity	The location of the helipad should consider the proximity to waste disposal site due to the interactions of the helicopters with avian fauna which are attracted to the disposal site (for aircraft safety reasons and to reduce impacts on birds).	The ESHIA will evaluate potential impacts of aircraft movements on avian fauna, especially with respect to waste sites.
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Cletus Nateg	Biodiversity	How will the Project impact marine life, especially whales, and what mitigation measures will be put in place?	Risks and impacts to marine biodiversity, including whales, will be evaluated in the ESHIA.
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Nana Kofi Adu-Nsiah	Biodiversity	Hunting by workers has the potential to impacts onshore biodiversity.	This will be evaluated in the ESHIA.
03-Dec-14	Petroleum Commission	Mr. Alfred Ayah	Biodiversity	The EPA is currently updating coastal sensitivity maps and these should be referenced to have the most current information.	This will be evaluated in the ESHIA.
08-Dec-14	EPA (Western Region)	Mr. Shine Fiagome Mr. Hakim Seidu	Biodiversity	A biodiversity offset program should be considered if the Project impacts sensitive biodiversity resources.	The ESHIA will evaluate the impacts to biodiversity. Offset will be considered as part of the mitigation strategy where applicable. Given the limited footprint of the Project and the low sensitivity of the habitat, the need for offsets would be unlikely.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
04-Dec-14	Ghana National Petroleum Corporation (GNPC)	Mr. Seth Foli	Biodiversity, Air Quality	The following impacts should be considered: - Impacts on birds and on the communities from use of helicopters - Impacts to air quality from the operation of the onshore facility - Various social impacts - Potential for introdution of alien invasive species during onshore pipeline clearing and restoration.	This will be evaluated in the ESHIA.
02-Dec-14	Ministry of Energy & Petroleum	Prof. Thomas Akabzaa	Capacity Building	The Project should consider capacity building for the ministries.	The impact assessment will evaluate the capacity of the relvant authorities to provide oversight and monitoring. Capacity building may be suggested depending on the outcome.
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Nana Kofi Adu-Nsiah	Community Health	There could be health impaqcts associated with the algal bloom.	This will be evaluated in the ESHIA.
03-dic-14	Ellembelle District Assembly	Mr. Ted Teffey	Community Health	Communities' health may not be able to be properly monitored as there was not enough health baseline information available on the communities in Ellembelle.	Community health information will be gathered as part of the ESHIA to support the evaluation of impacts.
02-Dec-14	Fisheries Commission	Mr.Samuel Quartey	Community Investment	The Project should support research in fisheries.	This suggestion was directed to the Project developer for consideration.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Community Investment	The quality of the social investment by oil companies has thusfar been low. The Project developer should consider district medium-term development plans in designing social investment.	Government development plans will be considered in the development of mitigation and management measures for the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
10-dic-14	Shama District Assembly	Mr. Hon. Kojo K. Appiah Mr. Kassim Sampson	Community Investment	The district is deprived of any of the social interventions or packages given by the operating oil and gas companies.	This concern has been passed to the Project developer.
09-dic-14	Fishermen of Essiama	Mr. Nana Kofi Bekoe Mr. Kwesi Kanas Mr. Emmanuel Asamah Mr. Kwamuku Accra Boy Mr. Prah Mr. Francis Mr. George Baly Mr. Emmanuel Kwofie Mr. Paa Kwesi Mr. Darkwa Stephen Mr. Yaw Hammond Mr. Samuel Bekoe Mr. Mohammed Muzo	Community Investment	Often community investment programs do not benefit the fisherman.	This concern has been passed to the Project developer.
04-Dec-14	Ricerca e Cooperazione	Dr. Gianna da Re	Compensation	Adequate compensation needs to be given to land owners and farmers whose land will be used for the development.	The assessment will evaluate impacts related to land take and physical and economic displacement. The Project will follow laws and regulations related to land acquisition and land taken. The Project is preparing a Resettlement Action Plan to address compensation and livelihood restoration.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Compensation	Displaced land owners and land users need to be compensated.	The assessment will evaluate impacts related to land take and physical and economic displacement. The Project is preparing a Resettlement Action Plan to address compensation and livelihood restoration.
02-Dec-14	EPA	Mr. Ebenezer Appah-Sampong	Cultural Heritage	Project design should avoid and preserve the royal cemetery located within the land being acquired for the Project. Museums and Monuments Board (MMB) should be consulted in matters related to cemeteries.	Information gathered during the ESHIA will input into the design for the onshore pipeline route. The MMB is being consulted.
17-Dec-14	Ghana Museums and Monuments Board (GMMB), Central and Western Regional Office, Cape Coast	Mr. Mark Amenyo-Xa Mr. Ebenezer Collins Bordoh Mr. Essel Blankson	Cultural Heritage	There are no documented sensitive cultural resources (slave forts or castles) in the area. It will be important to understand whether there are any artefacts of archaeological value within the project footprint area.	The ESHIA will include a study of cultural resources and provide mitigations and management The management plan will specify a procedure in the event of finding cultural resource by chance.
17-Dec-14	Ghana Museums and Monuments Board (GMMB), Central and Western Regional Office, Cape Coast	Mr. Mark Amenyo-Xa Mr. Ebenezer Collins Bordoh Mr. Essel Blankson	Cultural Heritage	There should be a buffer zone around sensitive areas of customary and heritage significance (eg, the Royal Cemetery). 100 m is suggested although there is no legislation with requirements for the size of the buffer zone. If required, it is common for cemeteries and graves to be moved through negotiation with local communities and local traditional leadership; including performing of traditional ceremonies.	The Project is being designed to avoid area of important cultural heritage as much as possible. The ESHIA will include a study of cultural resources and provide mitigations and management The management plan will specify a procedure in the event of finding cultural resource by chance.
04-Dec-14	Ricerca e Cooperazione	Dr. Gianna da Re	Cultural Heritage	Archaeological and historical sites encountered during construction need to be protected.	This will be evaluated in the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
02-Dec-14	EPA	Mr. Ebenezer Appah-Sampong	Cumulative Impacts	There are several ongoing projects along the coastline affecting people, especially the fishermen.	Cumulative impacts will be assessed.
02-Dec-14	Fisheries Commission	Mr.Samuel Quartey	Cumulative Impacts	The will be cumulative effects on fishing due to the exclusion zones for the various projects being developed.	This will be evaluated in the ESHIA.
04-Dec-14	Ricerca e Cooperazione	Dr. Gianna da Re	Cumulative Impacts	Cumulative impacts from the several projects currently ongoing in the area could include: - Disturbances to population - Air emissions - Biodiversity disruption.	This will be evaluated in the ESHIA.
04-Dec-14	Ghana Ports & Harbour Authority	Mr. James Ben Gaisie	Cumulative Impacts	Cumulative impacts should be assessed given that there are a number of projects being developed in the Western Region.	This will be evaluated in the ESHIA.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Cumulative Impacts	The assessment needs to evaluate cumulative impacts.	This will be evaluated in the ESHIA.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Employment	In view of the low capacities of the people in the area in relation to the various component s of the project, it is unlikely for many to be employed by the company. It will therefore be important to create the necessary awareness and understanding about the technical nature of the project to manage their expectations.	Information regarding job creation and employment will be provided as part of stakeholder engagement and disclosed in the ESHIA.
10-dic-14	Shama District Assembly	Mr. Hon. Kojo K. Appiah Mr. Kassim Sampson	Employment	Local content must be a priority for oil and gas companies.	The Project will follow the laws and regulations related to employment. The ESHIA will evaluate impacts related to employment.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
09-dic-14	Fishermen of Essiama	Mr. Nana Kofi Bekoe Mr. Kwesi Kanas Mr. Emmanuel Asamah Mr. Kwamuku Accra Boy Mr. Prah Mr. Francis Mr. George Baly Mr. Emmanuel Kwofie Mr. Paa Kwesi Mr. Darkwa Stephen Mr. Yaw Hammond Mr. Samuel Bekoe Mr. Mohammed Muzo	Employment	Emphasized the need for local content and youth employment.	The Project will follow the laws and regulations related to employment. The ESHIA will evaluate impacts related to employment.
02-Dec-14	Ministry of Energy & Petroleum	Dr. Kwesi Twum-Addo	Fishing	The Project should consider offsets for the loss of livelihood of fishermen such as aquaculture and mariculture.	This will be considered in the ESHIA.
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Andrew Kyei Agyare	Fishing	There is a perception that proliferation of seaweed is affecting fishing.	This will be evaluated in the ESHIA.
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Andrew Kyei Agyare	Fishing	Social impacts, especially the effects on the fishermen, need to be addressed.	This will be evaluated in the ESHIA.
02-Dec-14	Fisheries Commission	Mr. Samuel Quartey	Fishing	A Fisheries Impact Assessment (FIA) is required. The impact assessment should identify what indicators will be used to monitor changes.	A specific FIA will be done. The FIA will specify a monitoring programme and include specific monitoring indicators.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
02-Dec-14	Fisheries Commission	Mr. Samuel Quartey	Fishing	The Project should assist fishermen by developing mariculture projects.	The assessment will evaluate impacts on fishing. The possibility of mariculture as a means to restore livelihoods will be considered. The Project is preparing a Resettlement Action Plan to address compensation and livelihood restoration.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Fishing	The Project will create further restrictions on fishing. There are reports of human rights violations and abuse of power by government security forces on fishermen near the Jubilee Field FPSO.	This will be evaluated in the ESHIA.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Fishing	A Fisheries Impact Assessment (FIA) needs to be conducted.	A specific FIA will be done.
08-Dec-14	EPA (Western Region)	Mr. Shine Fiagome Mr. Hakim Seidu	Fishing	A Fisheries Impact Assessment (FIA) is required for this Project. It was advised for the Fisheries Commission to be consulted for its guidelines on the preparation of a FIA.	A specific FIA will be done. The Fisheries Commission will be consulted.
08-Dec-14	Marine Police	Captain Owusu Berko Mr. Charles Osei	Fishing	The Marine Police expressed concerns regarding repeated claims by fishers that they are neglected in decisions on social investments. The Project should consult fishermen on their needs to establish the basis of any social investment decision.	The ESHIA will evaluate impacts on fishing and Project-related community investments.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
09-Dec-14	Western Regional Fisheries Commission (WRFC)	Mr. Alex Sarbah	Fishing	The increased number of FPSOs would bring about the imposition of extra restrictions on the fishing space which fishermen already are having limited access (i.e. the exclusion zones around the FPSO). Reduction in fishing space is expected to be considered by fishermen to have an impact on the livelihood of fishermen and their dependants.	The ESHIA will evaluate the impacts on fishing from Project related safety exclusion zones. The cumulative impacts of multiple safety exclusion zones will also be evaluated.
09-Dec-14	Western Regional Fisheries Commission (WRFC)	Mr. Alex Sarbah	Fishing	There is a concern in relation to the interaction between security officers and fishermen who ignorantly entered the Exclusion Zones around the currently existing FPSOs and potential conflict. It is suggested that these problems could be avoided if sufficient awareness among fishermen is created regarding the exclusion zone restrictions. The Project is advised to provide geographic charts and carry out sufficient awareness–raising to ensure safe mouvement of fishermen.	ESHIA stakeholder engagement is being done at the national, regional and local scale. The mitigation measures will include recommendation for communication of safety requirements and safety exclusion zones.
05-dic-14	Jomoro District Assembly	Mr. Salil Ali Mahome Mr. Emmanuel Armo Mr. Abudu Amade Mr. Samuel Tutani	Fishing	Access to fishing grounds of fishermen might be impeded causing decline in livelihood activities and income.	This will be evaluated in the ESHIA.
06-dic-14	Jomoro District Assembly	Mr. Salil Ali Mahome Mr. Emmanuel Armo Mr. Abudu Amade Mr. Samuel Tutani	Fishing	Accidental pipe leakage might disturb the marine ecosystem and impact on fish stocks.	The ESHIA will evaluate risk of accidents and impacts to marine ecology and fish.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
05-Dec-14	Fisherman of Shama	Mr. Nana Efirimu Mr. Frank Pegu Mr. Emmanual Tecco Mr. Aworti Aygwenka Yakubo Mr. Kwesi Nkrumah, Kweku Bedu Papa Kofi-Essoun, Papa Kwesi Mr. Magya Kojo	Fishing	Oil and gas activities are causing the proliferation of weeds which are negatively affecting fish stocks.	This will be evaluated in the ESHIA.
05-Dec-14	Fisherman of Shama	Mr. Nana Efirimu Mr. Frank Pegu Mr. Emmanual Tecco Mr. Aworti Aygwenka Yakubo Mr. Kwesi Nkrumah, Kweku Bedu Papa Kofi-Essoun Papa Kwesi Mr. Magya Kojo	Fishing	The installation of the FPSO with its high illumination has drawn all the fish to its immediate surroundings where we are not allowed to fish.	This will be evaluated in the ESHIA.
05-Dec-14	Fisherman of Shama	Mr. Nana Efirimu Mr. Frank Pegu Mr. Emmanual Tecco Mr. Aworti Aygwenka Yakubo Mr. Kwesi Nkrumah, Kweku Bedu Papa Kofi-Essoun Papa Kwesi Mr. Magya Kojo	Fishing	Fisherman will experience the greatest impact of the development in comparison to other groups.	This will be evaluated in the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
05-Dec-14	Fisherman of Shama	Mr. Nana Efirimu Mr. Frank Pegu Mr. Emmanual Tecco Mr. Aworti Aygwenka Yakubo Mr. Kwesi Nkrumah Kweku Bedu Papa Kofi-Essoun Papa Kwesi Mr. Magya Kojo	Fishing	Fishermen have experienced abuse from the Ghana Navy when they drifted into exclusion zone accidentally.	This will be evaluated in the ESHIA.
05-Dec-14	Fisherman of Shama	Mr. Nana Efirimu Mr. Frank Pegu Mr. Emmanual Tecco Mr. Aworti Aygwenka Yakubo Mr. Kwesi Nkrumah Kweku Bedu Papa Kofi-Essoun Papa Kwesi Mr. Magya Kojo	Fishing	Fishermen are concerned that the fishing area is being reduced.	This will be evaluated in the ESHIA.
08-dic-14	Sekondi-Takoradi Metropolitan Assembly	Mr. Henry Owusu	Fishing	Fishermen are concerned that dwindling fish stocks were related to oil and gas activities.	This will be evaluated in the ESHIA.
08-dic-14	Sekondi-Takoradi Metropolitan Assembly	Mr. Henry Owusu	Fishing	Fishermen have been harassed by the Ghana Navy when entering the exclusion zone around the FPSO at Jubilee Field.	This will be evaluated in the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
08-dic-14	Sekondi-Takoradi Metropolitan Assembly	Mr. Henry Owusu	Fishing	Does the lighting around the FPSO attract fish? Fishermen believe that fish are all being attracted to the FPSO.	This will be evaluated in the ESHIA.
10-dic-14	Shama District Assembly	Mr. Hon. Kojo K. Appiah Mr. Kassim Sampson	Fishing	Capacity building only benefits the chief fisherman and not all fishermen.	This concern has been passed to the Project developer.
08-dic-14	Nzema East Municipal Assembly	Mr. Dominc Boadu-Ayebato Mr. Isaac Kwakye Mr. Kwabena Kesseh Mr. John Tetteh Doku Mr. Emmanuel Azuma Mr. Kingsley Ofori Mr. Eric Yeboah	Fishing	The additional light from oil and gas structures is drawing fish into the exclusion zone where they are unable to fish.	This will be evaluated in the ESHIA.
08-dic-14	Nzema East Municipal Assembly	Mr. Dominc Boadu-Ayebato Mr. Isaac Kwakye Mr. Kwabena Kesseh Mr. John Tetteh Doku Mr. Emmanuel Azuma Mr. Kingsley Ofori Mr. Eric Yeboah	Fishing	If fishing livelihoods are impacted they will not have sources of income to provide for thier families (singular livelihood).	This will be evaluated in the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
08-dic-14	Chief Fisherman of Upper Axim (Ahanta West DA)	Mr. Nana Etwe Azane Mr. C.K.Attah Mr. Kofi Yankey Uncle Kwabena Mason Uncle Ebukobo	Fishing	The fishermen were concerned that there may be an exclusion zone around the subsea pipeline.	The details related to exclusion zones and restriction of certain activities around the offshore pipeline will be provided in the ESHIA. eni Ghana will communicate the location of the exclusion zones and restrictions to sea users, including local fishermen and will be included in the Project's mitigation plan.
09-dic-14	Fishermen of Essiama	Mr. Nana Kofi Bekoe Mr. Kwesi Kanas Mr. Emmanuel Asamah Mr. Kwamuku Accra Boy Mr. Prah Mr. Francis Mr. George Baly Mr. Emmanuel Kwofie Mr. Paa Kwesi Mr. Darkwa Stephen Mr. Yaw Hammond Mr. Samuel Bekoe Mr. Mohammed Muzo	Fishing	The fishermen are concerned that the construction of the pipeline will negatively affect fish stocks.	This will be evaluated in the ESHIA.
03-dic-14	Chief Fisherman of Half Assini	Mr. Nana Emma Odwire Mr. Paul Forson	Fishing	The fish catch has declined over the past 10 years.	This will be evaluated in the ESHIA.
03-dic-14	Chief Fisherman of Half Assini	Mr. Nana Emma Odwire Mr. Paul Forson	Fishing	Potential adverse effects of the Project can be addressed if a management plan is put in place.	A management plan will be prepared as part of the ESHIA process.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
03-dic-14	Chief Fisherman of Half Assini	Mr. Nana Emma Odwire Mr. Paul Forson	Fishing	Fishermen will be the most directly affected by the proposed project because the sea is their source of livelihood.	This will be evaluated in the ESHIA.
09-dic-14	Chief Fisherman of Sekondi	Mr. Nana Essoun	Fishing	The impacts of additional lighting from oil and gas infrastructure on fisheries.	This will be evaluated in the ESHIA.
09-dic-14	Chief Fisherman of Sekondi	Mr. Nana Essoun	Fishing	The Chief Fisherman requested more education on oil and gas activities in order to avoid conflict between fishermen and oil and gas operators.	This request has been passed to the Project developer.
08-dic-14	Nzema East Municipal Assembly	Mr. Dominc Boadu-Ayebato Mr. Isaac Kwakye Mr. Kwabena Kesseh Mr. John Tetteh Doku Mr. Emmanuel Azuma Mr. Kingsley Ofori Mr. Eric Yeboah	Fishing	There has been a reduction in the area that fishermen are able to fish due to restriction from oil and gas activities.	This will be evaluated in the ESHIA.
03-dic-14	Jomoro District Assembly	Mr. Emmanuel Armo Mr. Abudu Amade Mr. Raymond Seaworth.	Infrastructure	Health and education facilities might be overstretched due to influx of workers and their dependents into the project area.	This will be evaluated in the ESHIA.
10-dic-14	Shama District Assembly	Mr. Hon. Kojo K. Appiah Mr. Kassim Sampson	Infrastructure	Additional social infrastructure should be constructed to cope with influx of people into the area.	Impacts as a result of influx will be evaluated as part of the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
08-dic-14	Chief Fisherman of Upper Axim (Ahanta West DA)	Mr. Nana Etwe Azane Mr. C.K.Attah Mr. Kofi Yankey Uncle Kwabena Mason Uncle Ebukobo	Marine Ecology	The construction of subsea pipeline will cause degradation to the marine environment.	This will be evaluated in the ESHIA.
04-Dec-14	Ghana Ports & Harbour Authority	Mr. James Ben Gaisie	Project Design	Will the Project build a temporary jetty at the coast for transport of equipment?	The Project design at this time does not include a jetty at the coastline.
05-dic-14	Ellembelle District Assembly	Mr. Derrick Obeng	Resettlement	The Project may require resettlement and potential loss of land for communities.	The assessment will evaluate impacts related to land take and physical and economic displacement. The Project is preparing a Resettlement Action Plan to address compensation and livelihood restoration.
02-Dec-14	EPA	Mr. Ebenezer Appah-Sampong	Safety	There should be a clear demarcation of the offshore pipeline on nautical charts.	This will be included in the Project's mitigation plan.
02-Dec-14	Ministry of Energy & Petroleum	Dr Kwesi Twum-Addo	Safety	There should be a clear demarcation of the project facilities on nautical charts. The pipeline should be buried to avoid damage.	This will be included in the Project's mitigation plan.
02-Dec-14	Fisheries Commission	Mr.Samuel Quartey	Safety	The Project should considering burial of the offshore pipeline to prevent damage from vessels and anchors. The offshore pipeline locations should be clearly communicated to marine users and mapped on nautical charts.	This will be evaluated in the ESHIA.
04-Dec-14	Ghana National Petroleum Corporation (GNPC)	Mr. Seth Foli	Safety	Will the offshore pipeline be buried?	Alternatives for burial of the offshore pipeline are being developed by the Project's technical team. This will be described and evaluated in the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
04-Dec-14	Ghana Ports & Harbour Authority	Mr. James Ben Gaisie	Safety	The Project should considering burial of the offshore pipeline to prevent damage from vessels and anchors. The offshore pipeline locations should be clearly communicated to marine users and mapped on nautical charts.	Alternatives for burial of the offshore pipeline are being developed by the Project's technical team. This will be described and evaluated in the ESHIA. Requirements for documenting the final pipeline route will be specified in the ESHIA.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Safety	Will the FPSO be a single hull or double hull design?	The FPSO will have a double hull.
09-Dec-14	Ghana Tourism Authority (GTA), Western Regional Directorate	Mr. Michael Kpinghi	Safety	The Project will need to consider safety of tourists. The Project is advised to pay serious attention to safety communications through the necessary safety and warning signs along the gas pipeline.	The ESHIA will evaluate risk and impacts to public safety.
09-dic-14	Fishermen of Essiama	Mr. Nana Kofi Bekoe Mr. Kwesi Kanas Mr. Emmanuel Asamah Mr. Kwamuku Accra Boy Mr. Prah Mr. Francis Mr. George Baly Mr. Emmanuel Kwofie Mr. Paa Kwesi Mr. Darkwa Stephen Mr. Yaw Hammond Mr. Samuel Bekoe Mr. Mohammed Muzo	Safety	The fishermen are concerned about the impeded access to fishing grounds.	The Project will require a safety exclusion zone around offshore facilities. The size of the zone has not been finalised at this time. The impacts will be evaluated in the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
03-dic-14	Chief Fisherman of Half Assini	Mr. Nana Emma Odwire Mr. Paul Forson	Safety	Consultation and education should be done ahead of contraction activities to alert fishermen of the dangers involved in getting close to demarcated danger zones.	This will be evaluated in the ESHIA. The management plan will include requirements for notifications and communications.
03-dic-14	Chief Fisherman of Half Assini	Mr. Nana Emma Odwire Mr. Paul Forson	Safety	The Project must adhere to high construction standards to avoid pipe burst in future.	This will be evaluated in the ESHIA.
08-Dec-14	Marine Police	Captain Owusu Berko Mr. Charles Osei	Security	The Marine Police expressed concerns that fishers have exaggerated misconceptions about the effect of oil and gas operations on fisheries, which exposes oil and gas operators to frequent agitations. The Marine Police indicated that these agitations pose security threats as conflict can turn violent. It was therefore advised for efforts to be made to sensitise and reorient fishermen on the actual impacts of the oil and gas operations as against the perceived impacts.	The ESHIA will evaluate issues of safety and security, including potential conflict between marine security and marine resource users, in particular fishermen.
08-Dec-14	Marine Police	Captain Owusu Berko Mr. Charles Osei	Security	Based on experience with similar projects in the Atuabo area, the Marine Police proposed the establishment of a security base within the onshore project development footprint. According to the Marine Police, their officers stationed at Ainyinase find it very difficult to swiftly respond to security calls due to the long distance. They also indicated that the Marine Police are in need of a vessel for offshore policing.	The ESHIA will evaluate issues of safety and security, including capacity of public law enforcement to implement mitigation requirements.
02-Dec-14	EPA	Mr. Larry Kotoe	Social Impacts	ROW should be surveyed for encroachment.	This will be included in the Project's monitoring plan.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Nana Kofi Adu-Nsiah	Social Impacts	The increase in population as a result of the influx of workers, including job seekers, may result in social issues.	This will be evaluated in the ESHIA.
02-Dec-14	Wildlife Division of Forestry Commission	Mr. Nana Kofi Adu-Nsiah	Social Impacts	The Project should consider the risks and impacts that would arise if minerals were found during development. This might induce illegal mining (galamsy).	This will be evaluated in the ESHIA.
04-dic-14	Jomoro District Assembly	Mr. Abudu Amade	Social Impacts	Influx of workers into the project area might increase the incidences of social vices and health problems for the host communities.	This will be evaluated in the ESHIA.
02-Dec-14	EPA	Mr. Larry Kotoe	Stakeholder Engagement	It is important that consultations are held at an early stage of the project. The Project should consult with GNGC the owner of the onshore pipeline ROW.	ESHIA stakeholder engagement is being done at the national, regional and local scale. Consultation with GNGC is being arranged.
02-Dec-14	Ministry of Energy & Petroleum	Prof. Thomas Akabzaa	Stakeholder Engagement	The ESHIA process should include comprehensive stakeholder engagement.	ESHIA stakeholder engagement is being done at the national, regional and local scale.
04-Dec-14	Ghana National Petroleum Corporation (GNPC)	Mr. Seth Foli	Stakeholder Engagement	The ESHIA schedule is too short and may not allow for a detailed assessment and enough time for disclosure of the impact assessment report.	The assessment will follow Ghana regulatory requirements including the duration requirements for review and disclosure as specified by the Ghana EPA.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Stakeholder Engagement	What consultations will take place as part of the ESHIA process?	The scoping report includes the details of the stakeholder engagement plan.
05-Dec-14	Friends of the Nation	Mr. Kwesi Randolph Johnson	Stakeholder Engagement	Problems may arise if the Project development is rushed.	The assessment will follow Ghana regulatory requirements including the duration requirements for review and disclosure as specified by the Ghana EPA.

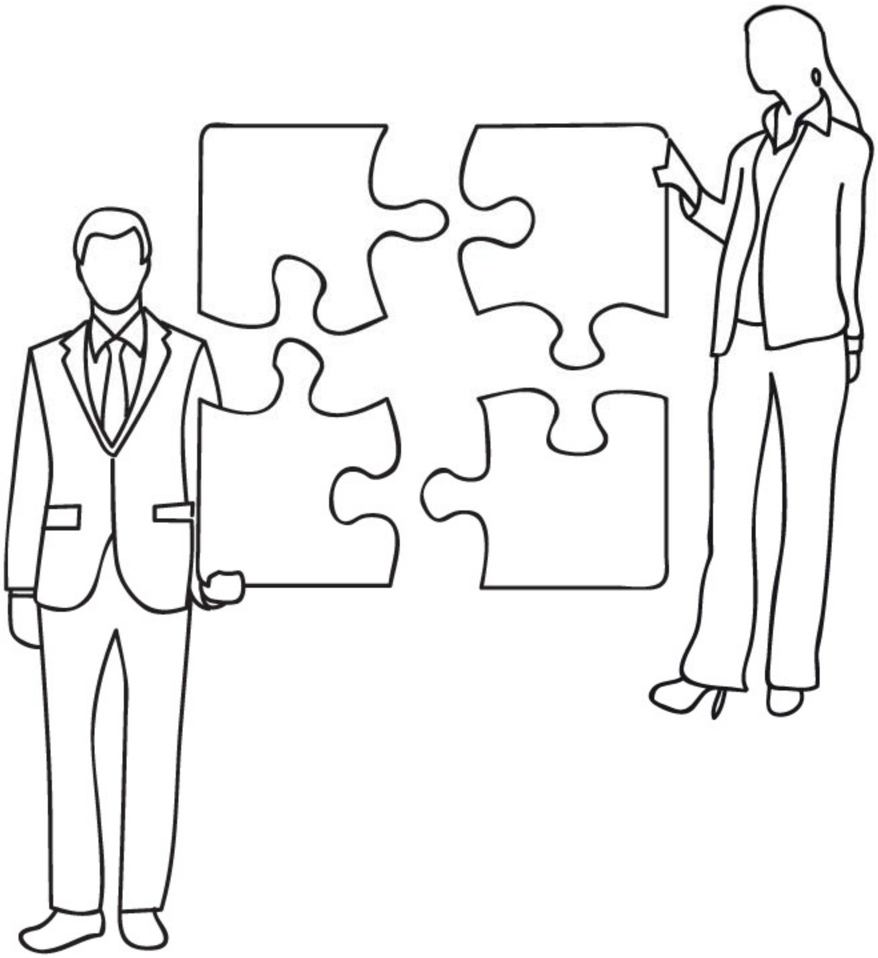
Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
08-Dec-14	EPA (Western Region)	Mr. Shine Fiagome Mr. Hakim Seidu	Stakeholder Engagement	Consultations with local communities should be extended to issues of traditional and customary concerns to help gather sufficient information on taboos, sacred sites along with guidance on the traditional protocols.	The scope of the socio-economic studies will include evaluation of impacts to traditions and cultural heritage.
08-Dec-14	EPA (Western Region)	Mr. Shine Fiagome Mr. Hakim Seidu	Stakeholder Engagement	The Environmental Health Department should be consulted if the project will result in the decommissioning of a cemetery. It was suggested that the age of the cemetery should be ascertained as this could have implications on the requirements for the mouvement or protection of the graves.	The Project will consult with the Environmental Health Department on matters related to cemeteries.
08-Dec-14	Western Regional Coordinating Council (RCC),	Mr. Hon Alfred Ekow Gyan Mr. Hope Howusu, Mr. Edward Nelson	Stakeholder Engagement	Community and district structures should not be ignored in project siting and planning of projects. There should be more collaboration with the authorities at the community and district level throughout the phases of the project. The Project should consider working with RCC to assist in coordinating between these groups.	ESHIA stakeholder engagement is being done at the national, regional and local scale.
09-Dec-14	Western Regional Coordinating Council (RCC),	Mr. Hon Alfred Ekow Gyan Mr. Hope Howusu Mr. Edward Nelson	Stakeholder Engagement	The RCC also expressed concern that companies invest in social interventions which do not meet the needs of the people in the host communities. They urged the proponent to consult the communities to understand their needs.	ESHIA stakeholder engagement is being done at the national, regional and local scale.
04-dic-14	Ellembelle District Assembly	Mr. William Tei-Kpoti	Stakeholder Engagement	Communities may have a problem fully understanding the EIA process and project activities.	This will be considered in developing the ESHIA stakeholder engagement plan.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
07-dic-14	Ellembelle District Assembly	Mr. Innocent Haligah	Stakeholder Engagement	There should be greater communication between the Project and the Ellembelle DA.	This will be considered in developing the ESHIA stakeholder engagement plan.
08-dic-14	Chief Fisherman of Upper Dixcove (Ahanta West DA)	Mr. Nana Acheampong	Stakeholder Engagement	All suggestions from communities must be taken seriously.	The ESHIA report will document how comments are addressed.
02-Dec-14	Regional Health Director (Western Region)	Dr. Emmanuel Tinkorang	Stakeholder Engagement	The ESHIA Team need permission to engage with health informants at the District Level.	Permission was obtained to engage at the District level.
02-Dec-14	District Health Director (Ellembelle)	Mrs. Elizabeth Corney	Stakeholder Engagement	The District Health Director needs to be aware of stakeholder engagement in the project area so engagement can be directed to key people for Key Informant Interview.	The District Health Director was informed.
09-Dec-14	Ghana Tourism Authority (GTA), Western Regional Directorate	Mr. Michael Kpinghi	Tourism	The coast of the Western Region is highly valued for tourism and has therefore planned to enhance the attractiveness of the various beaches to create jobs and prosperity for people in the coastal communities. The project should to be developed in a manner that does not negatively affect the tourism activities or potential for new tourism developments and activities. The project should avoid destroying any resources of tourism value and work towards enhancing the attractiveness of the place.	The ESHIA will evaluate impacts to tourism.
06-dic-14	Ellembelle District Assembly	Mr. Ted Teffey Mr. Kwabena Asiedu-Bediako Mr. Derrick Obeng Mr. William Tei-Kpoti	Tourism	Wetlands, mangroves and extensive wildlife near New Bakanta must be preserved as a potential tourism site.	This will be evaluated in the ESHIA.

Date	Stakeholder Group	Stakeholder	Issue	Comments	Response
08-Dec-14	EPA (Western Region)	Mr. Shine Fiagome Mr. Hakim Seidu	Traffic	Increased traffic and movement of heavy-duty trucks will have an impact on road safety in the area. Dust associated with vehicle movements will also likely affect air quality. The Project should consider sea routes for transport of equipment and goods.	Traffic effects on road safety and ambient air quality will be evaluated in the ESHIA. The Project will evaluate the possibility of transport of equipment and goods via the sea.
02-Dec-14	Fisheries Commission	Mr.Samuel Quartey	Transboundary Impacts	Transboundary impacts should be taken into consideration due to proximity to the border and direction of currents.	This will be evaluated in the ESHIA.

Plan

HSE-PLAN-003 “DEVELOPMENT DRILLING & PRODUCTION OPERATIONS OIL SPILL CONTINGENCY PLAN – OCTP Block”



TITLE:	
DEVELOPMENT DRILLING & PRODUCTION OPERATIONS OIL SPILL CONTINGENCY PLAN - Offshore Cape Three Points (OCTP) Block	
NOTE:	
Revised by OSRL to include development drilling and production operations, where information is available.	
DATE OF ISSUE:	EFFECTIVE DATE:
May 2015	May 2015

PREPARED BY:	CHECKED BY:	APPROVED BY:
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For information:

- All eni Ghana employees

REVISION SHEET

Rev.	Date	No. pages	Change Description	Prepared	Verified	Approved
3	May 2015	211	Development drilling and production operations update (4th Draft)	D. Fraser (OSRL) M. Mariani (EMERG)	J. Deffis	F. Cavanna
2	27/03/2013	92	Annual revision and template change	M. Bartels-Kodwo	F. Manglaviti	F. Cavanna
1	26/01/2011	75	Annual revision	F. Manglaviti	F. Manglaviti	F. Conticini
0			First Issue	F. Manglaviti	F. Manglaviti	G. Moscato

CONTENTS

1. SCOPE AND OBJECTIVE

1.1 Scope

The scope of this Oil Spill Contingency Plan (OSCP) is to cover eni Ghana development drilling and production operations in the Offshore Cape Three Points (OCTP) Block in Ghana. The following development drilling and production operations will be covered by this OSCP:

- Development Drilling operations: Oil spills resulting from the drilling of 19 subsea wells (8 oil producers, of which 2 are re-entry, 5 subsea gas producers wells, 3 water injectors and 3 gas injectors) via the Maersk Voyager Drilling Vessel;
- Production operations:
  - Oil spills resulting from production operations relating to the Floating, Production, Storage and Off-loading (FPSO) unit;
  - 8 subsea oil producer wells;
  - 5 subsea gas producer wells;
  - Subsea network of flexible flowlines and risers to the process facilities on the FPSO;
  - Processed crude oil stored in the FPSO cargo tanks;
  - Shuttle tankers periodically moored to the FPSO;
  - Stored crude oil pumped to the shuttle tanker via an offloading hose;
  - gas sealine 63 km long to the Onshore Receiving Facilities (ORF).
- Field Support: Oil spills resulting from activities involving the field support vessels.

The Plan contains organisational responsibilities, actions, reporting requirements and resources available to ensure the effective and timely management of an accidental oil spill; and supplies the Emergency Response Team (ERT) with a high level strategic document that covers the main procedures and information required during an oil spill response.

1.2 Objective

The objective of this OSCP is to offer guidance on the necessary actions to prevent and/or minimise any accidental discharge of oil and to mitigate any negative effects. The OSCP is a product of the eni Ghana Integrated Management System and interfaces with the following plans:

- Ghana National Oil Spill Contingency Plan (NOSCP) and;
  - The National Oil Spill Response Dispersant Use Policy;
  - Oil Spill Dispersants Guidelines;
  - Guidelines for Management and Disposal of Oil Spill Debris.
- Environmental Sensitivity Map for Coastal Areas of Ghana;
- eni Ghana Emergency Response Plan (HSE-PLAN-002);
- eni Ghana Waste Management Plan (HSE-PLAN-005);
- eni Ghana / Rig vessel operator in place.

1.3 How to use this document

The implementation of the OSCP is subject to the following general instructions:

- Where a spillage is a part of a wider emergency, such as a blowout or fire or explosion, these aspects of the incident must be addressed first and reference should be made to the eni Ghana Emergency Response Plan.
- Effectiveness of intervention and communication has priority over normal Company hierarchical relationships.
- Should a position be unavailable along the activated/information chain, the action is transferred to that person's stand-by. If the nominated stand-by is absent, the role transfers to that person's signature authority.
- Persons assigned to the Emergency Response Team generally perform their normal daily roles but in the more critical environment generated by an emergency situation.

2. ACRONYMS

EPA	Environmental Protection Agency
UPSTREAM	Upstream and Technical Services
EC	Emergency Coordinator (eni Ghana)
ERC	Emergency Response Coordinator (eni Upstream)
ERM	Emergency Response Manager
ERP	Emergency Response Plan
ERR	Emergency Response Room
ERT	Emergency Response Team
ft	Feet
GNPC	Ghana National Petroleum Corporation
GPS	Global Position System
HQ	Head Quarters
HRO	Human Resources and Organisation
HR	Human Resources
HSE	Health, Safety, Environment and Public Safety Integrated Management System
HSE & CI	Health, Safety, Environmental And Community Investment
IBC	Intermediate Bulk Container
IMO	International Maritime Organization
IPIECA	International Petroleum Industry Environmental Conservation Association
ITCZ	Inter – Tropical Convergence Zone
JOA	Joint Operating Agreement
km	Kilometre
lts	Litres
LM	Logistics Manager
m	Metre
min	Minute
mm	Millimetre
µm	Micrometre

NAG	Non Associated Gas
NCA	National Competent Authority
NCP	National Contingency Plan
NEBA	Net Environmental Benefit Analysis
nm	Nautical mile
NOSCP	National Oil Spill Contingency Plan
OSC	On Scene Commander
OSCP	Oil Spill Contingency Plan
OSRL	Oil Spill Response Limited
PEAR	People, Environment, Assets and Reputation (An acronym used when assessing the significance of the emergency event under the Incident Command Structure).
PIC	Person in Charge
PoB	People on Board
PPE	Personal Protective Equipment
sec	Second
SITREP	Situation Report
PSV	Platform Supply Vessel
SOPEP	Shipboard Oil Pollution Emergency Plan
UVF	Ultra-Violet Fluorometry
WACAF	West and Central Africa

3. ACTION PLAN

Figure 1 illustrates the reporting procedures and key actions that the key personnel will follow in the event of an oil spill incident from eni Ghana's operations.

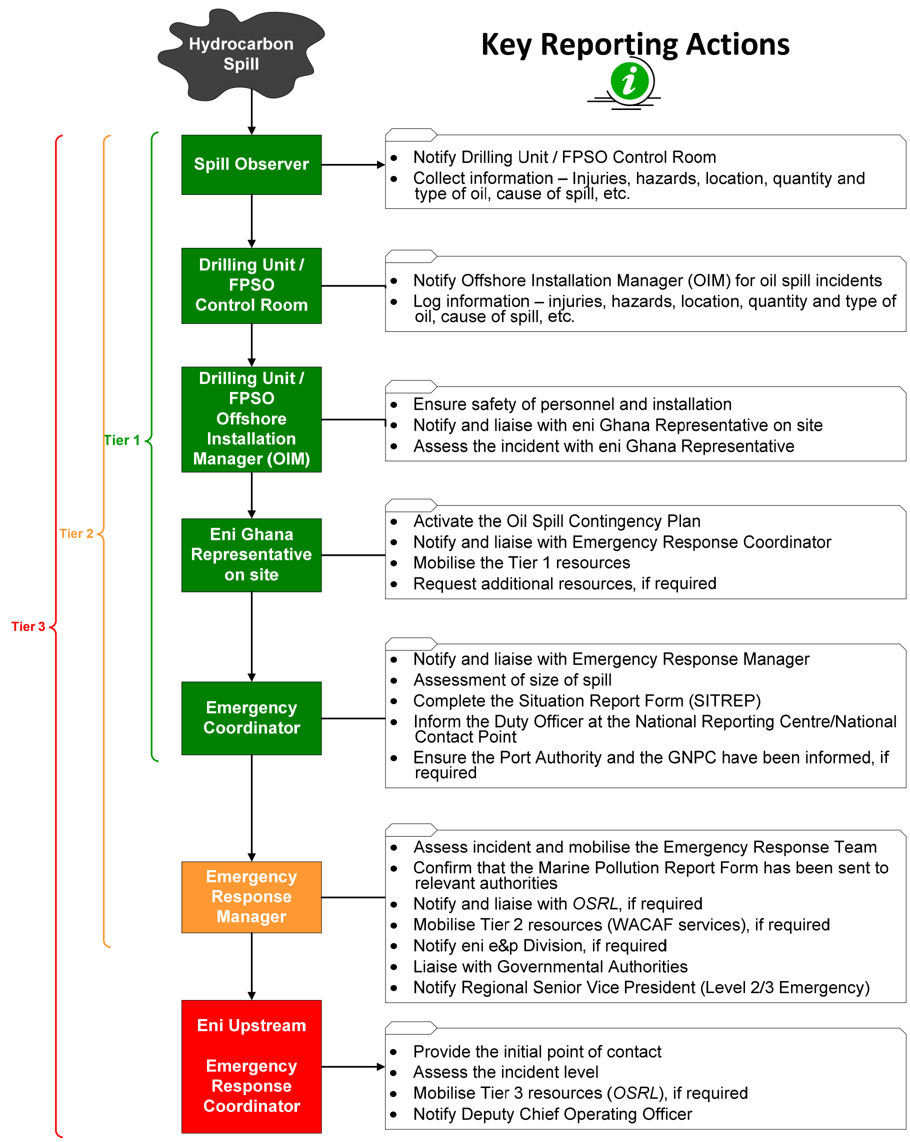


Figure 1 Initial Notifications and Reporting Procedures

Note: The Emergency Coordinator has to report all spills to the (EPA +233 (0) 0302 664697/8, 667524, 662465).

In the event of a Tier 1 spill in the Harbour from one of the PSVs the Vessel Master will report the incident to the Harbour Master and the eni Ghana Emergency Response Coordinator.

3.1 Action Checklists

Once the OSCP has been activated and the ERT have been mobilized (in part or in full), individual ERT members will assume the roles set out in Section 4.2.1. The checklists describe the supportive response procedures and typical issues that may require being considered and activated. ERT members should familiarize themselves with these checklists prior to commencement of operations and use them as an individual 'aid memoir' in the event of an oil spill response situation. These Checklists are provided in Sections 3.1.1 to 3.1.10. ERT members should ´personalize´ these as appropriate.

3.1.1 Spill Observer

STEP	ACTION	✓
Initial Actions	Notify Drilling Unit / FPSO Control Room and inform of:	
	▪ Location of spill/incident;	
	▪ Safety and status of personnel	
	▪ Source the cause of spill;	
	▪ Hydrocarbon type (e.g. diesel, utility oils);	
	▪ Extent of spill;	
	▪ Time and duration of incident;	
	▪ Potentially hazardous aspects; and	
	▪ Any other relevant information (particularly: is spill contained or is the release ongoing).	
	Contact all personnel in the vicinity of the source or spill and warn of hazard.	
Further Actions	Cease hot work if applicable, isolate ignition sources.	
	If safe to do so, stay in vicinity of the spill and continue observation.	
	If safe to do so, take reasonable actions to contain or reduce the leak or spill.	
	Only approach the spill from downwind of the source with an area gas monitor and appropriate Personal Protective Equipment (PPE).	
	Do not allow oil to come into contact with the skin.	

3.1.2 Drilling Unit / FPSO Control Room Operator

STEP	ACTION	✓
Initial Actions	Collate relevant spill information received from the Spill Observer.	
	Notify Offshore Installation Manager (OIM).	
	Request full details of the incident to the Spill Observer:	
	▪ Safety and status of personnel;	
	▪ Location of spill/incident;	
	▪ Source of spill;	
	▪ Hydrocarbon type (e.g. diesel, utility oils);	
	▪ Extent of spill;	
	▪ Time and duration of incident;	
	▪ Potentially hazardous aspects; and	
	▪ Any other relevant information (particularly: spill contained or ongoing release).	
	Start a Personal Log and record time and details of own actions.	
Further Actions	Maintain communication between the spill observer, OIM, Field Supply Vessels and Offshore Emergency Response Team.	

3.1.3 Offshore Installation Manager

STEP	ACTION	✓
Initial Actions	**ENSURE SAFETY IS A PRIORITY IN ANY SPILL.**	
	Muster/evacuate personnel as required.	
	Notify the eni Ghana Representative on site.	
	Obtain full details of the incident from the Control Room:	
	▪ Safety and status of personnel;	
	▪ Location of spill/incident;	
	▪ Source and cause of spill;	
	▪ Hydrocarbon type (e.g. diesel, utility oils);	
	▪ Extent of spill;	
	▪ Time and duration of incident;	
	▪ Potentially hazardous aspects; and	
	▪ Any other relevant information (particularly: spill contained or ongoing release).	
	Start a Personal Log and record time and details of own actions and own decisions.	
	Assess the source and cause of spill with assistance from eni Ghana Representative on site.	
Further Actions	Ensure that the eni Ghana Representative is provided with timely situation reports as and when required.	
	Obtain information on tides and direction/speed of current and wind.	
	Identify tasks that must be performed to implement the initial strategy with assistance from eni Ghana Representative on site.	
	Channel information to relevant parties and prioritise requests.	
Final Actions	Hold debrief for onsite personnel involved in the response.	
	Complete incident log and pass it to eni Ghana Representative on site.	
	Offer support to the incident investigation.	

3.1.4 eni Ghana Representative On Site

STEP	ACTION	✓
Initial Actions	**ENSURE SAFETY IS A PRIORITY IN ANY SPILL.**	
	Obtain full details of the incident from the OIM.	
	Activate the Oil Spill Contingency Plan (OSCP).	
	Assume the role of the On-Scene Commander (OSC).	
	Notify and liaise with the Emergency Coordinator (EC)	
	Start a Personal Log and record time and details of own actions and own decisions.	
	Alert the Offshore Emergency Response Team (ERT).	
	If required, request mobilisation and deployment of Tier 1 resources.	
	Make sure action has been taken to stop operational activities and if safe, stop spill.	
	Assist the OIM to assess the source and cause of spill.	
	▪ Estimate quantity of spilled oil (Section 395.2);	
	▪ Estimate direction of slick movement (Section 5.2);	
	▪ Allocate spill into appropriate Tier Level (Section 4.1).	
Further Actions	Complete the Situation Report Form (SITREP) (page 190)	
	Monitor the spill. If observation from deck / Field Supply Vessel is not sufficient, request aerial surveillance via the Emergency Response Coordinator.	
	If tracking of slick is not possible, request oil spill modelling via the Emergency Response Coordinator.	
	Monitor effectiveness of response strategy.	
	Ensure that timely situation reports are provided to the Emergency Response Coordinator, outlining: ▪ Changes to the incident situation. ▪ The effectiveness of the response strategies being employed.Support requirements. ▪ Site safety concerns.	
	Request additional resources from the Emergency Coordinator (EC) as soon as possible.	

STEP	ACTION	✓
	Coordinate activity for all Site ERT members in line with objectives and priorities.	
	Coordinate the arrival of Tier 2/3 resources and personnel.	
	Ensure new personnel arriving on site are fully briefed, emphasising safety issues associated with the drilling unit / FPSO and incident.	
	Collect and maintain relevant documents for response operations.	
Final Actions	Complete demobilization procedures.	
	Assist OIM to hold debrief for onsite personnel who were involved in the response.	
	Support the incident investigation and analysis as required.	
	Ensure Tier 1 resources are returned to standby.	
	When safe, restart normal operations.	
	Complete incident log.	
	Collect incident logs and pass them to HSE&CI Manager.	

3.1.5 Offshore Emergency Response Team

STEP	ACTION	✓
Initial Actions	**ENSURE SAFETY IS A PRIORITY IN ANY SPILL**	
	Respond immediately to any oil spill notification.	
	Collect PPE, communications and safety equipment.	
	Go to the muster point to wait for briefing.	
	Receive briefing from the eni Ghana Representative onsite (On-Scene Commander - OSC) before going on site.	
	Ensure awareness of the hazards that may occur (e.g. gas, explosive vapour, fire risk and dangers when using response equipment or chemicals).	
Further Actions	On arrival at the site of the spill:	
	▪ If area is unsafe, leave taking others with you; ▪ Assume fire or explosion risk until proven otherwise; ▪ Test communications; ▪ Be aware of muster points, evacuation routes and on site alerting system; ▪ Be aware of danger/exclusion zones and the areas where entry is forbidden for people, boats or helicopters; and ▪ Know what actions to take if someone is injured (i.e. first aid and contacting emergency services).	
	Follow instructions from the OSC.	
	Deploy oil spill response equipment as instructed.	
	Observe correct safety procedures for working in boats, handling equipment.	
	Know the locations and tasks of others on site and ensure that they are aware of your location and task.	
	Regularly reassess safety hazards to yourself and to other team members.	
Final Actions	Complete demobilisation procedures.	
	Give Individual Logs to the OSC.	
	Recover and clean equipment and if necessary repair all equipment after use.	
	Clean/decontaminate at a pre-identified site.	
	Report any damage to equipment to eni Ghana Representative on site (OSC).	
	Participate fully in debrief.	

3.1.6 Emergency Coordinator

STEP	ACTION	✓
Initial Actions	**ENSURE SAFETY IS A PRIORITY IN ANY SPILL.**	
	Obtain full details of the incident from the eni Ghana Representative (OSC)	
	Establish nature and severity of incident: ▪ Safety of personnel; ▪ Location of spill/incident; ▪ Source and cause of spill; ▪ Hydrocarbon type (e.g. diesel, utility oils); ▪ Extent of spill; ▪ Time and duration of incident; ▪ Potentially hazardous aspects; and ▪ Any other relevant information (particularly: is spill contained or is the release ongoing).	
	Start a Personal Log, record time and details of actions and decisions.	
	Assist eni Ghana Representative with the assessment of spill size.	
	Notify and liaise with the ERM and give full briefing on the situation.	
	Inform the Duty Officer at the National Reporting Centre and the National Contact Point.	
	Ensure the Port Authority, Petroleum Commission and the GNPC have been informed, if required.	
	Proceed to the ERR, if the ERM decides to mobilise the ERT.	
	Establish communication with incident site.	
	Complete Situation Report Form (SITREP) (Annex B, Section 3).	
Further Actions	Maintain close liaison with eni Ghana Representative onsite.	
	Update the Logistics Manager and HSE&CI Manager on the situation.	
	Update the ERM and agree actions.	
	Obtain all relevant technical information that may be necessary	
Final Actions	Confirm incident closure and agree stand down with ERM.	
	Attend debrief meeting.	
	Complete incident log.	
	Collect incident logs and pass them to Log Keeper.	

3.1.7 Emergency Response Manager

STEP	ACTION	✓
Initial Actions	**ENSURE SAFETY IS A PRIORITY IN ANY SPILL.**	
	Establish communication with the Emergency Coordinator (EC).	
	Obtain update of available information:	
	▪ People;	
	▪ Safety hazard;	
	▪ Damage to facilities;	
	▪ Extent of pollution (spill size and source, type of spilt oil);	
	▪ Actions taken so far.	
	Start a Personal Log and record time and details of own actions and own decisions.	
	Make, jointly with the EC, an initial evaluation of the situation and the need to mobilise ERT members.	
	Request HSE&CI Manager to mobilize the Emergency Response Team (ERT).	
	Proceed to Emergency Response Room (ERR).	
	With input from the ERC, prepare an assessment of the situation as the basis for a response strategy including:	
	▪ Situation: stable or escalating;	
	▪ Ability of the Site Emergency Teams to control the event;	
	▪ Environment damage status: extent, containment, clean-up actions, expected long-term effects;	
	▪ Assistance: focus on immediate / priority tasks (as requested).	
	Ensure the members of ERT are fully briefed.	
	Identify the initial actions required from the ERT.	
	Ensure that Navy Operations and EPA have been notified.	
	Confirm that the Marine Pollution Report Form has been sent to the appropriate Regulatory Bodies (PC and EPA).	
	For Tier 2/3 spill aerial surveillance should be initiated in order to determine position of slick, progress of natural dispersion and potential requirement for dispersant spraying (Refer to Section 6 for details).	

STEP	ACTION	✓
	Note: If chemical dispersant strategy is to be initiated, request HSE&CI Manager to make contact with EPA, as appropriate.	
Further Actions	Hold regular update sessions.	
	Notify OSRL even if their mobilisation may not be required.	
	Communicate with Emergency Response Coordinator (eni Upstream & Technical Services).	
	Authorise mobilisation of equipment necessary for implementation of response strategy.	
	If extra resources are needed (or if continuous spill or if shoreline is at risk), mobilize resources from *OSRL*.	
	Establish contact with shareholders' Emergency Response Coordinator and clarify the specific communications between individual ERT members and shareholders' emergency response personnel.	
	Maintain an overview of the status of events and actions, manage the ongoing ERT response effort and delegate actions.	
	Mobilize the Public Affairs Advisor.	
	Ensure that local opinions and concerns are monitored and addressed.	
	Ensure that up-to-date reports are circulated to all notified parties.	
	Discuss situation with Shareholders Business Area.	
	Assess possible escalations and continuation of the emergency, reviewing response strategy accordingly.	
	Establish appropriate authorization for expenditure as required.	
	Ensure that an initial media holding statement is available and ready for issue if required.	
	Ensure logs and records of events, actions and information are being kept.	
	Decide with HSE&CI Manager, *OSRL* and relevant Authorities the close-out response.	
	Decision with ERT to stand-down incident.	
Final Actions	Confirm incident closure with field team.	
	Close out liaison with contractors.	
	Arrange for de-brief and consolidate costs.	

STEP	ACTION	✓
	Complete incident log.	
	Pass incident log to Log Keeper.	
	Arrange with HSE&CI Manager for a brief summary paper of the incident to be developed, based on the logs. Highlight any issues and make lessons learnt profile after the incident.	

3.1.8 HSE & CI Manager

STEP	ACTION	✓
Initial Actions	**ENSURE SAFETY IS A PRIORITY IN ANY SPILL.**	
	Obtain a briefing of the situation from the ERM.	
	Request the following information:	
	▪ time and date of the spill;	
	▪ type of oil;	
	▪ cause of spill (if known);	
	▪ estimated quantity spilled;	
	▪ estimated rate of spill if continuing;	
	▪ whether clean-up activities have been initiated;	
	▪ any other relevant comments;	
	▪ actions taken so far.	
	Start a Personal Log and record time and details of own actions and own decisions.	
	Assist the ERM to assess the spill:	
	▪ Estimate quantity of spilled oil (Section 5.2);	
	▪ Estimate direction of slick movement (Section 5.2);	
	▪ Allocate spill into appropriate Tier Level (Section 4.1).	
	Mobilize other ERT members if required by the ERM.	
	Set up the Emergency Response Room (ERR).	
	Obtain copy of the completed Marine Pollution Report Form.	
	Assist Emergency Coordinator (EC) to complete the Situation Report Form (Annex B, Section 3).	
	Ensure that the Statutory Bodies have been informed:	
	▪ National Oil Spill Reporting Centre (Navy Operations);	
	▪ National Oil Spill Response Centre (Environmental Protection Agency - EPA).	
	Assist the ERM to determine the appropriate response strategy and the resources required.	
	Note: If chemical dispersant strategy is to be initiated, make contact with	

STEP	ACTION	✓
	EPA, as appropriate.	
	Request weather forecast information.	
	Notify *OSRL* and request oil spill modelling. If needed, request a Technical Advisor.	
	Advise the ERM of health or safety risks, staffing and logistics requirements and HSE perspective.	
STEP	**ACTION**	
Further Actions	Continue communications and briefings.	
	Liaise with Logistics Manager regarding mobilisation of air/land transportation.	
	Ensure aerial surveillance flight to monitor slick movement. Ensure you receive an aerial surveillance log from aircraft following each flight.	
	Ensure proper HSE procedures have been implemented for the response.	
	Maintain ongoing liaison with relevant authorities and affected communities through Social Representatives/CLOs.	
	Request *OSRL* to re-run oil spill model on a regular basis using updated sighting reports and weather forecast information.	
	Send the Situation Report Form to eni Upstream & Technical Services (within 24 hours).	
	Request regular updates from the incident site on:	
	▪ Activities of Offshore Emergency Response Team;	
	▪ Condition of oil;	
	▪ Effectiveness of response strategy (via Well Operations Manager).	
	Ensure that proper HSE procedures have been implemented for the response, i.e. teams receive:	
	▪ Personal Protective Equipment (PPE);	
	▪ Communication equipment;	
	▪ Supplies.	
	If the spill is likely to impact the shoreline, liaise with Local Authorities and EPA. Consult environmental sensitivity maps as required.	

STEP	ACTION	✓
	Assess the environmental and community damages resulted by the spill, waste collected, and waste disposal.	
	If required, contact the oiled wildlife specialist (Sea Alarm) via OSRL. Additionally, discuss the requirement for specialised wildlife response equipment with the OSRL Duty Manager.	
	Establish if extra stocks of dispersant / earth moving equipment from other companies are required.	
	Submit briefing report to Oil Spill Response Contractor.	
	Keep Emergency Coordinator informed of actions taken and status.	
	Ensure that up-to-date reports are circulated to all notified parties.	
Final Actions	Provide status reports on safety, environmental and community impacts to the ERM.	
	Assist ERM with incident investigation.	
	Confirm incident closure and notify all authorities.	
	Complete incident log.	
	Attend debrief meeting.	
	Collect personal incident logs from all members involved in the incident via the Log Keeper.	

3.1.9 Logistics Manager

STEP	ACTION	✓
Initial Actions	If called, proceed to the eni Ghana Emergency Response Room (ERR).	
	Receive incident status report from the Emergency Response Coordinator.	
	Start a Personal Log and record time and details of own actions and own decisions.	
	Review with eni Ghana Representative on site the need for logistics support.	
Further Actions	Obtain weather forecast (sea conditions / wind direction).	
	Establish contact (and provide briefing) as required with:	
	▪ Aircraft contractor;	
	▪ Contracts for support services;	
	▪ Equipment;	
	▪ Transport.	
	Arrange for overflight (aerial surveillance) to establish spill development/assess response action effectiveness.	
	Update eni Ghana Representative on site on status of resources contacted / mobilized.	
	Monitor progress of mobilization through regular contacts and updates.	
	Coordinate logistic support to the Oil Spill Response Contractor, with assistance from Well Operations Manager.	
	Update the Status Boards with all air / land transportation information. Pass information to Log Keeper.	
	Contact Government Departments and any other relevant agencies that need to be notified of the emergency.	
	Arrange for supplies of:	
	▪ Dispersants;	
	▪ Fuel;	
	▪ Transportation of equipment;	
	▪ Maintenance.	
	In collaboration with the HSE&CI Manager, contact possible waste disposal contractors to arrange for disposal of waste materials based to likely	

STEP	ACTION	✓
	quantities of wastes.	
Final Actions	Ensure return of all equipment.	
	Confirm incident closure and notify all contractors.	
	Complete incident log.	
	Attend debrief meeting.	
	Pass incident log to Log Keeper.	

3.1.10 Log Keeper

STEP	ACTION	✓
Initial Actions	If called, proceed to the eni Ghana Emergency Response Room (ERR).	
	Ensure that the ERR is equipped with necessary documentation, maps, information means and provisions if necessary.	
	Obtain a full briefing from the HSE&CI Manager.	
	Ensure that the necessary Status Boards in the ERR are displayed and begin the process of transferring information.	
Further Actions	Consult with the Emergency Response Coordinator to distil the relevant information from the Incident Information Checklist.	
	Register on the log sheet all the events occurring during the incident.	
	Record the corresponding time: facts, received and outgoing messages, facts and actions, human, technical and financial means engaged, phone calls, faxes and emails.	
	Post the following information on an situation display board during incident:	
	o details of the accident (location, nature and severity of the incident);	
	o follow-up of logistical means engaged / available;	
	o weather in progress and forecast bulletin.	
	Ensure that the above-mentioned information is regularly updated.	
	Consult with individual ERT members to ensure actions taken, information received is recognized and transferred to the appropriate board as required.	
	Ensure the information entered on wallboards is consistent. Point out any anomalies to the Emergency Response Manager and/or refer them to the site.	
	Ensure separate copies of the Status Boards are prepared for records/references purposes.	
	Ensure individual team member log sheet slips are placed into the filing tray.	
Final Actions	Ensure that all the registers are collected at the end of the incident.	
	Participate in the debriefing.	
	Assist the Emergency Response Manager with the preparation of the final report.	
	Pass all incident logs from ERT members to HSE&CI Manager.	

3.2 Termination of Operations

3.2.1 Termination Of Oil Spill Response

Once the oil spill incident has been controlled, an assessment will be made as directed by the Emergency Response Manager. If the assessment reveals that the incident is under control and emergency response is no longer needed, the emergency will be declared over, by the Emergency Response Manager and the Emergency Response Team will be dismissed. This will be communicated to all the concerned external agencies.

3.2.2 Follow – Up Response

Once oil spill response has ended, clean-up of the environment and repairs to equipment may continue, as needed. These continued actions will be directed by eni Ghana's normal chain of command.

3.3 Updating Responsibility

3.3.1 Managing Director

The Managing Director approves the issue of the present document and oversees its drawing-up and updating, with the support of the HSE&CI Manager.

3.3.2 HSE&CI Manager

The HSE&CI Manager co-operates with the Managing Director to ensure the drawing up, updating and distribution of the present procedure and verifies its level of application.

4. OIL SPILL MANAGEMENT

4.1 Tier Level Assessment

eni Ghana has adopted the internationally recognised Tiered Response system for assessing the severity of oil spills (Figure 2). The purpose of the three tier levels is to establish, as soon as possible, what is the correct level of response needed to combat the spill. The severity of the spill depends on the size of the complexity of the response and the potential consequences for people, assets, reputation, economy and for the environment. By identifying the Tier, the eni Ghana Representative on site and the Emergency Response Manager can mobilise the appropriate resources to combat the spill.

FOR UNCONTROLLED WELL BLOW OUTS GO IMMEDIATELY TO TIER 3

Establish the tier level of the oil spill

Tier 1

Tier 1 oil spills are likely to be small and effect a localised area. The spill can be managed immediately by using the on site resources or local contractors.

Characteristics of a Tier 1 oil spill:

- Spill occurs within immediate site proximity and is contained
- Minor environmental impact and likely to naturally dissipate
- Spill can be easily managed using eni Ghana oil spill response resources available on site
- The spill source has been secured
- No media interest
- Day time release / Light oil spill
- Oil is moving away from the coastline

Tier 2

Spill could cause significant pollution resulting in the activation of the local authorities' emergency response plans, and the mobilisation of external oil spill response resources.

Characteristics of a Tier 2 oil spill:

- Concentrated oil pooling in close proximity to the FPSO, field supply vessel, onshore storage tank etc.
- Danger of fire or explosion
- Possible continuous release
- Tier 1 resources are overwhelmed, requiring additional off site / regional resources
- Intervention by local / national authorities
- Night time release / poor visibility
- Heavy fuel or crude oil
- Potential impact to sensitive areas and / or local communities, coastline or inland waterway
- Spill source cannot be immediately secured
- Local / national media attention

Tier 3

A catastrophic spill requiring the mobilisation of international support and resources

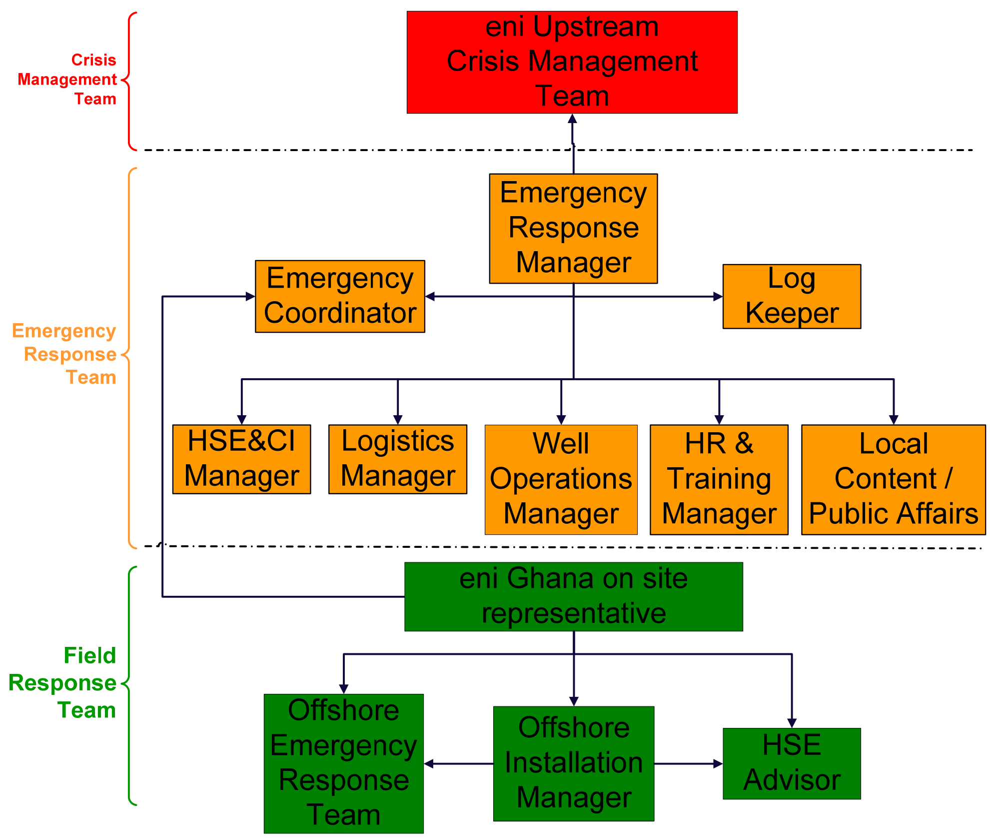
Characteristics of a Tier 3 oil spill:

- Uncontrolled well blow out or loss of well control
- Actual or potentially serious threat to life, property or industry
- Tier 1 and 2 resources are overwhelmed requiring international Tier 3 resources to be mobilised (e.g. OSRL)
- Significant impact to sensitive areas, shoreline and or local communities
- Spill has crossed international maritime boundaries and potential to impact neighbouring countries (Cote d'Ivoire)
- International media attention

Figure 2 Tiered Response Assessment System

4.2 Oil Spill Organisation

This section describes the management structure and reporting lines and roles during an oil spill incident. In the event of a Tier 1, 2 and 3 oil spill incidents, the reporting lines will be as per the flow diagram below.



4.2.1 *Tier Level 1*

An oil spill that can be dealt with by on-site/location personnel and resources; the oil spill does not have any effect outside the site and external agencies are unlikely to be involved. There is unlikely to be danger to life, to the environment, or to eni Ghana assets or reputation.

The Oil Spill Contingency Plan is activated by the eni Ghana Representative on site; eni Ghana is notified.

4.2.2 Tier Level 2

An oil spill which may be dealt with locally but requires involvement of wider eni Ghana support and external services. The initial oil spill may be "onsite", have some effect outside the site or be "off-site", and external (national) emergency services will be involved. There is likely to be danger to life, the environment, or to eni Ghana assets or reputation.

The Oil Spill Contingency Plan is activated by the eni Ghana Representative on site; the Emergency Response Team is activated; the eni Upstream & Technical Services is notified.

4.2.3 Tier Level 3

A major oil spill which requires involvement of the eni Upstream & Technical Services Emergency Organization and other National and International Resources. There is likely to be danger to life, the environment. For eni Ghana this may result from insufficient local resources and/or because the incident has broader implications for the JOA members such as reputation, legal, financial, license to operate, etc.

The Oil Spill Contingency Plan is activated by the eni Ghana Representative on site; the Emergency Response Team is activated; the eni Upstream & Technical Services Crisis Management Team is activated.

4.2.4 Eni Ghana Emergency Response Team (ERT)

The Emergency Response Team (ERT) is responsible for the coordination and implementation of the actions required to support the response and to manage any broader implications of the event, such as communicating with Authorities, mobilizing additional resources and equipment and liaising with Upstream & Technical Services.

Table 1 below presents a series of specific responsibilities ascribed to key members of the ERT.

Table 1 ERT Responsibilities

Position	All Levels	Tier Level 3
ANY COMMUNICATION NODE, SUCH AS SWITCHBOARD, RECEPTION ETC.	Commence notification to the Company representative in accordance with local procedures.	
COMPANY REPRESENTATIVE ON SITE / ON SCENE COMMANDER	Notification/reporting of details of any emergency situation to the Emergency Coordinator (EC). Establishing and maintaining effective communication with EC for situation updates and support request.	
EMERGENCY RESPONSE MANAGER (ERM)	Manages the ERT and the overall response of the on/offshore support and associated eni Ghana activities and ensures it is effective and communicates to PA the ERC contacts. Appoint the On-Scene Commander if needed.	Establish and maintain communications with the Upstream & Technical Services Person in Charge and coordinate support activities.
EMERGENCY RESPONSE COORDINATOR (EC)	Provides the first point of contact for notification/reporting of an incident/emergency on the SITE and maintains a 'permanent' open communication with the SITE.	Maintain contact with specific Upstream & Technical Services resources as necessary
LOGISTICS MANAGER (LM)	Reporting to the Emergency Response Coordinator. They will coordinate the logistical support to the response, in particular related to air service contractor.	Liaise with the specific Upstream & Technical Services Emergency Contacts as necessary

Position	All Levels	Tier Level 3
HSE&CI MANAGER	Reports to the Emergency Response Manager. Evaluates the HSE implications of the emergency. Establishes contact with Logistics Manager in order to mobilize necessary support. Establish contact with external agencies, Medical Contractor, Oil Spill Contractor and relevant Government agencies as required and mobilize necessary support.	Liaise with Upstream & Technical Services HSE for information and support as necessary
HR & TRAINING MANAGER	Reports to the Emergency Response Manager. Manages the personnel implications of the incident (PoB, Casualties, Personnel movements, Relatives) and establishes contact with the relevant contractors.	Liaise with the Upstream & Technical Services HRO Department for further support if required.
PUBLIC AFFAIRS	Assess the implications of the emergency in terms of media and public stakeholders and advise the Emergency Response Manager.	
LOG KEEPER	Ensures relevant information is transferred to the respective Status Boards in the ERR and updated as required and that appropriate documented records are maintained.	

4.2.5 Eni Upstream & Technical Services HQ (Milan)

The eni Emergency Response organization is involved for Level 3 emergency situations. They should be informed as necessary of other Level 1 or 2 situations. The principal roles of the Milan organization are to:

- Manage any broader implications to eni Ghana as a result of the incident.
- Provide support to eni Ghana where local/national resources and arrangements are not sufficient to manage the emergency.

The eni Ghana ERT, via the Emergency Response Manager, should inform and establish communications with the "Person in Charge" who will mobilize necessary personnel and resources in Milan.

5. RESPONSE STRATEGY

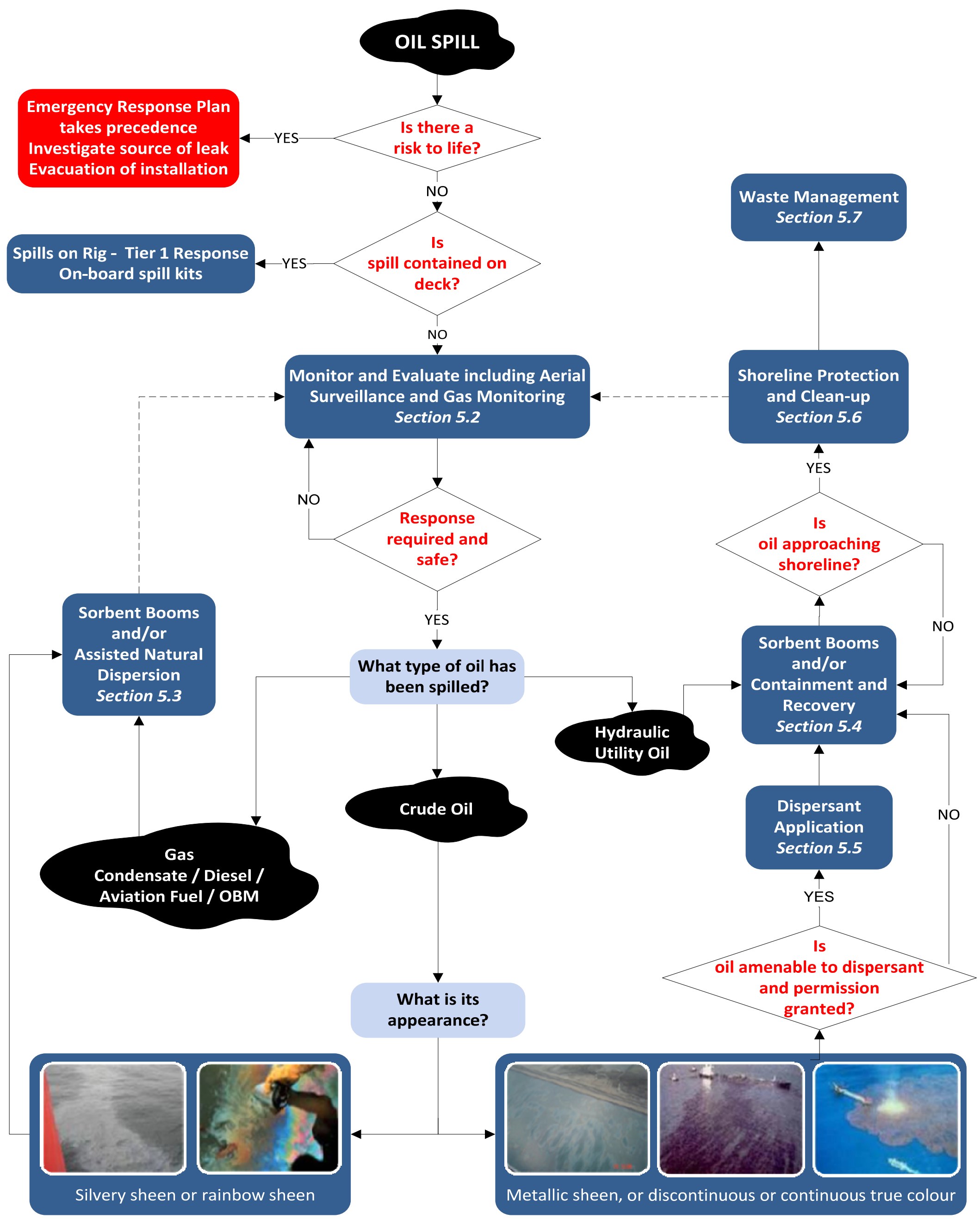
This section is designed to aid in the decision making process on which is the most appropriate strategy for the spill depending on type and location. Every oil spill incident is different in terms of the type of oil spilled, volume, location, time of day, weather and sea conditions, and potential impact to environmental and socioeconomic sensitivities, thus not all techniques are appropriate for every oil spill. A degree of flexibility is required as more than one strategy may be appropriate, and the chosen strategy could well change with time as the incident develops, refer to Table 2 below. Guidance is provided for the following strategies:

- Monitor and Evaluate (including aerial surveillance);
- Assisted Natural Dispersion;
- Containment and Recovery;
- Chemical Dispersants;
- Shoreline Protection and Clean-up.

Table 2 Response Options for eni Ghana

Section	Response Strategy	Oil Type					Level of Response
		Crude	Gas	Diesel	Oil Based Mud	Utility Oils	
5.2	**Monitor and Evaluate**	✓	✓	✓	✓	✓	1
5.3	**Assisted Natural Dispersion**	✓	✓	✓	✗	✗	1
5.4	**Containment and Recovery**	✓	✗	Likely to evaporate readily both off and near shore	Likely to sink and form a sheen on the water surface	✓	1/2
5.5	**Chemical Dispersion**	✓	✗	✗	✗	✓	2/3
		Obtain approval from the EPA prior to spraying operations. Conduct a test spray.					
5.6	**Shoreline Protection and Clean-up**	✓	N/A	Likely to evaporate readily. Shoreline response is unlikely	Likely to sink and form sheen on the water surface. Shoreline response is unlikely	✓ If oil threatens or impacts shoreline	2/3

5.1 Response Decision Flowchart



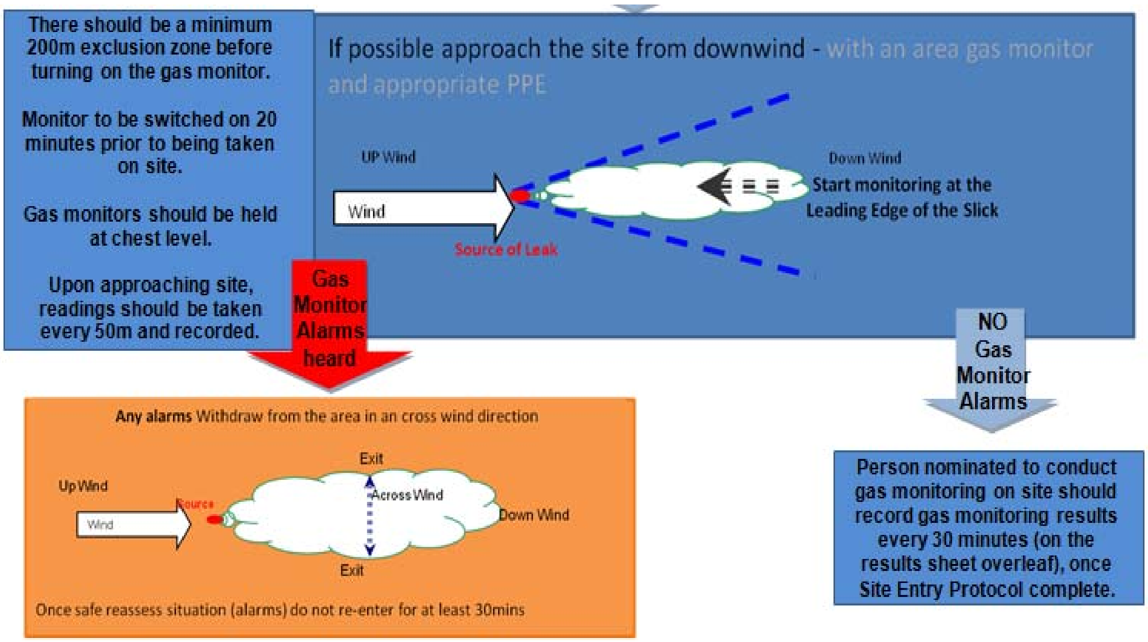
5.2 Monitor and Evaluate, Aerial Surveillance

Resources Available

Tier 1	• Offshore Dispersant Capability • Oil spill modelling
Tier 2	• OSRL aerial surveillance responders and oil spill modellers
Tier 3	• OSRL aerial surveillance responders and oil spill modellers

Safety

- **Aircraft** - monitor the area to ensure that there is no explosion risk
- **Support vessels -** approach spill site from downwind of the source with an area gas monitor
- Wear the appropriate Personal Protective Equipment (PPE)
- Identify risks and mitigate them where possible
- Communicate any risks and controls in place to control them through a pre-flight or pre-operation safety brief
- All activities will be carried out under the appropriate systems



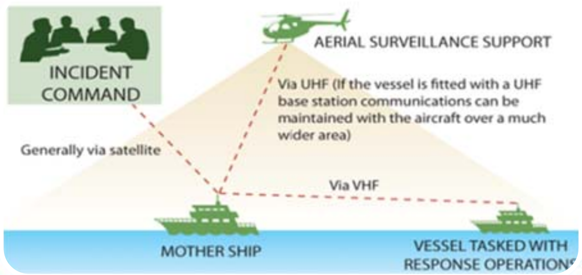
Key Steps

Step 1 - Prepare

Communications

Effective communication can enhance operation success.

Ineffective communication can lead to unsafe situations and accidents.



Communications Plan

Who to call in an emergency. Names of assets deployed, call signs and radio communication frequencies.

Use of 'mother ships'

Ensures a clear line of communication. Can provide additional resources to response vessels.

GPS Tracking System

To track surveillance operations from Emergency Response Room.

Organise Tools

The resources required for aerial surveillance operations are:

- Report / Log form and clipboard
- Method of communication with the crew of all aircraft and vessels
- Handheld global positioning system (GPS) unit
- Digital camera
- Compass (may be useful to orientate direction in flight)
- Spare batteries
- High visibility jackets for walking on airfield (remove on aircraft)

Receive Tasking information

Tasks should include:

- Confirm spill location
- Direct response operations. For example, direct dispersant operations to the area of thickest oil
- Survey shoreline to identify oil impacted areas
- Quantify oil slick

Receive Pre-Flight Briefing

Note: For aerial dispersant operations, give joint briefings to the assigned spotter and spray crews

The briefing should include:

- Location of the operational area
- Radio frequencies used for the response in the area
- Call signs of other aircraft operating in the vicinity
- Locations of any temporary or permanent exclusion zones

Factors Affecting Visual Observations

Note: Your perspective will be different from another observer. Ensure a comprehensive hand over brief is given to maintain consistency of approach.

Take note of the following factors that can affect the visual observations of oil.

Angle of the Sun on the Water

- To obtain the best view, the aircraft should:
  - Fly at an altitude of 500 to 1000 feet
  - Survey at 30°, with the sun behind the direction of view.

Weather

- Observation can be difficult in:
  - Low contrast light conditions (haze or fog)
  - Extremely bright sunlight, due to glare.
  - Clouds

Sea Conditions

- Oil can become submerged by waves when:
  - Surface wind approaches 30 knots
  - Sea state becomes moderate (2-4 m wave height)

Water Clarity

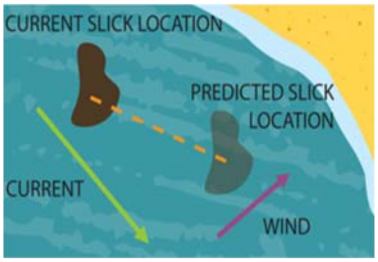
- Can affect the visual appearance of oil.
- Convergence zones
- Seaweed/seagrass
- River outlets
- Algal blooms

Step 2 – Conduct Mission: Confirm Spill Location

Predict Spill Location

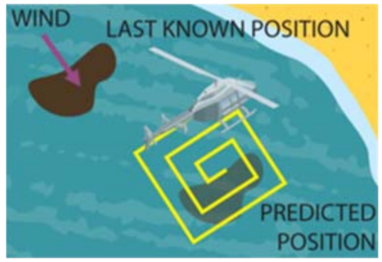
Use wind and current data. Use the predicted location as a starting point for your search.

Note: It is useful for the aerial observer to sit directly behind the pilot when in flight. You will share the same perspective making it easier to direct the aircraft to the oil spill.



Predict Spill Location

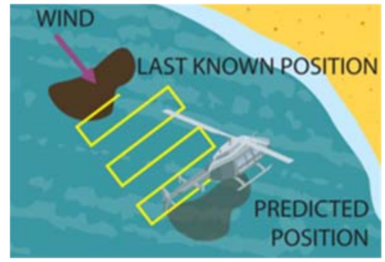
Oil moves ~3% with the wind and 100% with the current.
Use wind and current data to predict the spill location.



Expanding Square/Spiral Search

How: Fly in ever increasing circles around the oil's predicted position until you see the slick.

Why: You expect the oil to have remained within the vicinity of the release position.



Ladder Search

How: Fly a set length and width from the oil's last known position to its predicted position.

Why: You expect the oil to be anywhere in the allocated search area with equal probability.

Step 2 – Conduct Mission: Quantify Spill

Calculate spill quantity on the return journey or when the aircraft has landed.

Calculate Spill Area

1. Fly the length of the spill - note speed and time taken
2. Fly the width of the spill - note speed and time taken
3. Calculate distance of spill length or width.

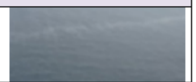
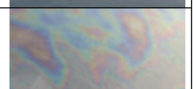
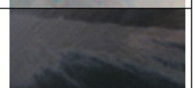
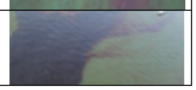
$$\boldsymbol{Distance\ of\ slick\ length\ or\ width}\ (\boldsymbol{nm})\ \textbf{Note}\text{: Divide answer by 1.85 to convert to km}$$
$$= \frac{time\ taken\ to\ fly\ (seconds) \times\ speed\ (knots)}{3600\ (or\ 60\ if\ time\ taken\ to\ fly\ is\ in\ minutes)}$$

4. Calculate the area

$$\boldsymbol{Spill\ area}\ (\mathbf{km^2}) = length\ (km) \times width\ (km)$$

Calculate Spill Volume

1. Use the Bonn Agreement Oil Appearance Code (BAOAC) to estimate the percentage spill coverage.

Code	Description / Appearance	Layer Thickness Interval (Microns)	Litres per km^2	Typical Appearance
1	Sheen (silver / grey)	0.04-0.30	40-300	
2	Rainbow	0.30-5.0	300-5,000	
3	Metallic	5.0-50	5,000-50,000	
4	Discontinuous True Oil Colour	50-200	50,000-200,000	
5	Continuous True Oil Colour	>200	>200,000	

2. Divide the slick into the percentage of each oil thickness based on its appearance.

   For example; 10% Sheen, 40% Rainbow and 50% Metallic.

3. Use the following equation to calculate the minimum and maximum spill volume for each oil type.

$$\begin{aligned} \boldsymbol{Spill\ volume}\ (\boldsymbol{m^3}) &= total\ area\ oiled\ (km^2) \\ &\times\ area\ covered\ with\ specific\ appearance\ (\%) \\ &\times layer\ thickness\ (max.\ or\ min.)\ (microns) \end{aligned}$$

4. Sum the volumes of all oil types to calculate total minimum and maximum spill volume.

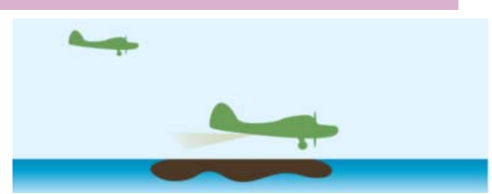
   Note: It is standard practice to calculate two volumes when using the BAOAC: minimum and maximum volume.
   Use the maximum volume to determine the appropriate level of response.

Step 2 – Conduct Mission: Direct Response

Aerial surveillance can increase efficiency of a response.

Aerial Operations

Direct the spray aircraft to the thickest part of dispersible oil. Aerial dispersant aircraft typically fly 30-45 m (100-150 ft) above the water to apply dispersant at the correct droplet size and swath width. This limits visibility from the spray aircraft.



Note: There will be a delay between the spotter crew telling the spray crew to spray, and spraying commencing.

Vessel Operations

Direct the vessel to the thickest part of the oil for:

- Containment and recovery
- Dispersant application

Note: Although vessels may have a variety of tasks, the role of aerial surveillance support remains broadly the same.

Other uses of the spotter aircraft:

- Visual assessment of dispersant efficacy
- Direct vessels measuring dispersant efficacy by fluorometry and water sampling to the dispersant application area
- Wildlife monitoring

Step 2 – Conduct Mission: Aerial Shoreline Surveys

Two types of survey:

- **Pre-impact** –Prioritise sites for protection. Assess the best method and suggest resources.
- **Post-impact** – Report the location and extent of oiling

Note: Oil can get buried by sediment mobilised by the incoming tide.

A ground based shoreline assessment team can verify the presence of oil.

How to survey shorelines from the air

Record on Map / Chart	•Incident name, date, flight start/end time, aircraft and observers •Location/source of incident •Locations of sighted oil
Take Photographs	•Ensure the camera date and time settings are correct •If taking photos through a window turn off flash •Photograph with the sun behind you •Geo-reference photos if possible

Step 3 – Record and Report

Record the mission using:

- Annotated maps
- Photographs (preferably geo-referenced)
- Aerial Surveillance Log

Report to the Emergency Response Room:

- Personal Log
- Location of identified oil (either on a map/chart, waypoints on GPS or geo-referenced photo on mapping software)
- Quantity of oil observed, this can be calculated on the Aerial Surveillance Log
- Information on any oil spill response activities

5.3 Assisted Natural Dispersion

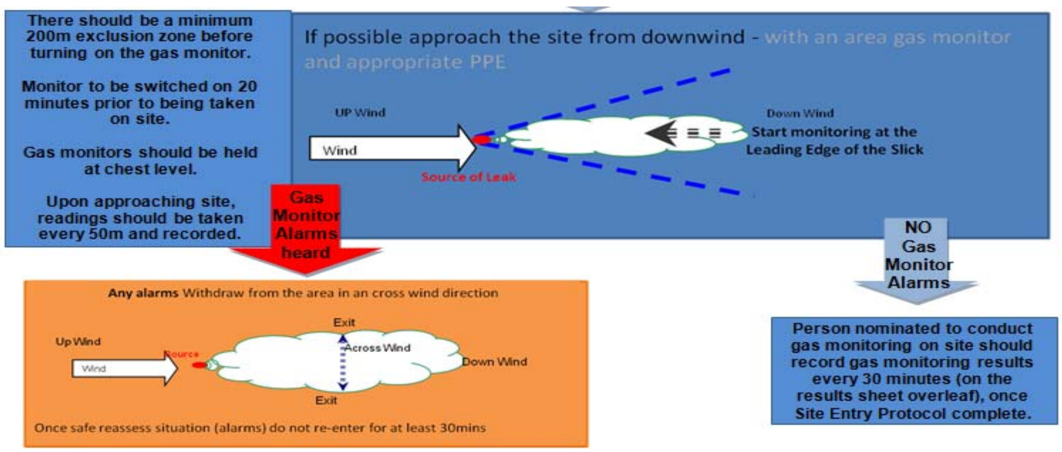
By closely monitoring and evaluating any accidental release of product, eni Ghana will be able to choose the most appropriate strategy to combat any pollutant risk. Given the high ambient air and sea temperature a suitable response strategy for such products as Light Oils (Diesel, Kerosene, Avgas) might be one of allowing them to evaporate safely.

Resources Available

Tier 1	• Supply ships, fire fighting hoses to break up the slick
Tier 2	• local vessels / supply vessel contractor • OSRL

Safety

- Immediately implement all fire, gas and explosive vapour safety precautions
- Wear the appropriate PPE.
- Alert all nearby vessels and installations that there is a spill.
- Emergency shut down if necessary and ensure gas monitoring is undertaken.
- Prevent further spillage (stop or isolate the source if safe).
- Communicate any risks and controls in place through a pre-operation safety brief.
- Approach spill from downwind with an area gas monitor



Key Steps

Step 1 – Prepare

Communications – Refer to Section 5.2, Monitor and Evaluate, Aerial Surveillance, p. 39. Decide strategy suitability

- ✔ Assisted natural dispersion is suitable for **condensate**, **diesel, aviation fuel and light crude oil**.
- ✖ **Do not use on hydraulic oil** – this is likely to produce a frothy emulsion and not disperse.

Step 2 – Assist Natural Dispersion

Select suitable method

Enhanced agitation by water application: Spray seawater onto the surface of the oil spill using fire-fighting hoses to break up slick and aid dispersion.

Propeller assisted agitation
Use vessel "prop wash" to mechanically break up and disperse the oil. Direct the vessel to the thicker leading edge of the spill if safe to do so.

- Approach the slick from upwind at 90° to the current.
- Assist natural dispersion on non-boomed oil for maximum efficacy.

Step 3 – Record and Report

Record the operation and report to the ERT using:

- Oil Spill Report Forms.
- **Refer to:** Appendix 2 Forms (p.187).
- Annotated maps.
- Photographs (preferably geo-referenced).

5.4 Containment and Recovery

Effective recovery requires trained operators, suitable and well-maintained equipment, equipment, vessel logistics, aerial support, temporary storage, transportation and waste disposal. If weather conditions are good, then containment and recovery of oil may be possible.

If oil is continuing to escape from the source, the eni Ghana Representative on site needs to estimate the rate of the spill and for how long it is going to continue. Obviously the oil will only begin weathering once it has spilled into the sea.

Resources Available

Tier 1	• Sekondi and Takoradi - Harbour equipment: 100m permanent buoyancy boom, Komara 12k skimmer system, 1,500 gallons temporary storage tank • Spill kits on Field Support Vessels, drilling unit and eni Ghana base
Tier 2	• OSRL
Tier 3	• OSRL

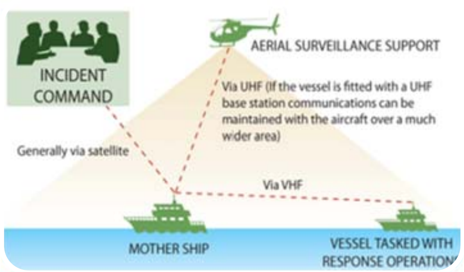
Safety

- Wear the appropriate Personal Protective Equipment (PPE)
- Stop any ignition sources and ensure gas monitoring is undertaken
- Identify risks and mitigate them where possible
- Communicate any risks and controls in place through a pre-operation safety brief
- Do not contain oil directly around the spill site or a tanker. Concentrated oil may increase explosive risk especially when fresh, ensure gas monitoring is undertaken

Key Steps

Step 1 - Prepare

Effective communication can enhance operation success. Ineffective communication can lead to unsafe situations and accidents.



Communications Plan
Who to call in an emergency.
Names of assets deployed, call signs and radio communication frequencies.

Use of 'mother ships'
Ensures a clear line of communication. Can provide additional resources to response vessels.

Automatic Identification System (AIS)
AIS on vessels to track operations from the ERR.

Step 2 - Contain the Oil

Boom Handling

Do…	Don't…
✔ Nominate one person in charge of the deployment ✔ Ensure that all vessels involved in the operation communicate effectively ✔ Ensure equipment is correctly connected ✔ Maintain a slow towing speed (~0.75 knots)	✖ Proceed with deployment until certain that all equipment is secured

Terminology

1 Encounter

- Distance between the two vessels.
- The larger the encounter, the more oil contained.

2 Apex

- The part of the boom where oil will collect.
- Recovery devices are placed in the apex to recover the oil.

Deployment Strategies

Straight lay

- Boom is deployed straight from the boom reel with a buoy attached to the towing line.
- Once the entire boom is deployed the second vessel recovers the buoy and attaches the tow line.
- This is the quickest, most straight forward method of boom deployment; however the vessel which deploys the boom has less control of the boom.

Loop lay

- The boom tow line is secured to the deployment vessel. As the boom is deployed it forms a 'loop' around the stern of the vessel.
- The secondary vessel takes the towing line from the end of the boom as it comes off the reel.
- This method ensures the deployment vessel has control over the boom. It is more complicated and the transfer of lines between vessels can be hazardous. It should be well communicated and undertaken with care.

Boom Configurations

Pro

Simultaneous containment and recovery is possible.

Primary vessel should direct the speed and course of the recovery vessel.

Con

Provides a smaller encounter.

Pro

Provides a wide encounter.

Only the third vessel need break configuration to dispose of oil, leaving the U formation to continue collection.

Con

Difficult to coordinate vessels.

Wide boom apex - difficult to position recovery device for optimum oil recovery.

Greater demand on resources.

Pro

Wide encounter with oil.

Narrow apex, assists in maximising the amount of oil recovered.

Con

Difficult to coordinate vessels.

Wide boom encounter, difficult to hold position of recovery device for optimum oil recovery .

Greater demand on resources.

Pro

Less demand on logistics as only one vessel is required.

Quick to deploy (if side sweep system is available).

Easy to manoeuvre.

Con

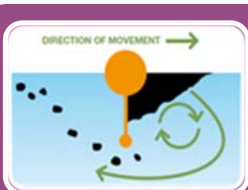
Small encounter area.

Causes of Boom Failure

Weather

• Conditions must be favourable:

WIND	WAVES	CURRENT	BOOM PERFORMANCE
0-10kts (0-20km/hr)	Calm, swells	0-0.5kts (0.25m/s)	GOOD
<20kts	<3-4ft (<1m)	>1kt (>0.5m/s)	BAD



Undercutting

- If the boom is towed at excessive speed or the current is running quickly, then oil may undercut the boom and escape.

Boom Saturation

- If the boom fills with oil and a recovery device is not deployed the oil collected may overwhelm the boom and escape.

Boom Damage

- If a chamber is damaged during operations the remainder of the boom will stay afloat.
- Oil may escape though the resultant gap so it should be repaired as soon as practicably possible.

Step 3 - Recover the Oil

Skimmers have a **pump rating.** This is based on test tank conditions and does not reflect offshore recovery operations. **Rated pumping volume will rarely be achieved in field conditions.**

Select the most appropriate skimmers to recover the oil.

Oleophilic

Pro

Less water collected compared to other types of skimmers

Efficiency can be increased by using brush or alternate attachments

Con

Generally ineffective in heavily emulsified oil

Oil will not adhere to the oleophillic surface if dispersant has been used

Step 4 – Store the Recovered Oil

Storage could be a limiting factor for offshore containment and recovery operations.

Arrange for suitable types and quantities of temporary storage for containment and recovery operations.

It is likely that a mix of oil and water will be recovered (not purely oil) which will increase the amount of storage required.

Types of temporary storage include:

- Inflated barge (pictured)
- Tanks loaded onto vessel decks
- Vessel internal tanks
- Storage barge

Ensure local oily water discharge regulations are adhered to. Authorities **MAY** allow oily water that has separated in recovery tanks to be discharged back into the apex of the boom to reduce the storage volume and onshore treatment.

The logistics of storage and transfer of recovered oil and oily waste must be organised by the Logistics Manager. The success of the oil recovery operation depends on temporary storage, transportation and identified methods of final disposal.

5.5 Chemical Dispersants

Dispersant should only be applied to crude and not light oils such as diesel. Ensure the dispersant has been approved for use and any necessary authorisation has been granted – contact EPA Ghana. Mobilise OSRL dispersant aircraft if large spill.

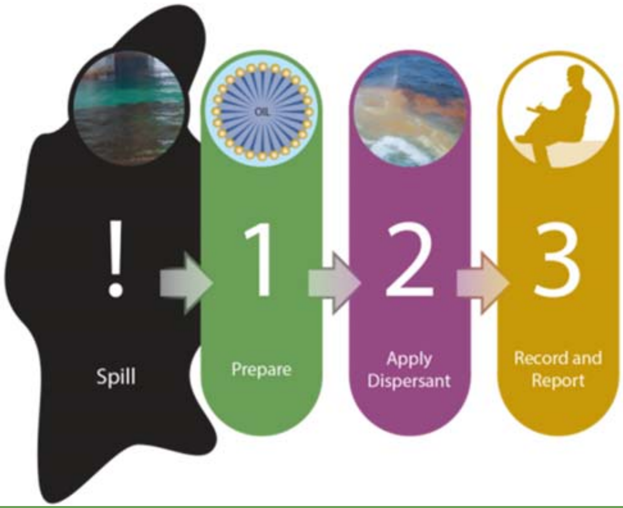
Resources Available

Tier 1	• 2 x dispersant spray sets, boat spray 50 • 8 x 1000ltrs IBC of Dasic Slickgone Dispersant • Sorbent booms and pads
Tier 2	• OSRL support and resources
Tier 3	• OSRL vessel and wide scale aerial application and fluorometry

Safety

- Wear the appropriate Personal Protective Equipment (PPE)
- Identify risks and mitigate them where possible
- Communicate any risks and controls in place through a pre-operation safety brief
- Use dispersants in accordance with the manufacturer's guidance and Safety Data Sheet (SDS)
    - Risk of eye irritation or damage
    - Harmful if inhaled or ingested
    - Can be absorbed through the skin
- Carry out under appropriate 'Permit to Work' systems, following the Life Saving Rules

Key Steps



Step 1 – Prepare: Organise communications

Aerial surveillance should be utilised for all dispersant application operations to direct events and monitor the effectiveness. A helicopter should fly an observation mission about 30 min after application. Application from a vessel is most likely method that may be employed.

Refer to: Section 5.2, Monitor and Evaluate, Aerial Surveillance, p. 39

Effective communication can enhance operation success. Ineffective communication can lead to unsafe situations and accidents.

Produce a communications plan to document:

- Emergency contacts
- Names of assets deployed, call signs and radio communications frequencies

Step 1 – Prepare: Determine dispersant suitability

Is the oil amenable to dispersant?

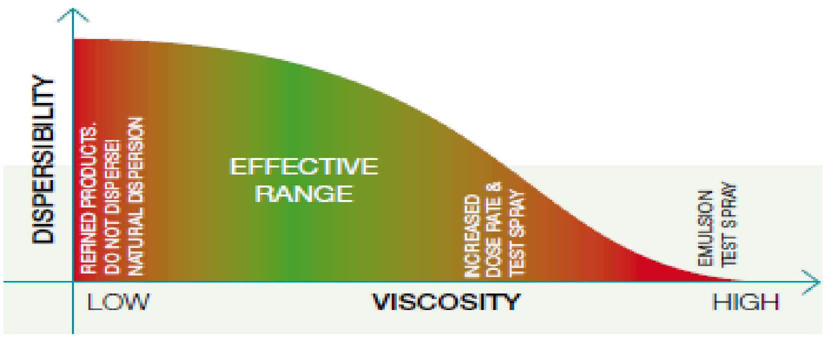
Dasic Slickgone is effective on heavy oils and water-in-oil emulsions and can be used undiluted or is compatible with seawater and can be used diluted to 10% with good results.

Dispersant effectiveness will decrease as the viscosity of oil increases, and will be ineffective for spills between 2,000–3,000 mPa.s (cP). It is unlikely that dispersant will be effective on emulsified crudes. Agitation will be required to produce the required mixing energy.

In calm sea states, the bow wave of the vessel should be sufficient. Applying dispersant in conditions above a Force 5 is not recommended as the turbulence will cover the oil and spray droplets will be blown away.

Manufacturer's guidelines need to be followed and any system should only be operated by trained personnel. Droplet size should be between 500–700 μm. Vessel speed should normally be between 5 and 10 knots. Use the chart below to determine if dispersant is likely to be effective on the spilled oil.

Use a basic dispersant effectiveness 'jar test' to confirm dispersant efficacy.



Is there a suitable window of opportunity to spray dispersant?

There is a window of opportunity in which dispersants are effective. The length of this window varies according to:

Climate: Oil viscosity decreases with temperature making the same oil more responsive to dispersants in warmer climates. However, some oils will be dispersed at 0 °C.

Weathering: Oil weathers as volatile light ends evaporate and emulsification occurs. Dispersants are ineffective on emulsified oil. The rate of weathering is determined by the oil type (in particular its asphaltene content), source of release and environmental conditions.

Are the weather conditions suitable?

Vessel operating conditions for dispersant application:

- Minimum wave height 0.2 m (10") or an active chop
- Calmer sea conditions require mixing energy from the vessel
- Maximum wave height 4 m (12')
- Optimal wind speed 4-12m/s

Aircraft operating conditions for dispersant application:

- Minimum wave height 0.2m
- Maximum wave height 4m
- Optimal wind speed 4-12m/s

- Pilots determine if weather conditions are suitable for flying

Will the EPA grant approval to apply dispersant?

Conditional Approval Zone: The use of any chemical agent in response to an oil spill in the coastal waters of the Republic of Ghana within two nautical miles of the mainland or has a mean low water depth of less than 40 ft will require approval under the methods and restrictions set forth in the latest National Oil and Hazardous Substances Pollution Contingency Plan, unless otherwise pre-authorized.

Pre-Authorized Zone: The use of chemical dispersants as described in the EPA guidelines for importation of chemical dispersants in response to an oil spill in the coastal waters of the Republic of Ghana, which are seaward of 2 nm of the mainland and have a mean low water depth of greater than 40 ft is pre-authorized under the supervision of the Pre-designated On-Scene Commander with restrictions set forth below.

Special Consideration Areas: Special Consideration Areas will consist of restrictions imposed on the use of chemical dispersants for a specific geographic area. These restrictions may range from outright prohibition to a requirement for consultation prior to deployment of the chemicals. They may be spatial, seasonal or species-specific in nature.

Are there adequate stockpiles of dispersant?

- How much is available?
- Has it been stored correctly? Out of direct sunlight?
- Is the dispersant within its recommended shelf life?
- **Refer to:** Section 6, Oil Spill Response Resources, (p. 87)

Step 1 – Prepare: Vessels

Select a suitable vessel

The Field Support Vessel must be able to:

- Maintain steerage at low speeds
- Provide enough deck space to load, store and secure dispersant
- Communicate with aerial support
- Accommodate responders onboard

Select a suitable spray system

The spray arms should be mounted at the bow of the vessel to avoid the effect of the bow wave which can push the oil beyond the spray width. The bow wave will also provide the required mixing energy. May need drop down tubes to ensure correct coverage at the water's surface

- 5-10% dispersant is typical
- May need to change nozzles - refer to manufacture's guidelines

Prepare dispersant application recording tools

Dispersant should be applied when steaming into the wind. Record the amount and location of dispersant sprayed and reported back to the Emergency Control Team. Use the following resources:

- Dispersant log form
- GPS
- Digital camera

Receive Tasking

Including:

- Location of the operational area
- Radio frequencies used in the area and on the response
- Call signs of other vessels operating in the vicinity
- Locations of any temporary or permanent exclusion zones
- Health and safety briefing for the vessel and operation

Step 2 – Apply Dispersant: Calculate dosage and assess efficacy

Conduct a small-scale test spray to check efficacy before continued, large-scale spray operations.

Calculate the correct dispersant dosage

Correct application is determined by the two variables i.e. pump speed (ltrs/min) and vessel speed (knots) – see formula below:

Discharge rate (ltrs/min) = application rate (ltrs/m2) x speed (m/min) x swath (m)

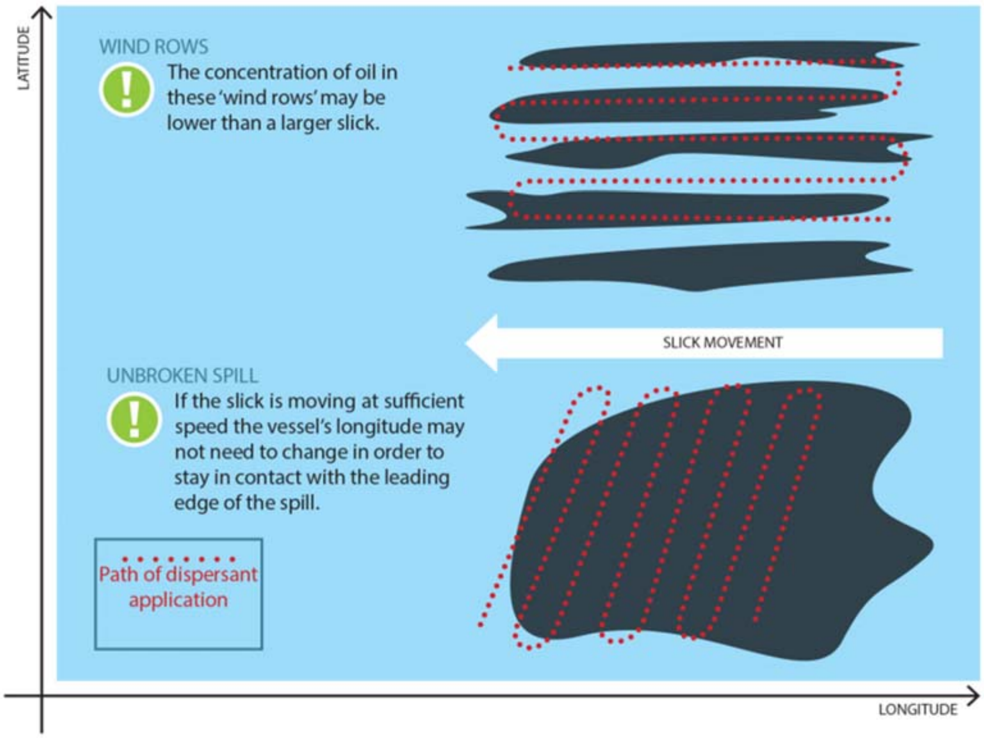
Target the thickest areas of the oil

Concentrate dispersant operations on the thickest portion of the slick (leading edge). Aerial support can assist with this. Vessel mounted operations can accurately target the thickest part of the slick, compared to fixed wing aerial operation.

Apply dispersant

Apply in a ladder or zig-zag pattern through the thickest area of the oil, as shown in figure below. Maintain the dispersant to oil ratio recommended in the manufacturer's guidance.

Note: Without feedback from aerial support this can be difficult.



Determine efficacy

The effectiveness of chemical dispersion should be monitored continually. Monitoring is best conducted from the air or at the highest point on a vessel. As soon as monitoring indicates that dispersant application is not effective; stop operations. In clear weather conditions successful dispersion will often produce a coffee-coloured plume seen to spread under the water surface. If a milky-white plume is visible, then the dispersant application has not been effective or the dose rate has been much too high:

Ultra-Violet Fluorimetry (UVF) can be used to provide an estimate of the concentration of dispersed oil in the water column during the application of dispersants. This technique can be provided by OSRL. Information gathered this way should be used in combination with visual observations to decide whether a worthwhile response can be achieved.

Step 3 – Record and Report

Record the operation using:

- Annotated maps
- Photographs (preferably geo-referenced)
- Dispersant Application Log

Report to the Emergency Response Room:

- Unit/personal Log
- Location of treated oil (either on a map/chart, waypoints on GPS or geo-referenced photo on mapping software)
- Quantity of dispersant applied
- Fluorometry measurements (if taken)
- Visual observations of effectiveness

5.6 Shoreline Protection and Clean up

In the event of a major oil spill a shoreline impact is possible. Eni Ghana will work closely with the EPA who must be informed of the likely impact to commence strategic discussions with the relevant Local Authority. Effective oil deflection and protection requires trained operators, using the correct equipment. The efficacy of booms is limited by wind, sea-state, and current. OSRL, can provide assistance should any shoreline contamination occur. As such the following information should be used for awareness/guidance.

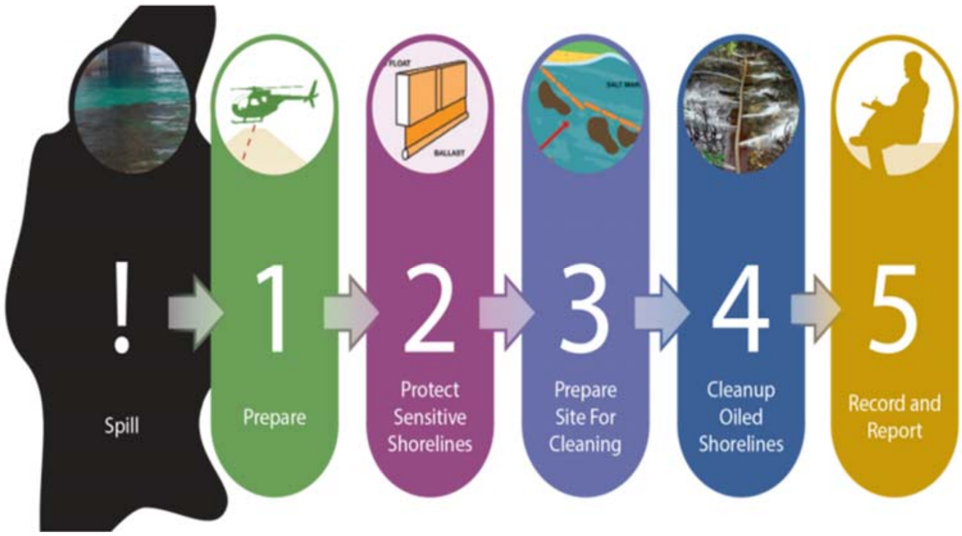
Resources Available

Tier 1	• eni Ghana
Tier 2	• Local Authority • EPA
Tier 3	• OSRL - Shoreline Cleanup Assessment Technique (SCAT) and equipment

Safety

- Wear the appropriate Personal Protective Equipment (PPE) including respiratory protection
- Identify risks and mitigate them where possible
- Communicate any risks and controls in place through a pre-operation safety brief

Key Steps



Step 1 – Prepare: Communications

Effective communication can enhance operation success. Ineffective communication can lead to unsafe situations and accidents.

Communications Plan

- Emergency contacts
- Names of assets deployed, call signs and radio frequencies

Step 2 – Protect Sensitive Shorelines: Identify and Prioritise for Cleanup

Monitor and predict the trajectory of the spill to provide an indication of where the impact may occur. Suitable protection strategies can then be determined as appropriate. Priority should be given to protecting coastal resources which are particularly sensitive to oil pollution and which can be boomed effectively if time allows (refer to the Coastal Sensitivity Maps). Some shorelines are more sensitive to oil due to their ecological, economic or cultural importance.

Refer to: Environmental and Socioeconomic Setting, Section 7.5, (p.114).

1. **Predict Spill Location** by aerial surveillance and oil spill modelling.

   Refer to: Aerial Surveillance, (p.39).

2. Identify Shoreline Ranking

Rank shorelines from 1-10 (where 10 is most sensitive, see Table 3) using information from the following resources:

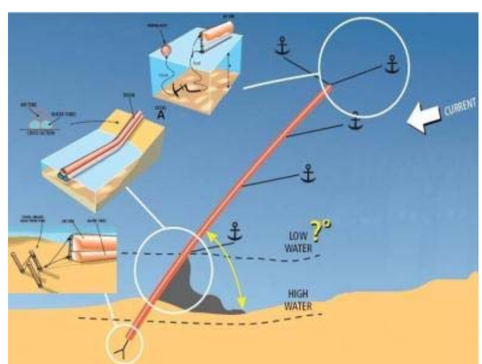
- Overflights
- Aerial photography
- Remotely sensed data
- Ground truthing
- Existing maps and data, for example, GIS files

Table 3 Environmental Sensitivity Index

ESI Value	Shoreline type
1	Exposed rocky shore
2	Exposed rocky platforms
3	Fine grained sand beaches
4	Coarse grained sand beaches
5	Mixed sand and gravel beaches
6a	Gravel beaches
6b	Riprap structures
7	Exposed tidal flats
8a	Sheltered rocky shores
8b	Sheltered artificial structures
9	Sheltered tidal flats
10a	Salt to brackish marshes
10b	Freshwater marshes
10c	Swamps
10d	Mangroves

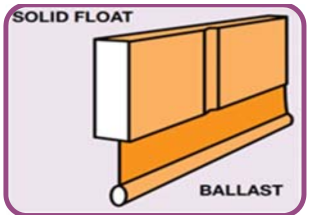
Step 2 – Protect Sensitive Shorelines: Deploy Shoreline Boom

The principle of protection is to deflect oil away from those areas of most importance in order to minimise damage. It is often desirable to direct oil to an accessible, less sensitive part of the shoreline where it can be easily collected. The shoreline can be protected by deploying shore sealing booms to deflect or contain oil as appropriate. Boom is best deployed at an angle to the current to reduce the possibility of oil escaping beneath the boom.



Choose the most appropriate boom type

Rigid Fence Boom



Pro

Quick to deploy.

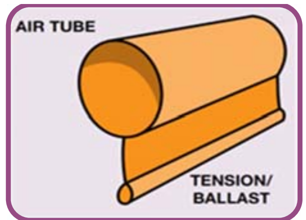
Functions well in calm sea conditions.

Con

Large storage space.

Less effective wave-following characteristics than inflation boom.

Inflation Curtain Boom



Pro

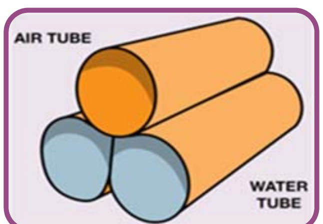
Good wave-following characteristics.

Stored deflated so require little storage space.

Con

Air fan needed to fill air chamber.

Shore Sealing Boom



Pro

Forms an effective barrier in intertidal areas.

Stored deflated so require little storage space.

Con

Water pump needed to fill two water chambers.

Air fan needed to fill air chamber.

Sorbent Boom

Pro

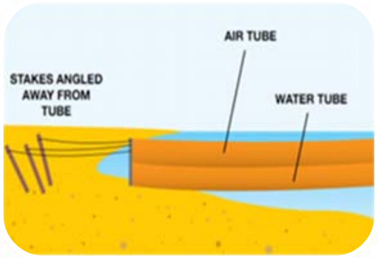
Useful for small spills.

Can use with other types of shoreline boom.

Con

Generates waste - control use.

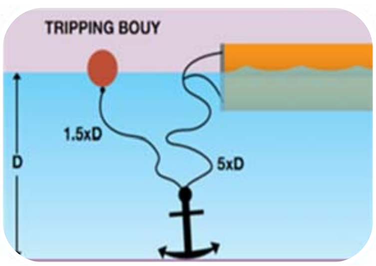
Boom deployment and handling techniques



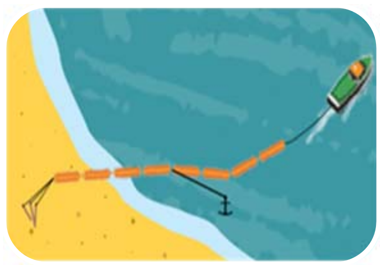
1. Ensure the boom is securely staked, anchored (using land anchors) or attached to a strong fixed point on the shoreline.

2. 'Flake' the boom along the shoreline.

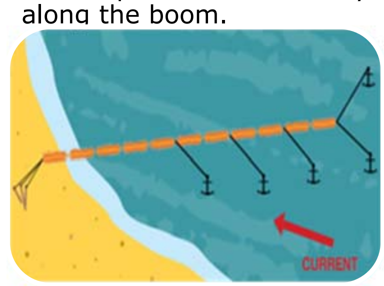
3. If it is a long piece of boom or there is a strong current running, tow the boom from one of the anchor points fixed midway along the boom.



4. Drop the anchor point. The length of the anchor lines should be 5x the water depth; the tripping buoy line should be 1.5x the water depth.

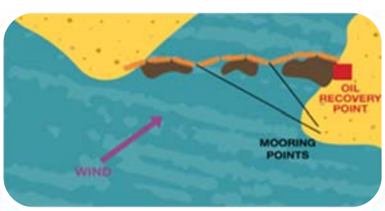


5. Return to the shoreline to retrieve the last anchor point. Drop the anchor to create a straight line of boom.



6. Set more anchors if necessary to hold the boom in place once the position is set.

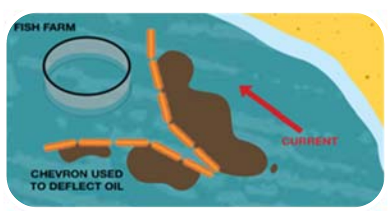
Boom formations



Exclusion booming

Protects sensitive sites such as inlets and harbour entrances.

Contains oil for recovery.

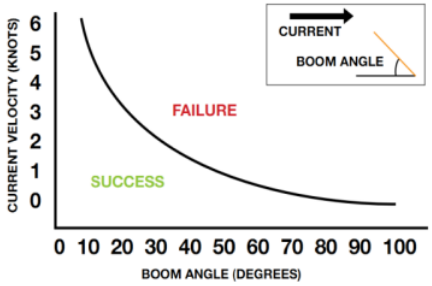


Chevron booming

Deflects oil away from sensitive sites or resources.

Cascade booming

Deflects oil away from sensitive shorelines to a point of enhanced natural collection for recovery.



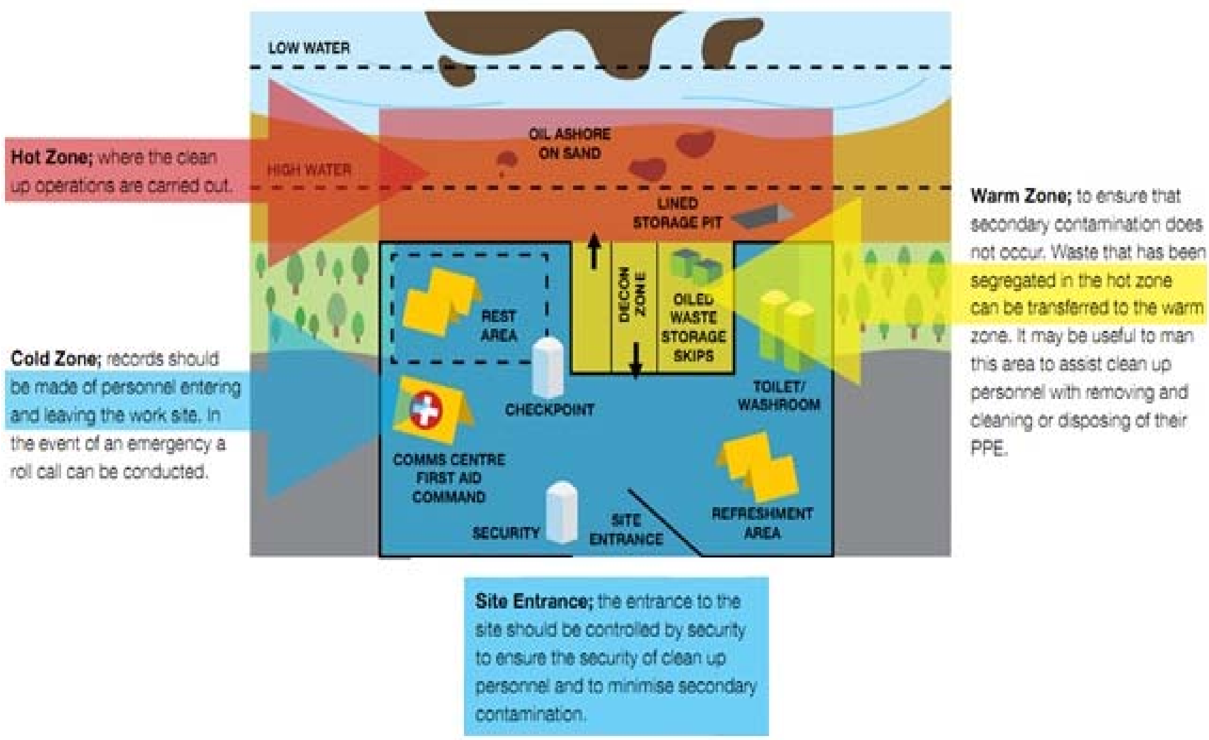
Boom Angle
The angle of the boom influences its success.
The faster the current, the narrower the boom angle should be.
Boom will be successful when deployed at an angle of 70-100° in slow current.

It is desirable that a good seal is made between the boom and the intertidal zone at low tide. Be prepared to allow oil to beach at areas that are of a lower sensitivity. It is better to use inshore booming techniques, to redirect oil away from sensitive locations to less sensitive areas where oil can be easily recovered.

Step 3 – Prepare Site For Cleaning: Site Set-up

Effective site set up will maximise site security and minimise secondary contamination.

Identify cold, warm and hot zones for each oiled site.



Step 4 – Cleanup Oiled Shorelines

The relevant Ghanaian Local Authority will coordinate the shoreline clean-up operations with the support from eni Ghana. OSRL, can provide assistance should any shoreline contamination occur. As such the following information should be used for awareness/guidance.

Depending on the degree of emulsification, amount of oiled debris and shoreline type, vast amounts of waste can be generated. In extreme cases, 30 times more waste can be generated than the volume of oil spilled.

Shoreline impact is often widely distributed as oil breaks up, spreads and fragments at sea under the influence of wind and currents. As a result, a range of different shores, of differing sensitivities, will inevitably be impacted by varying amounts of oil.

Sensitive areas should be protected where possible prior to oiling, the spill being deflected to less sensitive areas. Shoreline cleanup is generally extremely labour intensive and can in itself have a significant impact on the environment.

In general, heavily contaminated areas should be cleaned first so that bulk oil is not re-mobilised impacting other areas:

- Stage 1: Removal of heavy contamination and floating oil;
- Stage 2: Clean up of moderate contamination, stranded oil and oiled beached materials;
- Stage 3: Clean up of lightly contaminated shorelines and removal of oily stains.

In some circumstances oiled shorelines are best left to recover naturally, for example any areas exposed to high energy conditions.

Shoreline cleanup strategies are described below. The figures indicate how appropriate the strategy is for each shoreline type depending on the level of oiling (Low, Medium or High). The colours indicate whether the strategy is recommended (green), has potential (yellow) or should be avoided (red).

Natural recovery

This strategy leaves the shoreline to recover naturally without any human intervention.

- ✔ It may be less environmentally damaging to allow sensitive shorelines to recover naturally
- ✖ This process is slower than other cleanup srategies

Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures			Mud Flat / Tidal Flats			Mangroves / Salt Marshes		
L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

Dispersant application

Oil dispersants and surface cleaners could be appropriate for cleaning hard surfaces.

Check local regulations for approval before using dispersants or surface cleaners.

- Dispersed oil may contaminate lower shoreline areas that had previously been unaffected by oil

Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures			Mud Flat / Tidal Flats			Mangroves / Salt Marshes		
L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

Absorbents

Absorbents (blanket or boom form) are made of oleophillic material which selectively absorbs oil whilst repelling water.

Note: Absorbents are designed for use with light hydrocarbons. Heavy oils will adhere to the outside rather than absorb into the product. Use absorbents sparingly, they create solid waste which must be disposed of appropriately.

Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures		
L	M	H	L	M	H	L	M	H	L	M	H

Sediment relocation

Relocate oiled sediment (surface or buried) to the surf zone where it is cleaned by waves.

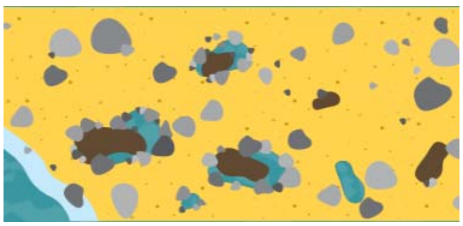
- Remobilised oil may impact other shoreline areas

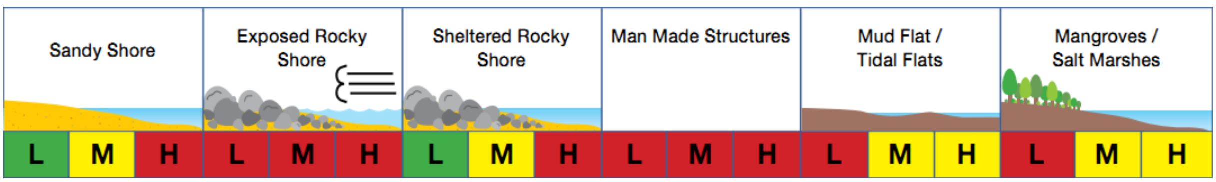
Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures			Mud Flat / Tidal Flats			Mangroves / Salt Marshes		
L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

Flooding

Flood oiled areas enclosed by booms or contained in natural geological features (such as rock pools) with seawater. Recover the remobilised oil using skimmers and pumps.

Before Flooding **After Flooding**

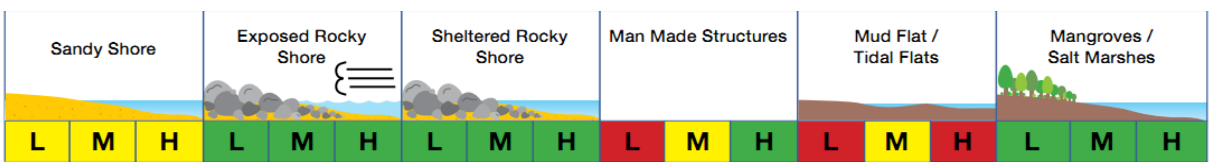




Mechanical recovery using pumping or vacuum equipment

Use specialist oil spill vacuum/pumping equipment or vacuum trucks to recover oil.

- ✖ Heavy machinery driving over oiled sediment will bury oil. Consider NEBA before using this equipment
- ✖ Don't use vacuum equipment for light oils until light ends have evaporated - risk of explosion
- ✔ Most successful on thick oil layers



Mechanical recovery using graders and scrapers

Remove oiled sediment from the beach using mechanical equipment if the beach needs to be cleaned quickly for socio-economic reasons.

- ✖ Heavy machinery driving over oiled sediment will bury oil.

Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures			Mud Flat / Tidal Flats			Mangroves / Salt Marshes		
L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

Low pressure washing at ambient water temperature

Use pumps and hoses to wash bulk stranded oil from the shoreline. Position containment boom to capture and recover the oily water wash off.

- Ambient water may harm shoreline organisms unaffected by oil

Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures			Mud Flat / Tidal Flats			Mangroves / Salt Marshes		
L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

High pressure washing at ambient water temperature

Use high pressure pumps to wash more persistent oil from the shoreline. Position containment boom to capture and recover the oily water wash off.

Note: This can dislodge shoreline organisms and potentially sterilise the area.

Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures			Mud Flat / Tidal Flats			Mangroves / Salt Marshes		
L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

Manual cleanup

Large groups of people collect stranded oil either by hand or with tools.

- Labour intensive
- Must be managed

Note: Ensure cleanup personnel only remove oiled sediment to minimise waste generation.

Sandy Shore			Exposed Rocky Shore			Sheltered Rocky Shore			Man Made Structures			Mud Flat / Tidal Flats			Mangroves / Salt Marshes		
L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H

Use of volunteers in shoreline cleanup

Benefits

- Local volunteers may know the affected area
- Can reduce response costs

Challenges

- Often unfamiliar with spill response and associated health and safety issues
- Require management and supervision
- Can be unreliable; may not be available for duration of response

Legal Considerations

It is advisable for the incident owner to ask volunteers to sign a legal release of liability form. This may or may not prevent legal claims, but can assist in clarifying expectations of cleanup volunteers.

Training

Give volunteers safety and operational training before they start work.

Work Assignments

Identify job role and responsibilities for volunteers. Ensure they are aware of the Volunteer Supervisor. Communicate their location, date and time of work.

Assign PPE

Supply volunteers with sufficient and appropriate PPE and safety equipment.

Step 5 – Record and Report

Repeat surveys throughout cleanup operations to assess progress and decide if strategy should be changed.

Record and report the following data to the Emergency Response Room:

- Time, date and location of survey
- Composition of shore substrate
- Shoreline features, such as access and potential lay down areas
- Beach profile
- Extent of surface oiling
- Extent of subsurface oiling
- Presence of sensitivities
- Treatment recommendations

5.7 Waste Management

Refer to: HSE-PLAN-005-WASTE MANAGEMENT PLAN, Rev 05

Oil spill response operations have the potential to generate liquid and solid wastes, if there is a shoreline impact. The types and quantities of waste material largely depend on the amount of oil that reaches the shoreline and the specific clean-up methods employed.

The objectives of waste management are addressed below:

- Provide safe working conditions and necessary personal protection;
- Comply with all applicable laws and regulations;
- Co-operate with all local community and government agencies to minimize the impact on local waste disposal facilities;
- Handle, store, and transport oily waste in appropriate containers or tanks;
- Minimize the amount of waste generated;
- Segregate oily and non-oily waste to allow optimum recovery and minimise disposal of each waste stream.

If waste oil and contaminated material are produced as a result of an oil spill incident, then eni Ghana has a duty of care to ensure that the waste is handled, transported and disposed of in an appropriate manner (eni Ghana Waste Management Procedure, HSE.PRO.018), with approval from the Environmental Protection Agency (EPA).

A useful reference document for oil spill waste Operations is the IPIECA Report Series Volume 12 'Guidelines for Oil Spill Waste Minimization and management', available for free download at www.ipieca.org

Ghana's National Guidelines for Management and disposal of oil spill debris states that "Environmentally and technologically sound disposal of oil spill debris is essential for minimizing the environmental damage from an oil spill".

A Waste Management Action Plan for the incident will require to be produced and the approval for an onshore waste contractor from Ghana's Regulator Authorities must be sought in accordance with their environmental standards.

Resources Available

Tier 1	•Vessels portable tanks, containers on recovery barges, shallow water barges, tank trucks, towable bladders, IBCs, barrels

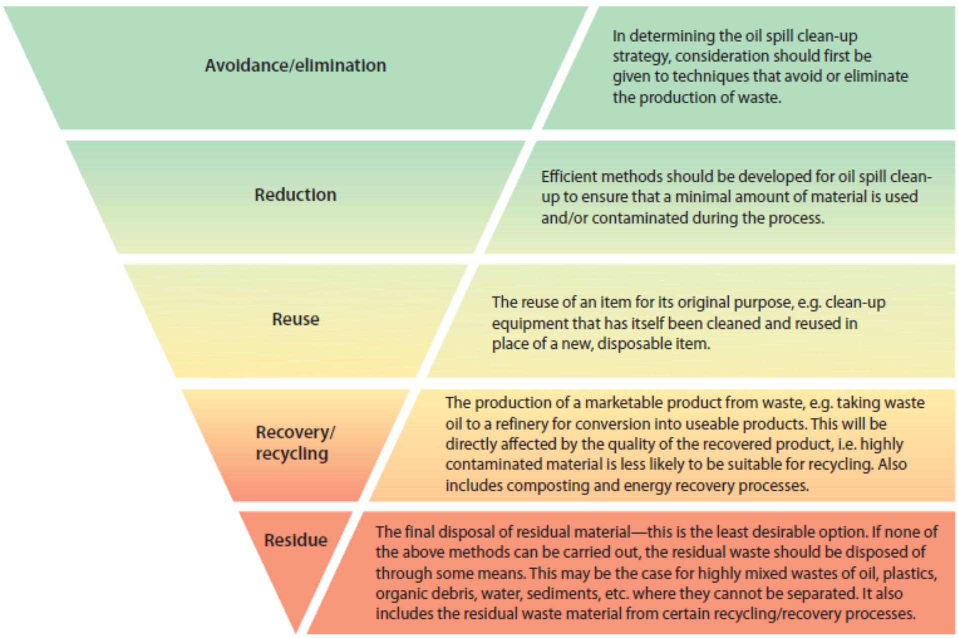
Safety

- Wear the appropriate Personal Protective Equipment (PPE)
- Identify risks and mitigate them where possible
- Communicate any risks and controls in place through a pre-operation safety brief

Key Steps

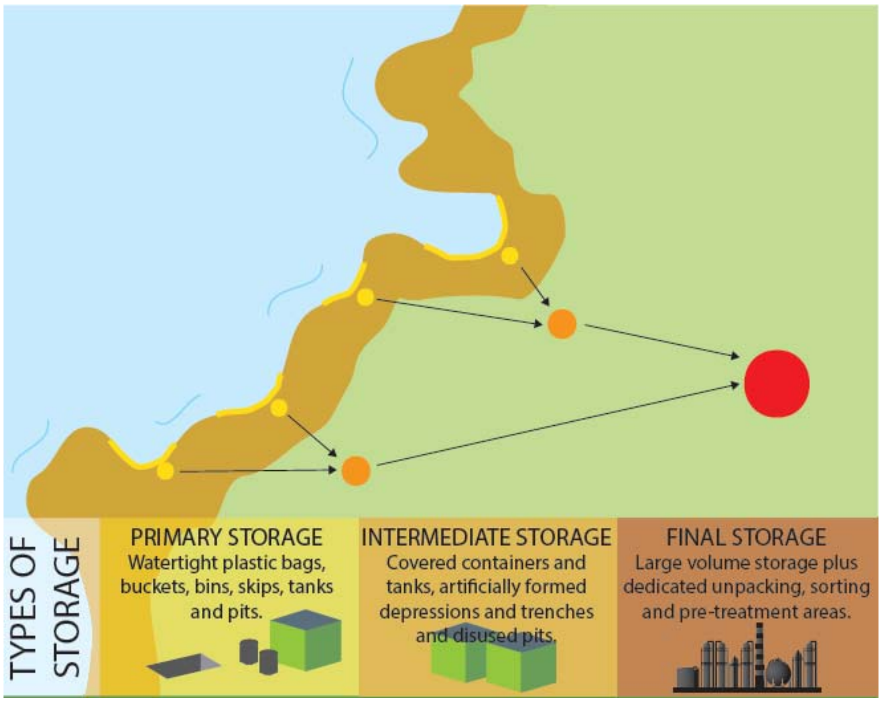
Step 2 – Prepare: Storage identification and workforce orientation

Use the waste hierarchy to manage the total amount of waste generated:



(Source: IPIECA, 2014)

Organise waste storage:



- Identify storage facilities for every stage of the response, from recovery to long term storage, treatment and/or disposal.
- Consider the use of staged storage facilities to minimise cross-contamination.
- Consult stakeholders (local authorities, government) to identify suitable locations of intermediate and long term storage sites.
- Establish waste minimisation guidelines with workforce and instruct in the proper use of equipment and storage facilities

Temporay Storage Facilities will:

- Prevent delays resulting from many vehicles trying to access one site.
- Allow time to organise final disposal sites or methods whilst the response effort continues.
- Assist in appropriate waste segregation.

Considerations:

- Local, regional and national legal regulations.
- Waste should be labelled with type and source of waste.
- The site set up should allow for waste separation to minimise secondary contamination.

Waste Sites Should:

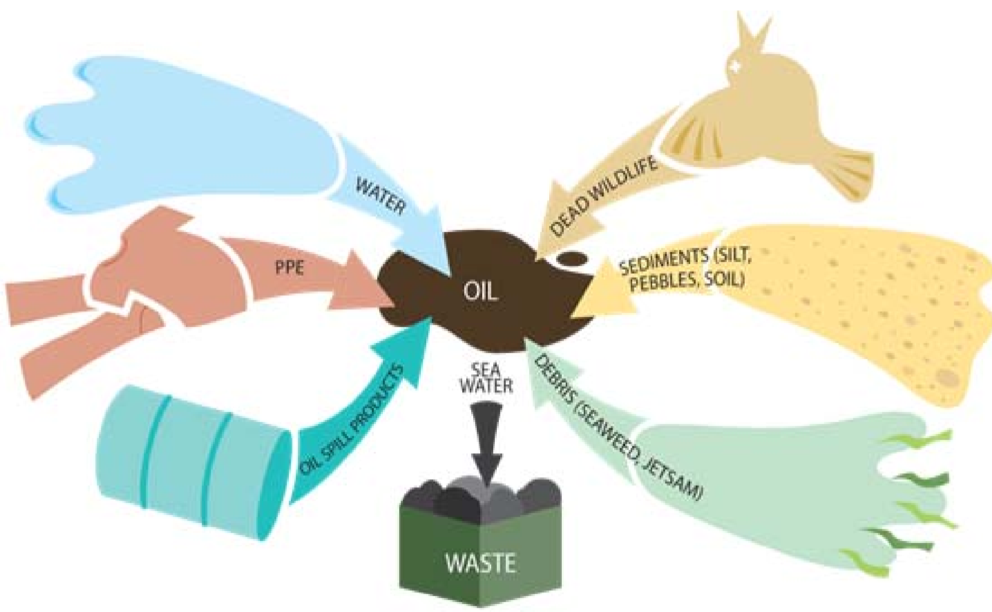
- Be fenced off with controlled site access.
- Have good access and egress.

Storage Containers Should:

- Be suitable for the waste type.
- Have useful and appropriate signage to reflect the site set up.
- Be water tight and lined with polyethylene sheeting to prevent oil leaching.

Step 3 – Reduce Waste: Site Set-Up and Housekeeping

Components of oily waste produced from a response operation

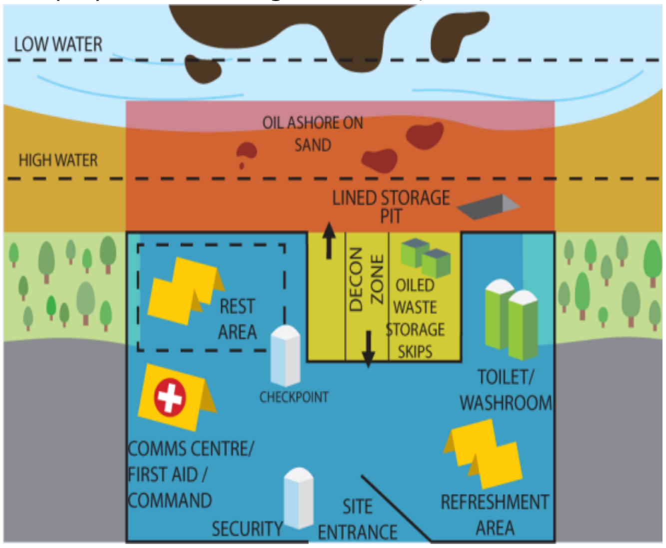


Shoreline / Inland

- Pre-clean beach/bank sections at risk of contamination before oil impacts to reduce oily waste.
- Block drainage points, if present, which could transfer oil beyond the immediate site.
- If beach/bank has been impacted, minimise contamination by using a defined site set-up (below).

Contain and recover pollution as close to the source as possible.

- Minimise the use of sorbents and re-use PPE where possible.
- Store shoreline response resources above high water mark and on level surfaces.
- A wide variety of options can be employed for storage onshore; cover and line storage containers.



Site Set-Up

Hot Zone: Oiled work area, all oil stays in this zone.

Warm Zone (Decontamination Zone): Clean down area; use one entrance/exit channel. Anyone leaving must pass through an organised decontamination process here.

Cold Zone: Waste removal vehicles collect full containers from this clean area so that they do not spread oil onto the roads.

Offshore

- Prepare sufficient temporary onboard waste storage to last operational period.
- Consider the use of inflatable barges, heated tanks and vessel storage tanks.
- Arrange intermediate storage or bulking facility for remote response operations, particularly if more than one vessel is recovering oil.
- Follow work zone arrangement on vessel of opportunity to prevent secondary contamination. Set up defined areas (hot, warm and cold zones) if vessel lacks defined work zones.
- Minimise the use of sorbents, re-use PPE where possible.

Housekeeping

Secondary contamination is the spread of oil via transport, people and equipment to unpolluted areas.

Avoid secondary contamination with good housekeeping:

- Regularly check pumps and hose connections for leaks
- Ensure all storage is water-tight and oil-proof to prevent leakage
- Cover waste containers to prevent rainwater increasing the waste volume
- Line and decontaminant all waste transportation vehicles before leaving site
- Establish a traffic circulation plan for vehicles
- Locate waste storage sites close to recovery equipment

Types of waste produced by each response technique

*****User guidance – remove irrelevant techniques*****

	Technique	Waste collected	Waste generated
Offshore Response	Natural Recovery	-	-
	Containment and Recovery	Oil and emulsified oil Contaminated water Contaminated debris	Contaminated boom and skimmer equipment Contaminated vessel
	Dispersant	-	PPE Dispersant storage containers Contaminated vessel
	In-Situ Burning	Burnt and viscous residue	Contaminated fire boom PPE Contaminated vessel
Shoreline and Inland Response	Sediment Relocation	-	Contaminated equipment (spade, bags) & PPE
	Manual Recovery	Oil and oiled sediment (tarballs, emulsified oil) Oiled debris & vegetation	Contaminated equipment (spades, buckets) PPE
	Sorbents	Oil	Sorbents, PPE
	Mechanical Recovery	Oil and oiled sediment	Contaminated equipment (skimmers, pumps) & PPE
	Flushing	Remobilised oil	Sorbents and/or containment boom & PPE

Step 4 - Reuse: Segregate

Segregation is the first step to reusing and recycling waste. Waste should be classified, segregated and labelled. Segregate different types of oiled waste and keep non-oiled waste separate. Oily debris should be segregated by types (i.e. sorbents, vegetation, sand, trash, etc.) and placed on a vessel or barge in a manner that will not allow seepage to occur. Oily debris will be transported in leak proof, sealable containers along with separate containers of recovered oil to temporary storage sites(s) onshore that are convenient to the recovery operation.

Consider the following to reuse or segregate different types of waste generated

Oiled waste	Considerations
Fluid oil	Feasibility of using recovered oil as a raw material or low grade fuel Prevent water or debris entering waste oil containers (consider decanting) Use cleaners and wash sparingly with water
Heavily contaminated oil	Discharge into lined lagoons, pits or large open topped tanks Separate oil, water and oiled debris; pre-treat if possible.
Solid waste (includes oiled debris and response material)	Do not mix oiled waste with domestic/non-oiled waste Prevent oily wastes from contaminating soil; use liners Use sorbent pads until they become moderately oiled Minimise collection of underlying, non-oiled sediment Clean and re-use recovery equipment (e.g. pom-poms) rather than discarding
Oiled wildlife	Keep dead animals separate from other waste types to prevent spread of disease

Step 5 - Recycle: Pre-treat

Pre-treat waste in situ to reduce the amount of waste that needs to be transported and treated.

Pre-treat by:

- surf washing
- burning
- sand sieving
- bioremediation

Step 6 – Dispose

Waste generated during the course of the spill incident should be minimized to the extent possible to reduce associated manpower and expenses. Each waste stream should be treated separately for waste determination, characterisation, and classification.

Table 4 provides some useful guidance on waste management considerations related to different strategies.

Table 4 Waste Management Considerations for Response Options

	Oily Liquids			
Location	**Recovery system(s)**	**Temporary storage area & resource**	**Emulsified**	**Non emulsified**
At sea	Single ship system	Barges, pillow tanks, offloaded at port into skips and trucks	✓✓	✓✓
Shoreline	Vacuum truck, oleophillic & mechanical skimmers, manual labour, adsorbent material	Heavy-duty plastic bags, skips, lined pits	✓✓✓	✓
	Waste Management Method (in order of preference)		Separation / Processing	Separation / Processing
	Oily Solids			
Location	**Biodegradable debris**	**Non-biodegradable debris**	**Sand**	**Pebbles**
At sea	✓	✓	n/a	n/a
Shoreline	✓✓*	✓*	✓✓	✓
	Waste Management Method (in order of preference)		Biodegradation / Landfill	Landfill / Incineration

✓✓✓ Relatively large amounts of waste produced
✓✓ Relatively moderate amounts of waste produced
✓ Relatively low amounts of waste produced
× Negligible amounts of waste produced
* Eni Ghana to remove debris from identified areas of coastline before oil impacts shoreline. This will severely reduce waste volumes

Initial transportation will involve small vehicles such as dump trucks and front end loaders. Subsequent transportation to intermediate or final disposal sites can include tankers for liquid waste and sealed trucks for solid waste.

Document and retain consignment notes for:

- all waste leaving the site
- waste being transferred from an intermediate storage site to a final suitably licensed disposal/treatment site

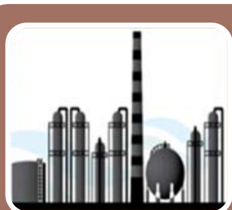
Disposal options depend on volume and type of oil, contaminated debris volume, spill location (offshore/shoreline), environmental and legal considerations, practical limitations and cost.

Oil-Water Separation

- Use an onboard oil-water separator to reduce contaminated waste quantities going to final disposal.
- The oil/water residue from separation should meet 15 ppm discharge standards for release into the environment.

Emulsion Breaking

- Waste emulsion can be broken down into its constituent parts of oil and water using a specialised emulsion breaking chemical.
- Oil can then be sent for refining. The emulsion breaking chemicals remain in the water which has to be disposed of appropriately.



Re-Processing

- Treatment of recovered liquid waste.
- Oil is reprocessed through an oil refinery or recycling plant.
- Oil with a high salt content may corrode refinery pipe work.
- Only debris free oil or an oil/water mix can be processed.

Incineration

- Treatment of recovered liquid waste.
- Small portable incinerators must be permitted by the Regulator prior to use.
- High salt content in the oil may render this option unsuitable.
- Costly option (environmentally and economically).
- Facilities are uncommon and are unable to deal with large quantities.

Land Fill

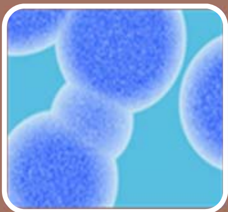
- Treatment of other oily waste (debris/PPE).
- If waste contains approximately 5% oil it can usually be disposed of with general waste, however local and national regulations should always be adhered to.
- Chemical testing required to determine hazardous content.
- Facilities able to receive this type of waste are limited.

Sand Cleaning

- Treatment of oiled sediment
- Specialist mechanical sand cleaners sieve contaminated sand to removed oil
- Consider NEBA to prevent damage by over cleaning or sterilisation

Beach Washing

- In-situ cleaning of sand, pebbles and cobbles
- Lightly oiled substrate can be cleaned naturally at the surf zone; collect remobilised oil in containment booms
- It is not always easy to identify when pebbles are oil free
- Produces oily water requiring treatment - costly and time consuming.



Bioremediation

- Treatment of oiled sediment
- Addition of microbes to breakdown oil contamination
- Can be done in-situ or oil waste can be removed and treated elsewhere
- Produces inert substance which can be disposed of at landfill if oil loading within permitted levels
- Should be carried out in a controlled environment

6. OIL SPILL RESPONSE RESOURCES

The Tier 1 response resources available in field are presented in Section 6.1, and can be mobilised by the eni Ghana Representative on site. The Tier 2 and Tier 3 response resources can be mobilised as per Section 6.2 and Section 6.3, respectively.

6.1 Tier 1 Capability

eni Ghana has at its disposal the following response equipment:

- Containerised Conventional Offshore Containment and Recovery Package (2 x 10ft DNV Containers)
  - 200m offshore boom and hydraulic reel system (2x)
  - Offshore skimmer, complete with diesel power pack, offloading screw pump and hose sets (2x)
  - Floating storage inflatable barge, 25m3 capacity (2x)
  - PPE sets (12x)
- Containerised High Speed Offshore Containment and Recovery Package (2 x 10ft DNV Containers)
  - High speed containment system, incl hydraulic reel
  - Diesel power pack, hose sets and offloading pump
  - Oil storage bags for containment system, 20m3 capacity (2x)
  - Paravane
  - PPE Sets (6x)
- Containerised Offshore Vessel Dispersant Spray Package (1 x 10ft DNV Containers)
  - Chemical dispersant spray unit, with Afedo nozzles (2x)
  - Corexit 9500 chemical dispersant, 1000 ltr in IBC tanks (8x)
  - Absorbent pads, bale (6x)
  - PPE sets (12x)
- Containerised Harbour Containment and Recovery Package (1 x 10ft DNV Containers)
  - 150m fence boom
  - skimmer and pump unit
  - Fastank 2000, incl box/ground sheet/liner
  - Absorbent pads, bale (3x)
  - PPE sets (6x)

- Shoreline Protection Containment and Recovery Package (1 x 20ft DNV Containers)
    - Response trailer (2x)
    - 250m shoreline skirt/shore sealing inflatable boom (2x)
    - Brush skimmer and pump unit (2x)
    - Fastank 2000, incl box/ground sheet/liner (2x)
    - Shoreline flushing equipment (2x)
    - Absorbent pads and 50m absorbent boom (2x)
    - Shoreline ancillary equipment, various (2x)
    - PPE sets (40x)
- Shoreline Support Package and Additional Support Package (2 x 20ft DNV Containers)
    - Trailerised 4.19 m vessel with a 40-70hp engine (stored in one of 20ft container)
    - Utility vehicle (UTV)
    - A command centre tent and supporting ancillaries
    - Communication equipment
    - Marine Tacking Buoy
    - Dispersant Sampling Kit

6.2 Tier 2 Arrangements

Eni Ghana have access to Tier 2 and Tier 3 resources through their contract with OSRL. It is the responsibility of eni to arrange transport of any equipment from the airport in Accra, this is the only international airport in Ghana. The distance from Accra to Takoradi (onshore logistics support base) is estimated to be 200km and will take roughly 3-4 hours by road. However, this is dependent on the availability of suitable hauliers.

6.2.1 West And Central Africa (WACAF) Aerial Surveillance And Dispersant Service

Eni Ghana have access to Tier 2 aerial surveillance and dispersant through OSRL. This service is provided by the WACAF aerial surveillance and dispersant application services. An Embraer Bandeirante aircraft has been modified to accommodate the fittings of the dispersant pod and spray arms. Details on the WACAF aircraft are presented in Table 5 below.

Table 5 WACAF Aircraft Information

Aircraft type	Embraer Bandeirante EMB110P
Location	Accra, Ghana
Transit Speed	200 knots
Spray Speed	120 knots @ 30-40 m altitude
Empty equipped	3,515 kg
Max take off	5,700 kg
Dispersant payload	2 tonnes (estimated)
Mobilisation time from San Tome Airport	4 hours surveillance 6 hours dispersant application
Dispersant Equipment	Palletised spray system installed internally on seat rails External mounted spray arms 2 m^3 internal tank and pump Swath width: 3 5 m
Surveillance Equipment	Fixed mount forward facing IR camera Fixed mount high resolution digital stills camera Camera stabilisation and protection Geo-referencing capability

The dispersant spraying equipment and a complete aerial observation package are available at Accra, with supporting dispersant stockpiles at the following locations:

- 4 m^3 in Accra (Ghana);
- 2.5 m^3 in Sao Tome;
- 5 m^3 in Malabo (Equatorial Guinea);

- 4 m^3 in Abidjan (Cote d'Ivoire);
- 4 m^3 in Sonils (Angola); and
- 8 m^3 in Port Gentil (Gabon).

Response Time

Response times to the predetermined dispersant stockpiles are given in Table 6. Flying times are for the aircraft in full spraying configuration including 1,000 litres of dispersant on board. *OSRL* will endeavour that response times from the initial call-out to first flight are 4 hours for aerial observation and 6 hours for dispersant spraying. Note that the response times below are in decimal rather than minutes.

Table 6 WACAF Response Times

Destination	Mobilisation Time (hrs)		Flight Time (hrs)	Total time (hrs)	
	Aerial Observation	Dispersant Spraying		Aerial Observation	Dispersant Spraying
OCTP area	**4**	**6**	**1.5**	**5.5**	**6.5**
Sao Tome	4	6	2.9	6.9	8.9
Malabo	4	6	3.1	7.1	9.1
Abidjan	4	6	1.2	5.2	7.2
Port Gentil	4	6	3.7	7.7	9.7
Luanda	4	6	7.8	11.8	13.8

Note: The flying time includes any fuel stop periods (if applicable).

Role of eni Ghana in Support of WACAF Aircraft

In advance of spraying operations it will be the responsibility of eni Ghana to obtain permission for dispersant spraying and blanket clearance for the aircraft to operate in the required region, and assistance with airport clearance / customs and immigrations, which equally applies for aerial observation. Immediate arrangement of these will aid the response time and thus the efficiency.

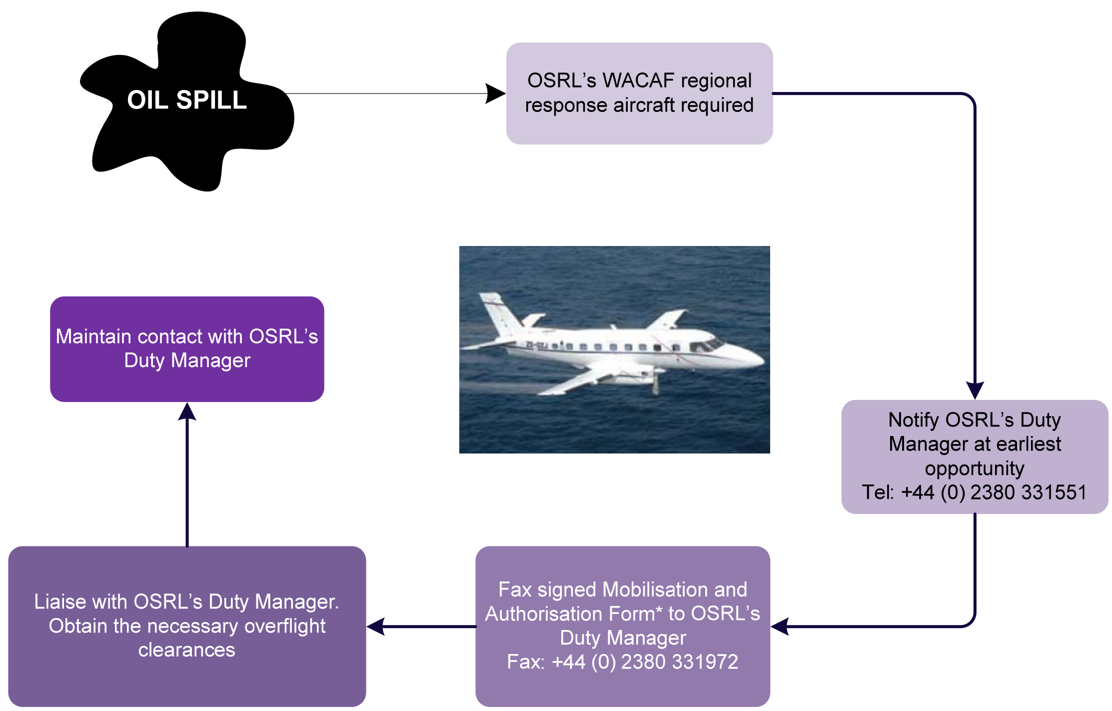
A helicopter must give aerial support to the dispersant spraying operations and provide aerial observation. A suitably trained person should be on board the helicopter to act as a spotter, to guide the spraying aircraft accurately onto the required oiled areas, and to observe the effectiveness of the spray operation. It is the responsibility of eni Ghana to arrange for a helicopter and spotter.

It is important that only the OSRL Duty Manager is used to contact WACAF (Aberdair) for additional flight times and other details for the WACAF plane. Over flight clearances for Togo, Benin, Nigeria and Cameroon can be secured within 48 to 72 hours, unless the request is made on a Friday – when it will be delayed until the Monday.

Note: All response times are subject to suitable weather conditions and over flight clearances.

6.2.2 WACAF Services Mobilisation Procedure

The mobilisation procedure for the WACAF aerial surveillance and dispersant application services is presented in the flow diagram below.



Note: any eni representative can notify *OSRL* but only the eni Call-Out Authorities have the authority to mobilize *OSRL*.

6.3 Tier 3 Arrangements

6.3.1 Oil Spill Response Limited

Eni is a Participant member with OSRL, therefore has immediate access to Tier 3 technical advice, resources and expertise 365 days a year on a 24 hour basis. OSRL can be mobilised by those personnel listed in Table 7. To maximise communication efficiency, it is recommended that one person acts as the eni Ghana point of contact for *OSRL*.

OSRL must receive official notification to mobilise from one of eni's Nominated Call-Out Authorities using the 'Mobilisation Authorisation Form', (Annex B, Section 6). The Nominated Call-Out Authorities are people within eni Ghana who have been appointed to approve the expenditure of mobilising Tier 3 resources.

In addition the 'Notification Form' should be provided to *OSRL* to convey technical details of the oil spill incident (Annex B, Section 5). The Emergency Response Manager would be in direct communication with the *OSRL* Duty Manager who would assist in coordinating the response. Eni Ghana is entitled to the services of a Technical Advisor.

Table 8 summarises the OSRL service level agreement (SLA) available to eni Ghana.

Table 7 Eni Ghana nominated call-out authorities

Eni Ghana
Managing Director
Emergency Coordinator
HSE & CI Manager

Table 8 OSRL Service Level Agreement (SLA) summary

<table>
<tr><th>Service</th><th colspan="2">Service Standard</th><th colspan="2">Eni Membership Type: Participant</th></tr>
<tr><td rowspan="7">Response notification, mobilisation, service and advice</td><td colspan="4">Notification of a spill should be placed to one of the following locations:</td></tr>
<tr><td>OSRL BASE</td><td>Southampton, UK</td><td>Loyang, Singapore</td><td>Fort Lauderdale, USA</td></tr>
<tr><td>TELEPHONE</td><td>+44 (0)23 8033 1551</td><td>+65 6266 1566</td><td>+1 954 983 9880</td></tr>
<tr><td>FAX</td><td>+44 (0)23 8072 4314</td><td>+65 6266 2312</td><td>+1 954 987 3001</td></tr>
<tr><td>EMAIL</td><td colspan="3">dutymanagers@oilspillresponse.com</td></tr>
<tr><td>FORMS</td><td colspan="3">Refer to: OSRL – Notification Form</td></tr>
<tr><td colspan="4">The Duty Manager will speak and advise eni Ghana immediately, or call back within 10 minutes.</td></tr>
<tr><td>Nominated contact</td><td colspan="4">OSRL must receive an official mobilisation authorisation from one of Eni Ghana's Nominated Call-Out Authorities (Table 7). Anyone can notify OSRL.</td></tr>
<tr><td rowspan="2">Spill response equipment</td><td colspan="4">SLA response equipment is housed in secure facilities in Southampton, Fort Lauderdale, Bahrain and Singapore. Response equipment is customs cleared response ready.
Refer to: OSRL Yearbook for a complete list of equipment available, www.oilspillresponse.com and refer to the equipment stockpile status report http://www.oilspillresponse.com/activate-us/equipment-stockpile-status-report</td></tr>
<tr><td colspan="4">As per the SLA, eni Ghana can mobilise up to 50% of the global stockpile. If there is more than one spill eni Ghana can mobilise 50% of what remains.</td></tr>
<tr><td>Global dispersant stockpile</td><td colspan="4">Following an incident, eni Ghana is entitled to 50% of the dispersant located in Southampton, Singapore, Fort Lauderdale and Bahrain. OSRL may be able to obtain further dispersant through the Global Response Network (GRN) and other organisations, if required.</td></tr>
<tr><td>World-wide transportation of equipment</td><td colspan="4">Global aerial dispersant coverage provided by aerial platforms and application systems.
Aerial dispersant coverage is mobilised within a six hour notice period.
Accra is the only international airport in Ghana able to accept equipment.
Logistics support including:
Own fleet of vehicles for local mobilisation of equipment.
24 hours a day access to global network of cargo and passenger charter services through a dedicated broker with specially negotiated payment terms.</td></tr>
</table>

<table>
<tr><td rowspan="3">Oil spill trajectory and tracking</td><td colspan="3">Trajectory and stochastic services for surface or subsurface oil spills on request, and backtrack services for surface oil spills using commercial modelling software:</td></tr>
<tr><td>Oil Spill Information System (OSIS)</td><td>OILMAP</td><td>Oil Spill Contingency and Response Model (OSCAR)</td></tr>
<tr><td colspan="3">Satellite imagery services can be provided on request.</td></tr>
<tr><td rowspan="2">Response personnel</td><td colspan="3">OSRL will provide the following response personnel on a first come, first served basis:
1 x Senior oil spill response manager.
1 x Oil spill response manager.
15 x Spill response specialists/responders.
1 x Logistics Service branch coordinators.</td></tr>
<tr><td colspan="3">A Technical Advisor (TA) can be deployed to support eni Ghana during an actual or potential oil spill incident. TA support is free for the initial assessment period of up to 48 hours. If a full response team is mobilised, the TA will form part of the team headcount.</td></tr>
</table>

6.3.2 Logistical Support

OSRL respond to locations around the world. To ensure equipment gets through customs clearance quickly and on to the lay down area for response, eni shall make the necessary arrangements for the equipment and OSRL personnel once in country.

Note: Mobilisation times **EXCLUDE** the time taken to get appropriate flight clearances and the time taken for the equipment to clear customs at Accra, which is the only international Ghanaian airport.

The times may vary depending on the events at the time and are given for guidance purposes only. The time taken to road-freight the equipment from Accra to Takoradi also should be taken into account, and is dependent on the availability of suitable hauliers. This will be arranged by eni Ghana. It is estimated that the 200 km journey along the coast road from Accra to Takoradi will take an estimated 3–4 hours.

The diagram below show in more details the different mobilisation responsibilities held by eni Ghana and *OSRL*.

An overview of the responsibilities for eni and *OSRL* are presented in Figure 3.

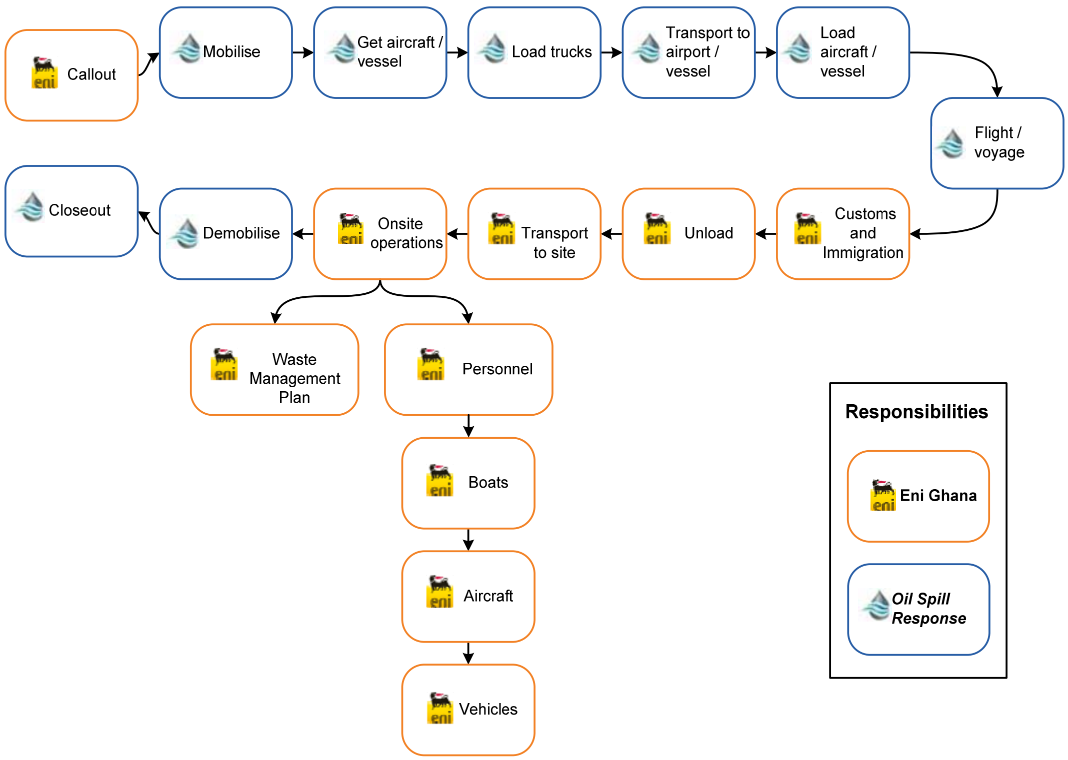


Figure 3 Overview of logistical responsibilities

6.3.3 Dispersant Stockpile

The Global Dispersant Stockpile (GDS) is an additional dispersant stockpile to the SLA. The GDS will total 5000 m^3 and will be located across the OSRL bases in the UK, Singapore, South Africa, USA, Brazil (in 2015) and France (Table 9). The dispersant types chosen are those with the largest worldwide approval. Unlike the SLA, 100% of the Global Dispersant Stockpile can be mobilised for a single incident.

Table 9 Global Dispersant Stockpile Quantities and Locations

Dispersant	Quantity (m^3)	Storage Location
Finasol OSR 52	3150	Southampton, South Africa, Singapore and France
Slickgone NS	850	Southampton and Singapore
Corexit 9500	350	Fort Lauderdale

6.3.4 Global Response Network

OSRL can facilitate the mobilisation of further resources through the Global Response Network (GRN). The GRN is a collaboration of six major oil industry funded spill response organisations whose mission is to harness cooperation and maximise the effectiveness of oil spill response services worldwide. It includes:

- Alaska Clean Seas (ACS)
- Australia Marine Oil Spill Centre (AMOSC)
- ECRC (formerly, Eastern Canada Response Corporation)
- Marine Spill Response Corporation (MSRC)
- Oil Spill Response Limited (OSRL) (America, Europe, Middle East, Africa, Asia and Pacific)
- Western Canada Marine Response Corporation (WCMRC)

6.3.5 Relief Well

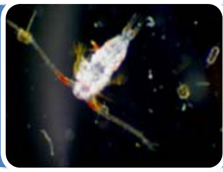
Eni Ghana will drill a relief well should there be an uncontrolled blowout at the OCTP area. This is anticipated to take up to 95days.

The company has in place a global agreement for Emergency Subsea Well Capping Equipment.

6.3.6 Oiled Wildlife Response

There are no formal guidelines for dealing with oiled wildlife incidents in Ghana. In case of an oiled wildlife incident, different organizations and bodies, such as the Ghana Wildlife Society or the University of Ghana (Oceanography and Zoology Departments), would probably get involved. The nearest area with experience in bird rehabilitation is in South Africa. Extensive expertise exists in Europe (France, United Kingdom) or the U.S.A. A report, *A Guide to Oiled Wildlife Response Planning* (IPIECA Report Series, Vol. 13) is available which provides an overview of the critical components of an oiled wildlife response. *OSRL* can also offer an oiled wildlife response service through an agreement with Sea Alarm (www.sea-alarm.org/).

Through OSRL, eni has access to an external international wildlife response capability. Sea Alarm has extensive experience in dealing with oiled wildlife emergencies. Specialised wildlife response equipment is pre-packaged, custom approved and stockpiled at OSRL. This equipment can be mobilised by the OSRL Duty Manager on request by eni. The mobilisation of Tier 3 wildlife emergency teams will be guaranteed both through voluntary commitment (external to the company) and internal dedicated resources through specific training. This equipment is available 365 days a year on a 24 hour basis, as part of the SLA. Experts from outside of OSRL and Sea Alarm are required to operate the equipment. Figure 4 outlines the effects of oiling on various wildlife.

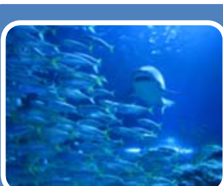


Plankton

- Includes juvenile fish and shellfish.
- Toxic, leads to death of plankton.
- Reduced future populations of fish and shellfish.

Coral

- Decreased growth, reproduction and colonisation capacity.
- Negative effects on feeding and behaviour.
- Death.
- Effects can be far-reaching.



Fish and Shellfish

- Smothering: loss of habitat, irritation and damage to the respiratory system, suffocation, damage to fins and scales, shell closure.
- Ingestion: enlarged liver, fish tainting, reduced growth, heart failure.
- Reduced egg hatching and larval survival.

Reptiles

- Smothering: irritation of skin, eyes and other orifices, limited mobility (especially juveniles) increasing vulnerability to predation.
- Ingestion: damaged digestive system and other organs, death by starvation.
- Inhalation: damaged respiratory system, death by suffocation.
- Loss of hatchlings and juveniles on oiled beaches.

Birds

- Smothering: loss of habitat, reduced mobility (increased vulnerability), loss of buoyancy, hypothermia, death.
- Ingestion: organ damage, gastrointestinal irritation and ulceration.
- Inhalation: pneumonia and death.
- Deformities, decreased reproduction / irregular breeding bevaviour.

Mammals

- Smothering (haired species): irritation, inflammation, infection, suffocation, hypothermia, reduced buoyancy and swimming ability.
- Ingestion: digestive complications, decreased chance of survival.
- Inhalation: respiratory system damage, disorientation, unconsciousness, paralysis, pneumonia, death.
- Loss of habitat

Figure 4 Effects of wildlife oiling

7. OPERATIONAL OVERVIEW

Eni Ghana intends to drill and produce oil from the Offshore Cape Three Points (OCTP) oil fields. The OCTP block is located in the Gulf of Guinea, in the Republic of Ghana, and is situated approximately 55 km South of the town of Atuabo and 60 km South of Sanzule. The water depth in the development area ranges from approximately 800 m to 1,000 m.

The development of the Sankofa and Gye Nyame fields will be carried out by an FPSO, which collects both the oil and gas production from different regions of the fields to collect and process the Oil. Sankofa field can be divided into four regions: North East, North West, South East and South West, while Gye Nyame is approximately 15 km East. Because of the well distance, the majority of the wells are satellite. The campaign will include the development of three non-associated gas fields (Sankofa Main, Sankofa East and Gye Nyame) and two oil fields (Sankofa East Cenomanian and Sankofa East-2A Campanian reservoirs). Figure 5 details the OCTP development project area.

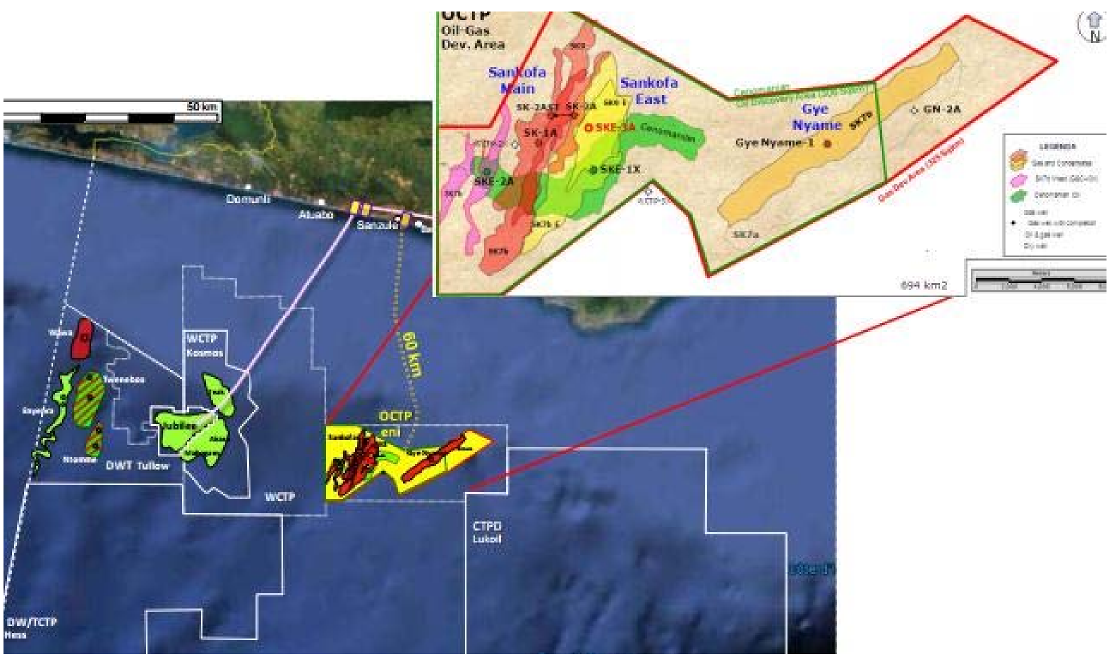


Figure 5 OCTP Development Project Area

The project considers drilling and then installing 19 subsea wells (8 Oil Producer wells (of which 3 are re-entry), 3 water injection wells, 3 gas injection wells and 5 subsea gas producer wells). A new conversion double hulled Floating Production Storage Offloading (FPSO) unit will be installed in the middle of the oil development area to collect and process the oil (dehydration and stabilization).

The project activities will include mobilization and rig installation, wells drilling; Production tests; Well completion and installation of X-Trees; Subsea Umbilical, Riser, Flowline installation; Installation of FPSO and mooring system; and then the Operation phase. See Table 10 for further information.

Table 10 OCTP Project Stages, Activities and Actions

Stage	Activity	Action
Wells Drilling	Drilling activities	Drilling system installation and removal
		Drilling system operation
		Production test
	Drilling support	Use of support vessels
X-Trees Installation and Removal	X-TREES installation and removal	Installation/removal activities
		Use of support vessels
Well Heads Operation	Normal operating procedures	Presence of production structures
		Protection of structures against corrosion (anodes)
	Production support, maintenance	use of support vessels
FPSO – Mooring System Installation	Installation activities	mooring system installation activities
		use of support vessels
	Structures normal operating conditions	protection of structures against corrosion (anodes)
		presence of mooring system
		use of support vessels
FPSO Process Commissioning and Operation	Commissioning	commissioning procedures, hydro test
	Process normal operating conditions	process operation production water discharge
		offloading activities
	Production support, maintenance	use of support vessels

7.1 Drilling Operations

Development drilling operations are scheduled to commence in Q1 2015, with an estimated drilling and completion total duration planned for 40 months baring offsets situations and drilling difficulties.

Common pollution prevention strategies, management systems and oil spill response plans will be covered in the bridging document with the drillship and FPSO contractors. The bridging document is to be issued as per eni’s standard Doc. N° 1.3.1.30 ‘Contract HSE requirements for abroad activities’, § 9.4.

The drilling and completion activities will be performed by the Maersk Voyager drilling rig. The rig will be capable of operating in water depths up to 3,300 m. It will be an advanced drilling ship, dynamic positioned (DP-3), Dual Activity/Dual BOP rig designed to minimize emissions and discharges to sea. The unit shall be capable of performing all the planned drilling and completion operations required to develop the fields and deploying the Subsea Production Trees and other associated subsea equipment. Table 11 lists the drillship storage capacities.

Table 11 Maersk Voyager Dynamic Positioned Drillship storage capacities

Maersk Voyager Dynamic Positioned Drillship


Maersk Voyager Dynamic Positioned Drillship	
Fuel (diesel or heavy fuel oil)	6,210 m^3
Drilling water	2,410 m^3
Potable water	1425 m^3
Liquid mud (active & reserve)	2,767 m^3
Waste liquid (mud & washing water)	2,000 m^3
Brine	777 m^3
Oil base Mud	998 m^3
Crude Oil	452 m^3
Bulk bentonite/Barite	452 m^3
Bulk Cement	2,300 m^3
Sack storage	7,540 m^3
Ballast water	6,210 m^3

Project Schedule

The activities listed below, as reported in the project schedule, partially overlap in order to limit the environmental impacts and their total duration. The activities taken into consideration will start in Q1 2015 and will end in Q2 2018 and so the total duration is 3 years. The Gye Nyame 1 well is excluded from this schedule, as its start is foreseen for 2028.

See Table 12 for details relating to the drilling project and also the facilities & equipment Installation. The expected duration of the production phase is 20 years.

Table 12 Project Schedule for Drilling, Facilities & Equipment Installation

Activity	Duration (months)
Wells Drilling and Completion	25 (with suspensions)
Flowlines, Risers, Umbilical's installation (3 major campaigns)	18 (total for all 3 campaigns)
Mooring / anchoring system installation	2.5
Mobilization / Demobilization drilling rig	1

OCTP Wells to be drilled

The campaign will include the development drilling of three non-associated gas fields (Sankofa Main, Sankofa East and Gye Nyame) and two oil fields (Sankofa East Cenomanian and Sankofa East-2A Campanian reservoirs). The project considers drilling and then installing 19 subsea wells (8 Oil Producer wells, of which 3 are re-entry), 3 water injection wells, 3 gas injection wells and 5 subsea gas producer wells. The wells to be drilled are as per Table 13.

Table 13 Well names and drilling targets

Phase	Well Name	x (m) @target	y (m) @target	z (m) @target	x(m)@seabottom	y(m)@seabottom	WD (m)
1	OP-1 (SkE-2A)	544565.81	493151.73	3760	544565.81	493151.73	989
1	OP-3	548775	492106	3654	549071.47	491302.15	941
1	OP-4	550628	492579	3527	551303.31	491585.16	870
1	OP-5	553853	495047	3422	554864.57	494507.31	708
1	OP-6 (SkE-1x)	551399.84	493700.60	3500	551399.84	493700.60	826
1	OP-7	555176	495628	3403	554910.35	494492.78	708
1	OP-CAMP1	HDst 542665.15 HDe 542333.46	HDst 493841.22 HDe 493349.70	2657.99 2662.37	543170.00	494598.00	997
1	OP-CAMP2	HD start 544716 HD end 544580	HD start 492894 HD end 492684	2655 2658	545000.00	493500.00	967
1	WI-1	547088	491508	3682	546451.05	492455.66	1014
1	WI-3	553506	495987	3497	553922.96	494882.71	726
1	GI-1	557346	495142	3369	557346.00	495142.00	630
1	GI-2	551600	491490	3481	551600.00	491490.00	865
1	WI-CAMP1	544907	497702	2710	545329.36	497321.86	954
1	GI-CAMP1	545647	495692	2630	545647	495692	897
2	Sk-2Ast (IWC)	549009.66 548968.74	496590.61 496588.26	2553 2605	549396.50	496615.96	863
2	Sk-D	547300	492850	2551	546627.504	493271.719	947
2	SkE-C (IWC)	551270 551270	493750 493750	2558 2599	551976.939	493375.518	811
2	SkE-D	548917.59	492133.46	2608	548847.18	491336.56	948
2	GN-1	565366.58	494899.22	2432	565340.77	494894.25	520

Table 14 Producer wells locations

Well name	Latitude (DMS)	Longitude (DMS)	Water depth (m)	Distance offshore (km)
OP-Camp 1	4° 28' 28.5198" N	2° 36' 39.1206" W	997	55
OP-Camp 2	4° 27' 52.7256" N	2° 35' 39.7572" W	967	56
OP-1 (SKE-2A)	4° 27' 41.3922" N	2° 35' 53.8506" W	989	57
OP-6 (SKE-1x)	4° 27' 59.1186" N	2° 32' 12.084" W	826	53
OP-3	4° 26' 41.0706" N	2° 33' 27.6834" W	941	57
OP-4	4° 26' 50.2434" N	2° 32' 15.2586" W	870	55
OP-5	4° 28' 25.3338" N	2° 30' 19.638" W	708	51
OP-7	4° 28' 24.8628" N	2° 30' 18.1548" W	708	51
Sk-2Ast	4° 29' 34.1226" N	2° 33' 17.031" W	863	52
Sk-D	4° 27' 45.2622" N	2° 34' 46.9488" W	947	56
SkE-C	4° 27' 48.5388" N	2° 31' 53.3634" W	811	53
Ske-D	4° 26' 42.1974" N	2° 33' 34.9632" W	984	57
GN-1	4° 28' 37.6854" N	2° 24' 39.6858" W	520	44

Sequence of operations

Pre drilling

The sequence foresees the positioning of the rig in the well location and the jetting of 36" conductor pipe. The drilling of 24" phase is made with sea water and viscous pillows, the cutting will be scattered on the sea bed because there isn't connection with the surface facilities through the marine riser. Then the 20" casing with wellhead housing is run and cemented in place.

The next sequence is to run the BOP stack with the marine riser and latch it onto the wellhead housing. Thereafter, all the drilling fluids and debris will be managed from the surface facilities of the rig. The operations will carry on in the same way until the 9 5\8" liner is set.

At that time the well is temporary suspended, the riser and BOP are recovered and the rig will move in the location of another well.

Re-entry and completion campaign

At the end of the drilling campaign eni will start the completion phase, so the rig will be back on the well, the corrosion cap will be removed and the Horizontal X-tree will be landed and installed with the BOP (Blow Out Preventer) on top.

The last 8 1\2 "drilling section is performed through X-Tree, then the cased hole logs are recorded.

Now the well is completed with lower, gravel or frac pack, and upper completion, tubing string packer and safety valves.

The last operation before to install the corrosion cap on X-Tree will be the well clean up.

Well start up

At the end of all the drilling and completion activities is highly recommended a well production test.

The main purpose of the operation is to eliminate all the debris from the well in order to avoid some damages of the downhole and surface equipments.

The test is usually done from the rig as soon as finished the completion job.

The period of the clean-up is quite short, around 3-4 hours, but it can hold up about 24 to better understand the productivity of the well.

Pollution prevention measures

All the systems on the drilling rig will be classified as controlled discharge to prevent any type of spill, drilling mud or bilge oil into the sea.

All drains will collect the liquids into the drain holding tanks. Operating on 3-way valves installed on drainage system, heavy rainfall could be diverted overboard. Collected liquids will be offloaded periodically to the supply vessel tanks and then carried to land for treatment and disposal. There will be no discharges of these liquids in the environment.

Civil wastewater (sewage, water from washbasins, showers, kitchen) will be treated with approved systems to achieve legal concentration limits, before being discharged into the sea, accordingly with MARPOL.

The machine room, pump zone and engine area will also be fitted with coaming and bilge to collect oily liquids. The fluids will be gathered and sent to an oil-water separation system. The water separated will be sent to the liquid waste collection tank while the oil will be stored in special drums to be transferred to land for disposal.

Drilling parameters will be monitored by two independent systems of sensors. Sensors will operate in continuous mode, during all drilling operations as monitoring permits ready recognition of any operating anomaly. The first monitoring system will be integrated in the drilling rig monitoring system, while the second is a computerized unit manned by skilled personnel and installed on the drilling rig by service contractor.

Blow Out Preventer

The rig will be equipped with 15,000 psi Blow Out Preventer (BOP) in accordance with eni well control policy and international standards. as they are critical to the safety of crew, rig and environment.

The two fundamental types of BOPs are annular and ram.

Annular BOPs will be installed on top of the BOP stack. They will have a suitably shaped rubber element that can close and seal the casing/drill string.

Ram-type BOPs able to perform several functions, such as closing around a tubular, or cutting a tubular and ensuring hydraulic sealing, or closing without tubular in the wellbore will have two prismatic gates to fit the diameter of the equipment in the borehole.

BOPs will be assembled to form the BOP stack, generally including 1 or 2 annular BOPs and 3 or 4 ram BOPs. There will be a set of shear rams that ensure total closing of the borehole during emergency situations by shearing the drilling pipes.

The BOPs will be hydraulically operated from 2 remote panels.

7.2 Production Operations

Oil producers, gas and water injection wells will be connected directly to the FPSO unit (no manifolds) through flexible risers and flowlines. Crude oil will flow continuously from subsea trees through the subsea flowlines via risers to the process facilities on the FPSO (coordinates: 549548.848 mE; 494023.114 mN).

The produced oil will be separated from both water and associated gas, stabilized and stored into storage tanks in the FPSO prior to being properly metered. Shuttle tankers will then be periodically moored to the FPSO and the stored crude oil will be pumped to the shuttle tanker via an offloading hose. Exported crude will be fiscally metered on board of the FPSO. Condensates produced later, during the following non associated gas project, will be separated offshore and blended with the oil on the topside facility of the FPSO.

The associated gas produced from the oil separation train, will be compressed dehydrated before being re-injected into the reservoirs (Cenomanian and Campanian) and sent by the gas sealine (63 km long) to the Onshore Receiving Facilities (ORF). Part of this gas will be used for fuel for power generation. Oily and accidentally oily waters will be stored in drums to be transferred to land for proper disposal/treatment.

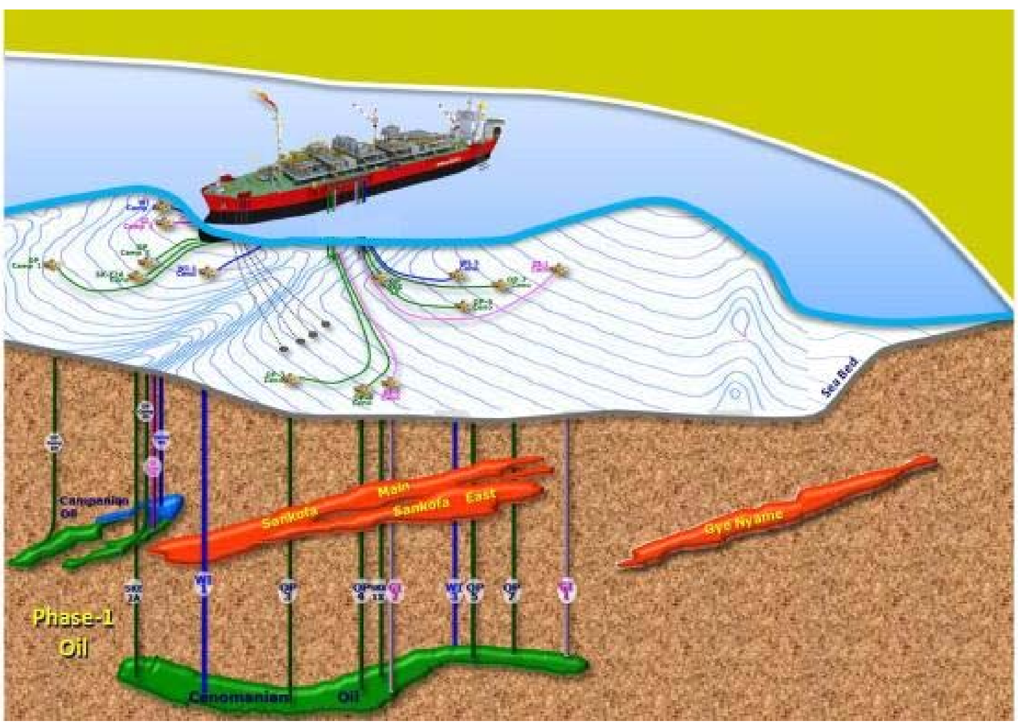


Figure 6 OCTP Schematic Operational Layout

The FPSO will be constructed through the conversion of an existing very large crude carrier (VLCC). The FPSO will be a double hull and will be classified with DNV that will ensure all the hull requirements are in accordance to international and local standards. The design is according to worst conditions (100 years) return period. FPSO design characteristics are reported in Table 15.

Table 15 Floating Production Storage Offloading (FPSO) unit

Floating Production Storage Offloading (FPSO) unit	
Non Associated Gas design capacities	
Gas production	210 MMSCFD (including overdesign)
Condensate production	8,000 bblsd
Water production	1,000 bblsd
Gas treatment capacity	210 MMSCFD (including overdesign)
Booster compressor capacity	210 MMSCFD (future installation)
Oil design characteristics	
Total liquid capacity	75,000 bblsd
Oil treatment capacity (including condensates from NAG)	58,000 bblsd
Produced water treatment capacity	45,000 bblsd
Gas injection capacity	150 MMSCFD
Water injection capacity	55,000 bblsd

7.3 Field Support Vessels

Both drilling and production operations will be assisted by supply vessels. The main hydrocarbon inventory onboard the vessels is detailed in Table 16.

Table 16 Hydrocarbon Inventory for Field Support Vessels

Vessel	Hydrocarbon Inventory
Platform Supply Vessel	Marine Gas Oil storage tank: 1,000 m^3 (actual capacity may slightly vary from vessel to vessel)

Precautions include a supply vessel normally stationed on location, 24-hour watches, establishment of a 500 m radius exclusion zone around the unit, and access to current weather data.

The drilling system is manned from a supply vessel that not only serves as temporary storage for drilling materials (diesel fuel, water, bentonite, barite) but also holds drums of dispersant and equipment with special arms for deployment in the sea in the case of accidental oil spills.

During the production phase, supply vessels (one on stand by and one commuting) will provide food and materials to the FPSO.

Additionally, the onshore logistics support base is located at Takoradi, which is approximately 100 km from the OCTP locations. The marine support base at Takoradi Port provides dock space which serves as a loading/offloading point for equipment and machinery. It also provides quayside facilities for dispatching fuel, chemicals and equipment, and allow for the temporary storage of spares, production chemicals, fuel and other supplies. On occasion if the Takoradi Port is full, the Naval Port at Sekondi may be used.

Normal operations will include well drilling and completion, loading and offloading of supply vessels and helicopters, fuel transfers and mud and chemical transfers.

7.4 Oil Properties

The main properties that affect the behaviour of oil spilled at sea are:

- Specific gravity (its density relative to pure water often expressed as °API).
- Distillation characteristics (its volatility).
- Viscosity (its resistance to flow).
- Pour point (the temperature below which it will not flow).

The International Tanker Owners Pollution Federation (ITOPF) classifies oil into four main groups according to specific gravity. This classification can be used to predict rate of dissipation. Figure 7 shows the oil classifications and the time anticipated for the oil to dissipate naturally in the marine environment.

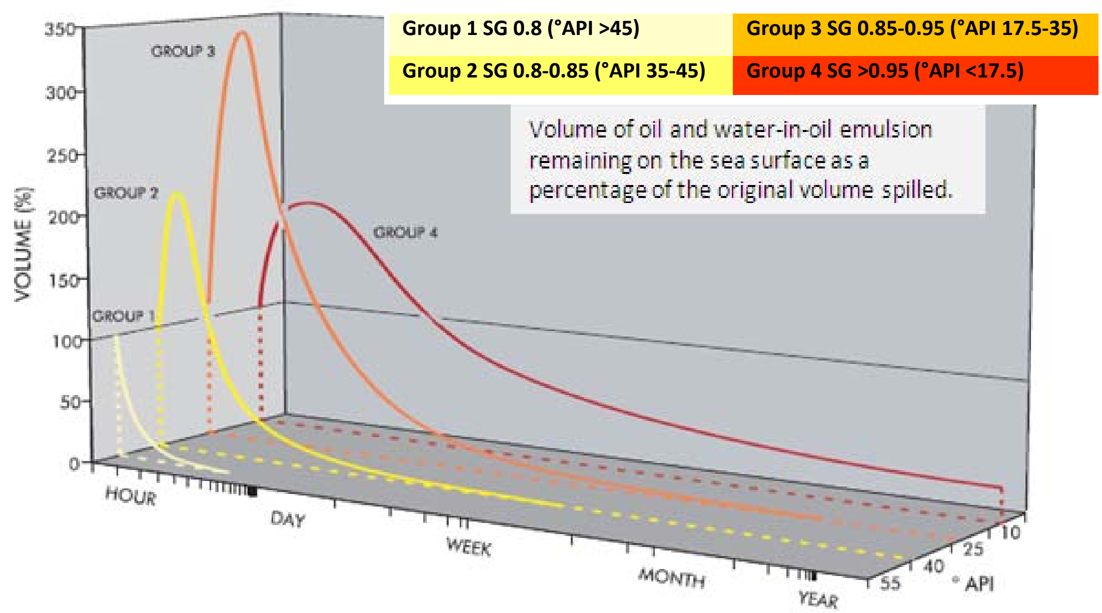


Figure 7 Variation in persistence between oil groups defined by the ITOPF classification[1].

Spill Fate and Behaviour in the Marine Environment

The fate and behaviour of oil spilled at sea depends largely on the physical and chemical properties of the oil. It is the oil's chemical composition, in combination with meteorological conditions, which affect the way in which the oil breaks up and dissipates into the marine

[1] ITOPF. 2010. Handbook 2010/11. Fate of Marine Oil Spills.

environment, or persists. This interaction between the spilled oil and its new environment is a process known as weathering and it can only be predicted if the oil's properties are known.

The Weathering Process

The weathering processes applicable to oils covered by this OSCP are described in Table 18. Response techniques have been suggested using oil spill models that include algorithms for weathering processes based on tested oils. If oil is spilled, additional modelling will predict the fate and behaviour of the spilled oil based on the current and forecast meteorological conditions.

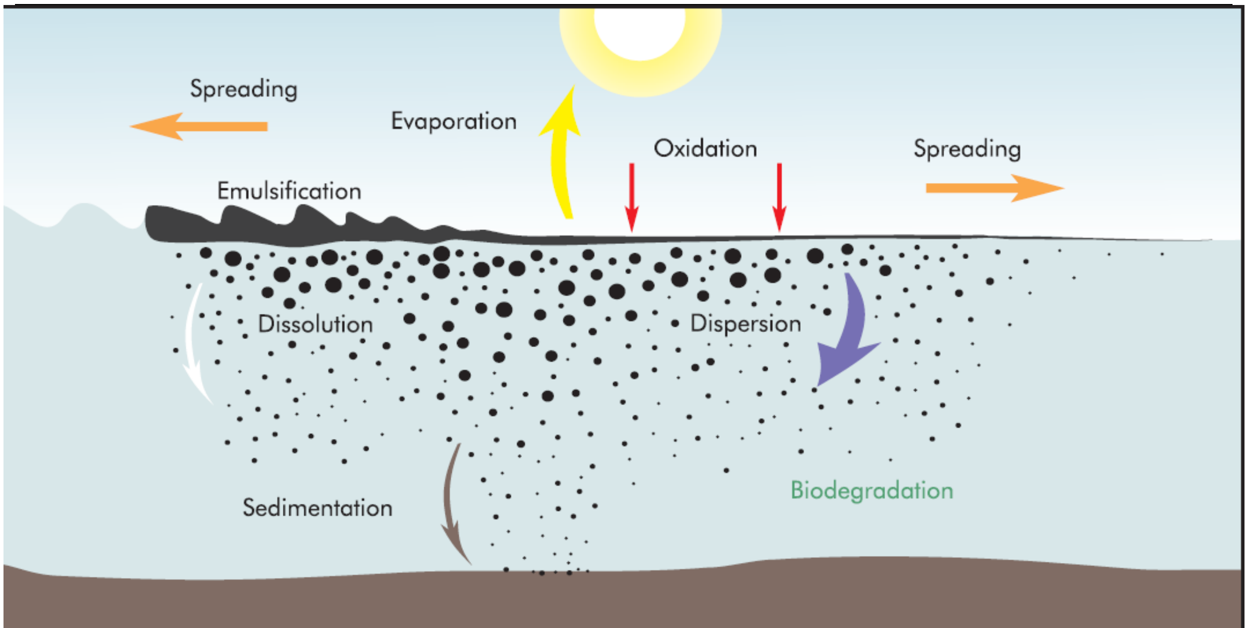
Oil Properties for the Sankofa East Fields

The oil properties for the Sankofa East 'Campanian' and 'Cenomanian' crudes are detailed within Table 17.

Table 17 Oil Properties for Sankofa East Fields

Field	Sankofa East	
Level	Campanian	Cenomanian
Oil type	Oil	Oil
Specific gravity	0.865	0.876
Density (°API)	32	30
Viscosity @BP (cP)	0.79	0.69
Sulfur (%)	4	-
Asphaltenes	4,9	-
Psat (psia)	3915	5349
Solution GOR (MSCF/STB)	0.817	1.103

Table 18 Weathering of oil spilled in the marine environment



Spreading	• Oil spreads over the sea, becoming thinner with distance from source. • Rate depends on oil viscosity, wave action, wind speed, and air and sea temperature. • Condensate, light crude oil, diesel and base oil spread thinly rapidly.
Evaporation	• Light ends evaporate quickly - can produce an explosive atmosphere. • Rate depends on volatile content of oil, wind speed, and air and sea temperature.
Emulsification	• Seawater mixes with oil to form a viscous and persistent emulsion. • Emulsion is difficult to recover and cannot be burnt or dispersed. • More likely to happen to hydraulic oil than condensate, diesel or base oil.
Dispersion	• Oil breaks down into droplets which mix into the water column. • Small droplets may remain dispersed in the water, large droplets may resurface. • Rate increases with decreasing oil viscosity and increasing wave action
Sedimentation	• Oil adheres to suspended particles which sink the oil to the seabed. • Rate depends on suspended sediment concentration. • High concentrations can occur in shallow seas, particularly during storm events.
Biodegradation	• Oil is consumed by bacteria that break it down into smaller compounds until it becomes carbon dioxide and water. • Rate depends on oil type, availability of nutrients (varies seasonally), oxygen concentration and water temperature.
Dissolution	• Water soluble components dissolve into the water column. • A large fraction of condensate, light crude oil, base oil, diesel and helifuel can dissolve; hydraulic and lube oils contain smaller soluble fractions.
Photo-oxidation	• Breaks down oil into smaller, soluble compounds – a slower process than evaporation

7.5 Environmental Settings[2]

This section describes the important physical and biological aspects of the Ghanaian environment with a particular focus on the well locations and its adjacent area.

Ghana lies along the Gulf of Guinea in West Africa, bounded within latitudes 04° 35′ N and 11° 00′ N and longitudes 03° 05′ W and 01° 10′ E. It covers an area of approximately 239,000 km^2. The country is bordered by Togo to the east, Côte D'Ivoire to the west and Burkina Faso to the north. The coastline of Ghana is approximately 550 km long. Around 70% of the coastline consists of sandy beaches, and the coastal zone is dotted with over 90 coastal lagoons, most of which are small.

The well locations fall within the west coast of Ghana, which covers 95 km of shoreline, extending from Ghana's border with Côte D'Ivoire to the estuary of the Ankobra River. The majority of this coastline is fine sand with beaches backed by coastal lagoons.

7.5.1 Climate

The climate of the region is governed by the latitudinal displacement of the Inter–Tropical Convergence Zone (ITCZ). The ITCZ separates two air masses: the humid air mass of oceanic origin (characterizing the monsoon period) and the dry air mass of continental origin (representing the Harmattan season). Alternation of the rainy and the dry seasons is regulated by zonal and seasonal variations of the ITCZ along the coastline. Ghana receives most rainfall during the major wet season (May to July). Rainfall is usually between 1,500 and 2,000 mm per year. The major dry and hot season occurs between December and March. Air temperature shows little variation around 26°C with an average daily and monthly change of 4 °C and 8 °C respectively. Monsoon trade winds blow for 10 months a year from the south-west and south-south-west. In January and February, the Northeast Trade winds blow offshore. The surface atmospheric circulation in the region is influenced by north and south trade winds and the position of ITCZ.

[2] Additional details are explored in the eni Ghana ESHIA developed for the Phase 1 and 2

7.5.2 Oceanography

Surface water temperatures are expected to be warm (27–29 °C), but with a marked thermocline at ~30 m depth. Currents at the surface (<30 m depth) are likely to be flowing in an eastwards direction (average velocity 0.26 $m.s^{-1}$ and maximum velocity 1.03 $m.s^{-1}$), and in a westwards direction in the deeper layers (average velocity of 0.21 $m.s^{-1}$). Tides are semi-diurnal with a diurnal inequality, with a range from 0.4 m to 1.5 m. The bathymetry of the continental shelf off the Ghanaian coastline is generally regular with isobaths running parallel to the coast. The continental shelf is mostly narrow (about 25 km in width) with a marked increase in width to about 80 km off the central Ghana coastline (between Cape Three points and the Delta of the River Volta). The sediment types in the vicinity of the proposed well (outer part of the shelf and upper slope) are likely to be detrital sands with an admixture of carbonate and glauconite-rich sediment mixtures of biogenic carbonate.

Waves reaching the shores of Ghana consist of swells originating from the oceanic area around the Antarctica Continent and seas generated by locally occurring winds. The significant height of the waves generally lies between 0.9 m and 1. m. The most common amplitude of waves in the region is 1.0 m but annual significant swells could reach 3.3 m in some instances.

The bathymetry of the survey area is characterized by water depths that range from a minimum of 82 m in the north to a maximum of 1390 m in the south-west part.

7.5.3 Coral Reef

The continental shelf of Ghana's western region is traversed by a belt of dead madreporarian coral from 75 m depth. Beyond this coral belt, the bottom falls sharply, marking the transition from the continental shelf to the slope Soft sediment (mud and sandy mud) predominates along the coast and offshore of the coral belt. The central part of the continental shelf has extensive hard bottom areas, which are widest off Takoradi and Cape Coast and extend eastward. They consist of flat rocks and shoals and are covered by gorgonians, branched corals, and bryozoans (Rijavec, 1980). Mixed gravel and pebble bottoms, on the other hand, are usually covered with corallinaceous algae

7.5.4 Marine Mammals

The following populations of marine mammals pass through or live permanently/seasonally in the area of the project:

Common bottlenose dolphin, Clymene dolphin, Spinner dolphin, Pantropical spotted dolphin, Atlantic spotted dolphin, Long-beaked common dolphin, Fraser's dolphin, Rough-toothed dolphin, Risso's dolphin, Melon-headed whale, Pygmy killer whale, Short-finned pilot whale, Killer whale, False killer whale, Cuvier's beaked whale, Dwarf sperm whale, Sperm whale and Humpback whale.

7.5.5 Sea Birds

The west coast of Africa forms an important section of the East Atlantic Flyway, an internationally-important migration route for a range of bird species, especially shore birds and seabirds (Boere et al, 2006, Flegg 2004). A number of species breed in higher northern latitudes winter along the West African coast and many fly along the coast on migration. Seabirds known to follow this migration route include a number of tern species, skuas and petrels.

Species of waders known to migrate along the flyway include sanderling and knott. The highest concentrations of seabirds are experienced during the spring and autumn migrations, around March and April, and September and October. Waders are present during the winter months between October and March. The marine birds of Ghana include storm petrels and Ascension frigatebirds.

During the environmental baseline studies for the West African Gas Pipeline (WAGP, 2004) in 2002/2003, the survey crew recorded several sightings of black tern, White winged black tern, royal tern, common tern, sandwich tern, great black-back gull, lesser blackback gull, pomarine skua and great skua.

There are 40 Important Bird Areas (IBAs) designated by Birdlife International within Ghana located along the coastline of Ghana, namely: Amansuri wetland, Densu Delta (Ramsar Site), Keta Lagoon Complex (Ramsar Site), Muni-Pomadze (Ramsar Site), Sakumo (Ramsar Site) and Songor (Ramsar Site).

According to BirdLife International (2013) in Ghana there are a total of 676 species of birds divided in Landbirds (555 species), Migratory (211 species), Seabirds (15 species) and Waterbirds (120 species).

7.5.6 Sea Turtles

The following populations of sea turtles pass through or live permanently/seasonally in the area of the project: Olive Ridley, Green Turtle, Leatherback Turtle, Hawksbill Turtle, Loggerhead Turtle.

7.5.7 Fish Ecology

The composition and distribution of fish species found in Ghanaian waters, and the wider Gulf of Guinea, is influenced by the seasonal upwelling that occurs between Nigeria and the Ivory Coast mainly in July to September and to a lesser extent in December to February. The rising of colder, dense and nutrient-rich deep waters stimulate high levels of primary production (phytoplankton) and consequently this will increases the production of zooplankton and fish.

The fish species find in Ghanaian waters belong to four groups: small pelagic species, large pelagic species (tuna and billfish), demersal (bottom dwelling) species and deep sea species.

The most important pelagic fish species find in the coastal and offshore waters of Ghana are: round sardinella, flat sardinella, European anchovy and chub mackerel. These species are important commercially as they represent approximately 80 percent of the total catch landed in the country. Other pelagic species found in Ghanaian waters include: horse mackerel, little tunny, bonga shad, African moonfish, West African Ilisha, largehead hairtail, crevalle jack, Atlantic bumper and Barracuda.

Large pelagic fish stocks off the coast of Ghana include tuna and billfish. These species are highly migratory and occupy the surface waters of the entire tropical and sub-tropical Atlantic Ocean. The tuna species are: skipjack tuna, yellowfin tuna and bigeye tuna. Billfish species occur in much lower numbers and comprise: swordfish, Atlantic blue marlin and Atlantic sailfish.

Demersal fish are widespread on the continental shelf along the entire length of the Ghanaian coastline. Species composition is a typical tropical assemblage including the following families: Three Porgies or seabreams, Two Grunts, One Croakers or drums, Goatfishes, Snappers, Groupers, Threadfins and Emperors. The demersal species that are most important commercially are cassava croaker, bigeye grunt, red pandora, Angola dentex, Congo dentex and West African Goatfish.

7.5.8 Marine Habitats And Protected Areas

In the marine area affected by the project operations no protected or restricted areas have been highlighted by the desktop study. Ghana has not declared any marine protected area with the exception of Ramsar sites that are all located onshore.

7.5.9 Socioeconomic

Enrichment of coastal waters due to upwelling events is transferred to higher tropic levels and results in productive fisheries in Ghanaian waters. Ghana's coastal zone represents about 6.5% of the land area of the country, yet houses 25% of the nation's population and fishing is the primary economic activity in this zone (Amlalo 2005). It is estimated that 230,000 people in Ghana are employed in the fishing industry; fish protein forms 19% of the populations total protein supply and Ghanaian fish exports were worth some US$78 million in 2000 (http://earthtrends.wri.org 2000). The average annual marine fish catch in Ghana has increased substantially since 1970, reaching nearly 400,000 metric tonnes in 2000.

The general coastal area of Ghana has heavy shipping traffic, hence proper permitting and diligence during the performance of the development work will be necessary to ensure that there is no disturbance to or from shipping activities.

Tourism is an important yet relatively underdeveloped industry in Ghana in general and along the coastal zone in particular. Although the tourism industry is not yet operating at full potential, it is growing and the country features on travel websites. The most important tourist season is from October to March. Any accidental environmental degradation that impacts on the coast would impact negatively on tourism.

8. OIL SPILL RISK ASSESSMENT

This risk assessment has been carried out in accordance with the eni Company Risk Register Management (Document Number 1.3.0.05).

8.1 Risk Assessment Methodology

The oil spill risk assessment methodology consists of five key steps and meets the IMO guidance as issued in the Manual on Oil Spill Risk Evaluation and Assessment of Response Preparedness (2010 Edition).

Step 1 **Oil Spill Scenarios**	Identification of potential scenarios that may lead to an accidental release of oil. The source of the spill, event, oil type and volume are considered.
Step 2 **Likelihood and Consequence**	The likelihood and consequence of all oil spill scenarios identified are semi-quantitatively measured in accordance with the eni risk assessment process. Only the likely consequence and impact of the scenario on surrounding environment is considered.
Step 3 **Oil Spill Scenario Impacts**	The potential impact and likely trajectory of an oil spill identified in the oil spill scenarios outlined in the Risk Register has been assessed by conducting oil spill modelling of the potential worst-case scenario as to provide an indication of the likely trajectory of the oil spill. **Refer to:** Oil Spill Modelling, section 8.4. Reviewing the environmental and socioeconomic sensitivities that may be influenced from an oil spill from eni Ghana operations. **Refer to** Environmental and Socioeconomic Sensitivities Section 7.4.
Step 4 **Tiered Response**	The tiered response approach and response technique suitable for each scenario has been defined. Influencing factors include oil type, spill volume, climate, proximity to sensitive resources and response capability. **Refer to** Section 4 for the Tier Level Assessment. **Refer to** Section 5 for Response Strategy Selection.
Step 5 **Risk Assessment Matrix (RAM)**	The risk profile is completed using the RAM. The RAM highlights the scenarios that are deemed low, medium or high risk.

8.2 Operational Risk Assessment

The Ghana OCTP Block Phase 1 ESHIA, Attachment C, Fisheries Impact Assessment outlines that during the drilling and completion phase there is the potential for spills of fuels and oils during drilling operations, well head installations, fuelling, handling and storage of chemical and fuels including repair, fabrication and maintenance of machinery, as well as from support vessels.

During FPSO installations and operations (offloading), accidental spills may occur from a loss of well integrity, leaks in subsea manifolds, flowlines, riser through which crude oil is pumped into the FPSO. Also the water/oil separation operation in the FPSO has potential to spill produced water and oil. Offloading operations, ship to ship transfers as well as tanker vessels colliding are also key sources of spills of oil into the marine environment.

Evaluating oil spill risks requires consideration of two factors, namely the probability of a spill occurring, and the consequences. The probability was determined by using historical data and referring to eni Ghana's probability and consequence definitions as summarised in Table 19 and Table 20 below.

Table 19 Probability Definitions

Rating	Probability
0	Practically non-credible occurrence (Could not happen in E&P industry)
A	Rare occurrence (heard of in E&P industry)
B	Unlikely occurrence (occurred at least once in Company)
C	Credible occurrence (occurred several times in the Company)
D	Probable occurrence (occurred once in this location)/(occurred several times in the Company)
E	Likely/ Frequent occurrence (occurred several times in one location)

Table 20 Consequence Definitions

Severity		Environment Consequence
1	Slight Effect	Slight environmental damage – contained within the premises.
2	Minor Effect	Minor environmental damage, but no lasting effect.
3	Local Effect	Limited environmental damage that will persist or require cleaning up.
4	Major Effect	Severe environmental damage that will require extensive measures to restore beneficial uses of the environment.
5	Extensive Effect	Persistent severe environmental damage that will lead to loss of commercial, recreational use or loss of natural resources over a wide area.

Potential oil spill scenarios have been identified from the information in the operational overview. Understanding the overall oil spill risk requires these scenarios to be defined in terms of the likelihood of occurrence and potential consequences. The likelihood of each scenario has been qualitatively estimated based industry data and experience.

The potential oil spill scenarios for exploration drilling activities and associated operations are summarised in Table 22. The scenarios presented here are indicative only. Not every eventuality can be accounted for; however these represent a broad cross section of possible oil spill scenarios. The credible release quantities given are only an indication and an actual oil spill may vary significantly.

The Gye Nyame 1 well has been excluded from the risk register, as it will be started in 2028.

The sea gas line to the Onshore Receiving Facilities (ORF) has not been taken into account since the carried fluid, whose typical composition is shown in Table 21, is a dry gas at sea bottom environmental conditions (about 80 bar, 4.5 °C) and along the water column, therefore not posing a risk of oil spill.

Table 21 Typical composition of the fluid exported via the sea gas line.

Component	Molar fraction
Nitrogen	0.0043
CO2	0.0044
Methane	0.9117
Ethane	0.0428
Propane	0.0234
i-Butane	0.0034
n-Butane	0.0061
i-Pentane	0.0014
n-Pentane	0.0011
C6*	0.0008
Mcyclopentan	0.0001
Benzene	0.0000
Cyclohexane	0.0001
Mcyclohexane	0.0001
Toluene	0.0000
E-Benzene	0.0000
p-Xylene	0.0000
o-Xylene	0.0000
124-MBenzene	0.0000
C7*	0.0001

Component	Molar fraction
C19*	0.0000
C20+(SKF_GAS)*	0.0000
C20+(GYN)*	0.0000
C20+(OIL)*	0.0000
H2O	0.0001
TEGlycol	0.0000
EGlycol	0.0000

8.3 Mitigation Measures

Risk management evaluates the risk assessment results and puts in place measures to ensure that identified risks are acceptable or need mitigation measures. Risk reduction measures must be technically feasible and cost effective. The associated costs should not be disproportionate to the benefits gained.

It is eni Ghana's policy that all operations minimize the risk of oil spillage and pollution. eni Ghana, recognizing that spills can occur, implement precautionary measures to reduce the possibility of a spill occurring and minimizing the potential impacts. eni Ghana has put in place the following mitigation measures to reduce the potential for an oil spill to occur and the impact it may have. These include the following measures:

1. Process Safety Management and Training

Personnel who work on for eni Ghana are trained to ensure the prevention of unintentional releases of chemicals, energy, oil or other potentially dangerous materials during the course of operations at any of the facilities. There is focus on ensuring that the design and engineering of the facilities are of the highest quality and standards.

2. Asset Integrity Assurance

There are routine operator inspections, maintenance inspections and internal and external audits. These systems incorporate a number of management processes such as Risk, Safety, Maintenance and Environment management alignment in ensuring identification, reduction and eventually elimination of potential oil spill scenarios within the eni Ghana operations.

3. Process Isolation

Emergency Shut Down (ESD) valves exist offshore at every well head and platform. The ESD system is an integral part of the Combined Safety System (CSS) and executive actions, and provides full alarm and fault status indication as well as valve isolation.

4. Incorporation of Industry Lessons

Process incidents have been widely studied by industry and the lessons learned have been reviewed by eni Ghana to ensure that the recommendations have been understood and considered during the operation of the onshore oil production facilities.

- The design, installation and verification of barriers are critical and are key factors in operation of onshore processes;
- Secondary and emergency controls systems shall be understood and tested;
- Procedures will be followed on all occasions and not circumvented;
- Deviations and unexpected results are rigorously reviewed and appropriate actions generated;
- Disasters can result from multiple failures which often involve decisions made, actions taken or omitted and effectiveness of barriers;
- Human factors such as complacency represent a significant hazard that is recognized and is mitigated by having in place robust procedures, training and supervision.

5. Emergency Preparedness

eni Ghana have emergency preparedness in place. Detailed in this OSCP are the procedures, training requirements, equipment and agreements for assistance with contractors and other oil companies.

Guidelines for Mitigation Measures *(extracts from the Ghana OCTP Block Phase 1 ESHIA)*

Mitigation Measure	Description
Communications	Environmental issues will be communicated to the workforce on a regular basis. Daily project meetings, which follow a set agenda incorporating Health, Safety and Environmental issues will be held on-board the project vessels and a daily report will be generated and distributed. All staff and sub-contractors involved in all phases of the project will be encouraged to report environmental issues.
Environmental Policy Objectives	Environmental performance will be managed, monitored and improved through the implementation of this Sustainable Environmental Management Plan and associated Operational Control Procedures in accordance with ISO 14001:2004 standard.
Environmental Control & Monitoring	Environmental Control Procedures, Monitoring and Reporting, Environmental Performance Monitoring
Environmental Audit	eni Ghana shall conduct periodic HSE audits (monthly / quarterly / annually, etc) of the oil wells activities in OCTP Development project Area in order to ascertain extent of compliance with policy and regulatory requirements. The audits shall be carried out by certified auditors and in accordance with ISO 14001 guidelines.
Waste Management	All on-board waste discharge, from vessels, will follow the

	guidelines from MARPOL 73 / 78 for domestic waste discharges to the environment.
Pollution Emergency Procedures	The oil spill contingency plan outlines coordinated and integrated response actions to be implemented in the event of an oil spill. It highlights the roles and responsibilities of key personnel in eni operations and lists equipment and materials available to combat oil spills. The plan is designed to cover the control and removal of any oil spill occurring at any of the facilities operated by eni. On board procedures for pollution prevention and emergency response are laid down in each vessel Shipboard Oil Pollution and Emergency Plan (SOPEP). Details on project specific (oil) pollution combat equipment will be available on-board along with locations of equipment, availability, and contact details for support personnel / services. Each individual vessel will have regard to eni Oil Spill Contingency Plan, which contains detailed procedures to be followed in the event of a pollution emergency.
Safety Philosophy	The Project shall incorporate an Integrated Control and Safety System (ICSS) that shall provide an integrated monitoring, control, protection and safety system for the entire production, topsides, marine, and subsea facilities. The safety systems shall be separate from the Process Control System (PCS).
Safety Shutdown System	In the event that the primary control system fails to keep the process within specified operating limits, separate, dedicated safety systems shall be provided for the safe shutdown of equipment and/or process units. The purpose of these systems shall be; first, to protect personnel from an abnormal condition; second, to protect the environment and equipment from damage; and third, to safely isolate problem areas. An automatic and hierarchical Emergency Shut-Down System (ESD) shall be foreseen on the FPSO including a vessel shutdown system, a topsides shutdown system.

8.4 Oil Spill Scenarios

Table 22 Potential oil spill scenarios associated with eni Ghana drilling and production operations

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
OCTP Block, development drilling phase 18 subsea wells (8 oil, 4 gas condensate, 3WI, 3GI), Maersk Voyager Rig																
1	Maersk Voyager Rig	Collision causing full rupture of fuel tank	Diesel or HFO	n/a	6,210	m^3	Diesel spill likely to naturally dissipate, but due to large volume likely to spread over a large area.	B	3	Medium		B	3	Medium	Monitor and evaluate Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
2	Maersk Voyager Rig	Collision causing full rupture of crude oil storage tank	crude	n/a	452	m^3	Sea surface and water column. Could potentially spread over a large area.	B	2	Low		B	2	Low	Monitor and evaluate Offshore containment and recovery	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
3	Maersk Voyager Rig	Collision causing full rupture of OBM tank	Synthetic Oil Based Mud system SBM	n/a	998	m^3	Sea surface and water column. Could potentially spread over a large area.	B	2	Low		B	2	Low	Monitor and evaluate Offshore containment and recovery	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
4	Development drilling	Minor operational or maintenance spills at sea (Lubricant Oil, Base Oil, Hydraulic Oil)	Utility Oils	n/a	<1	m^3	Spill unlikely to have a significant impact due to size, and it would be easily mitigated. Release may not reach with the marine environment if contained on deck	C	1	Low		C	1	Low	Monitor and evaluate	Tier 1: Response vessel with dispersant application system
5	Drilling operations	Operational spill of OBM (low toxicity)	Synthetic Oil Based Mud system SBM	n/a		m^3										
6	Drilling operations - OP-Camp 1 well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	Days 1-5: 22,053 Days 6-30: 9,762 Days 31-94: 7,264	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
7	Drilling operations - OP-Camp 2 well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	Days 1-5: 22,053 Days 6-30: 9,762 Days 31-94: 7,264	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
8	Drilling operations - OP-1 (SKE-2A) well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	8,715	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
9	Drilling operations - OP-1 (SKE-1x) well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	8,715	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
10	Drilling operations - OP-3 well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	8,715	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
11	Drilling operations - OP-4 well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	8,715	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
12	Drilling operations - OP-5 well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	8,715	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
13	Drilling operations - OP-7 well blowout whilst drilling	Blowout causing an uncontrolled release of crude over 95 days	crude	8,715	819,175	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
14	Drilling operations – SNK-D well blowout whilst drilling	Blowout causing an uncontrolled release of gas condensate over 95 days	gas condensate	5,104	484,865	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
15	Drilling operations – SK-2AST well blowout whilst drilling	Blowout causing an uncontrolled release of gas condensate over 95 days	gas condensate	5,104	484,865	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
16	Drilling operations – SKE-C well blowout whilst drilling	Blowout causing an uncontrolled release of gas condensate over 95 days	gas condensate	5,104	484,865	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
17	Drilling operations – SKE-D well blowout whilst drilling	Blowout causing an uncontrolled release of gas condensate over 95 days	gas condensate	5,104	484,865	m^3	Possibility of fire and explosion. Sea surface and water column. High potential for oiling along shoreline.	B	5	High	Develop and maintain a regular training schedule. Develop and maintain a regular emergency drill schedule. Make sure that the equipment is in place and in perfect state of maintenance.	B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
18	Drilling operations	production test release oil to atmosphere (liquid carry over from flare KO drum to flare)	crude	n/a		m^3										
19	Drilling operations - loss of containment	metering skid equipment failure	crude	n/a		m^3										
20	Hawser line failure	overstretching or unintended overstretching of the quick release	crude	n/a		m^3										
21	Drilling operations	Towline failure or breakage		n/a		m^3										
OCTP Block, Production phase 18 subsea wells (8 oil, 4 gas condensate, 3WI, 3GI), FPSO, subsea network with flexible flowlines and risers																
22	FPSO oil storage operations	catastrophic failure due to collision or grounding, leading to rupture of cargo tanks	processed crude	n/a	7,000.0	tons	Sea surface and water column. Potential for oiling along shoreline.	B	3	Medium		B	3	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
23	FPSO oil storage operations	Stored crude oil pumped to the shuttle tanker via an offloading hose	processed crude	n/a		m^3										

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
24	FPSO storage operations	catastrophic failure due to collision or grounding, leading to rupture of cargo tanks	hydraulic oil	n/a		m^3										
25	FPSO storage operations	catastrophic failure due to collision or grounding, leading to rupture of cargo tanks	lube oil	n/a		m^3										
26	FPSO storage operations	catastrophic failure due to collision or grounding, leading to rupture of cargo tanks	diesel	n/a		m^3										
27	FPSO production operations	production operations leading to minor oil spills	crude	n/a		m^3										
28	OP-CAMP, SKE-2A, OP-2 Production Loop	2 x risers and 4 x flowlines 6 inch (3,610m is worst case length) - Human error, corrosion, failure of flowline, loss of containment - worst case scenario	crude	n/a	345	m^3	Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
29	OP-3, OP-4 Production Loop	2 x risers and 2 x flowlines 6 inch (3,500m is worst case length) - Human error, corrosion, failure of flowline, loss of containment - worst case scenario	crude	n/a	345	m^3	Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
30	OP-5, OP-7, SKE-1x Production Loop	2 x risers and 2 x flowlines 6 inch (3,790m is worst case length) - Human error, corrosion, failure of flowline, loss of containment - worst case scenario	crude	n/a	345	m^3	Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
31	SK-D, SKE-D Production Loop	2 x risers and 2 x flowlines 6 inch (3,790m is worst case length) - Human error, corrosion, failure of flowline, loss of containment - worst case scenario	gas condensate	n/a	37.7	m^3	Sea surface and water column. Potential for oiling along shoreline.	B	3	Medium		B	3	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
32	SK-2AST, SKE-C Production Loop	2 x risers and 2 x flowlines 6 inch (3,790m is worst case length) - Human error, corrosion, failure of flowline, loss of containment - worst case scenario	gas condensate	n/a	37.7	m^3	Sea surface and water column. Potential for oiling along shoreline.	B	3	Medium		B	3	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
33	Shuttle tankers moored to FPSO	Collision during operations resulting in rupture and loss of containment from a tank	processed crude	n/a		m^3										
34	Shuttle tankers transferring stored crude from FPSO via offloading hose	Minor flexible hose leak during loading operations.	processed crude	n/a		m^3										
35	Tanker and loading operations	Catastrophic, full bore failure of flexible hose during maximum load rate conditions.	processed crude	n/a		m^3										
36	Production Operations	Condensates produced non associated gas project	gas condensate	n/a		m^3										
37	FPSO fuel tank rupture	catastrophic failure due to collision, leading to rupture of fuel tanks	Diesel	n/a	7,000	tons	Diesel spill likely to naturally dissipate, but due to large volume likely to spread over a large area.	B	4	Medium		B	4	Medium	Monitor and evaluate Offshore containment and recovery	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
38	Platform Supply Vessel	Loss of entire inventory due to collision or grounding	Diesel or HFO	n/a	1,000	m^3	Diesel spill likely to naturally dissipate, but due to large volume likely to spread over a large area.	B	2	Low		B	2	Low	Monitor and evaluate Offshore containment and recovery	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources
39	Production Operations	Malfunction of produced water clean up facilities allowing high crude concentration in effluent.	processed crude	n/a		m^3										

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
40	Production Operations	Isolatable loss of containment from topsides equipment (e.g. Production Separator).	processed crude	n/a		m^3										
41	Production Operations	Non- isolatable loss of containment from FPSO	processed crude	n/a		m^3										
42	Production Test	Uncontrolled release to the environment	crude	n/a		m^3										
43	Production operations - OP-Camp 1 well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
44	Production operations - OP-Camp 2 well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
45	Production operations - OP-1 (SKE-2A) well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
46	Production operations - OP-1 (SKE-1x) well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
47	Production operations - OP-3 well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
48	Production operations - OP-4 well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
49	Production operations - OP-5 well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
50	Production operations - OP-7 well	Loss of well control and uncontrolled release to the environment	crude	121	3,641	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
51	Production operations – SK-D well	Loss of well control and uncontrolled release to the environment	gas condensate	216	6,482	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
52	Production operations – SK-2AST well	Loss of well control and uncontrolled release to the environment	gas condensate	216	6,482	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
53	Production operations – SKE-C well	Loss of well control and uncontrolled release to the environment	gas condensate	216	6,482	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
54	Production operations – SKE-D well	Loss of well control and uncontrolled release to the environment	gas condensate	216	6,482	m^3	Possibility of fire and explosion. Sea surface and water column. Potential for oiling along shoreline.	B	4	Medium		B	4	Medium	Monitor and evaluate Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources Tier 3: OSRL Tier 3 resources
GENERIC OFFSHORE OPERATIONS																

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
55	Development / Production Operations	Minor operational or maintenance spills at sea (Lubricate Oil, Base Oil, Hydraulic Oil)	Utility Oils	n/a	<1	m^3	Spill unlikely to have a significant impact due to size, and it would be easily mitigated. Release may not reach with the marine environment if contained on deck	C	1	Low		C	1	Low	Monitor and evaluate	Tier 1: Spill kits
56	Development / Production Operations	Minor diesel spills during fuel transfer operations	Diesel	n/a	<1	m^3	Likely to naturally dissipate quickly	C	1	Low		C	1	Low	Monitor and evaluate	Tier 1: Spill kits
57	Development / Production Operations	Major spills during fuel transfer operations – Full flow release of diesel due to rupture of transfer hose	Diesel	n/a	<50	m^3	Diesel spill likely to naturally dissipate, but due to large volume likely to spread over a large area. Exact volume depends on shut down time	B	2	Low		B	2	Low	Monitor and evaluate Assisted natural dispersion	Tier 1: Spill kits
58	Development / Production Operations	Towing Supply Vessel incident resulting in total loss of fuel oil	Diesel	n/a	1191	m^3	Diesel spill likely to naturally dissipate quickly, but due to large volume likely to spread over a large area. Exact volume depends on vessel	B	3	Medium		B	3	Medium	Monitor and evaluate Assisted natural dispersion Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources
59	PSV	Collision/grounding/structural failure, resulting in loss of fuel	Diesel	n/a	1000	m^3	Diesel spill likely to naturally dissipate. Due to large volume likely to spread over a large area. Exact volume depends on type of vessel	B	3	Medium		B	3	Medium	Monitor and evaluate Assisted natural dispersion Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources
60	Aircraft/Vessel transfer	Crew transfer vessel/aircraft incident resulting in loss of fuel oil	Diesel, Jet A-1	n/a	10	m^3	Diesel/Jet A-1 spill likely to naturally dissipate quickly	B	2	Low		B	2	Low	Monitor and evaluate Assisted natural dispersion	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources
NEARSHORE OPERATIONS																
61	PSV - crew transfer vessel	Minor fuel spill	Diesel	n/a	<1	m^3	Likely to naturally dissipate quickly	C	1	Low		C	1	Low	Monitor and evaluate Assisted natural dispersion	Tier 1: Spill kits

#	Source	Event	Oil Type	Well Flowrate (m^3/day)	Spill Volume (Total)	unit	Impact	Likelihood	Consequence	Risk	Mitigation	Likelihood	Consequence	Risk	Response Actions	Tiered Resources
62	PSV - crew transfer vessel incident	Collision/grounding/structural failure, resulting in loss of fuel	Diesel	n/a	10-1,191	m^3	Diesel spill likely to naturally dissipate. Due to large volume likely to spread over a large area. Exact volume depends on type of vessel	B	3	Medium		B	3	Medium	Monitor and evaluate Assisted natural dispersion Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources
63	PSV - crew transfer vessel incident	Collision/grounding/structural failure, resulting in loss of utility oils	Lubricant / Base / Hydraulic Oils	n/a	<1000	m^3	Spill likely to have a significant impact due to size, and it would be easily mitigated. Exact volume depends on type of vessel	B	3	Medium		B	3	Medium	Monitor and evaluate Assisted natural dispersion Dispersant application if conditions allow Offshore containment and recovery Shoreline protection and clean-up	Tier 1: Response vessel with dispersant application system Tier 2: Additional resources

8.4.1 Risk Assessment Matrix

The matrix used for the qualitative assessment is based on the concept of applying experience of events in the oil and gas industry and the statistical incidents rates of the operations (the oil spill scenarios are defined in Table 22):

- The vertical axis represents increasing consequences (severity levels 1 to 5) in terms of harm to people, effect on the environment, damage to assets and impact on reputation (PEAR categories);
- The horizontal axis represents increasing likelihood (levels 0 to E) of the consequence under consideration;
- Boxes in the matrix represent levels of risk, increasing from top left to bottom right corners of the matrix;
- The matrix is divided into green, yellow and red areas to illustrate the increasing level of risk.

Table 23 shows the risk assessment matrix neglecting the effects of the mitigation actions planned.

Table 23 Risk Assessment Matrix - Before mitigation actions.

Severity	Consequence	Probability					
		0	A	B	C	D	E
1	Slight Effect				4, 55, 56, 61		
2	Minor Effect			2, 3, 38, 57, 60			
3	Local Effect			1, 22, 31, 32, 58, 59, 62, 63			
4	Major Effect			28 ÷ 30, 37, 43 ÷ 54			
5	Extensive Effect			6 ÷ 17			

Key Colour

Low Risk Medium Risk High Risk

The risk assessment matrix shows that relatively small spills are the most likely to occur whereas larger spills become increasingly unlikely to occur and major spill events, such as vessel collisions and blowouts would only be expected less often. Statistically the most likely spills are small operational type spillages, for example those occurring during routine maintenance operations, re-fuelling and transfer hose during oil unloading operations.

Table 24 shows the revised risk assessment matrix, considering the risk reduction due to the effects of the mitigation actions planned.

Table 24 Risk Assessment Matrix - After mitigation actions.

Severity	Consequence	Probability					
		0	A	B	C	D	E
1	Slight Effect			3	4, 55, 56, 61		
2	Minor Effect			2, 3, 38, 57, 60			
3	Local Effect			1, 22, 31, 32, 58, 59, 62, 63			
4	Major Effect			6 ÷ 17, 28 ÷ 30, 37, 43 ÷ 54			
5	Extensive Effect						

Key Colour

Low Risk

Medium Risk

High Risk

8.5 Oil Spill Modelling

Oil spill modelling has been conducted to predict where impact may occur for certain scenarios identified in the risk assessment. It is used to predict and assess where an oil spill may impact for defined time periods and is useful to help plan response strategies and response actions. Oil spill modelling is a decision support tool and not a decision-making tool and should be backed-up with aerial surveillance during a response.

8.5.1 Oil Spill Modelling Scenarios

Oil spill modelling was done at Eni using SINTEF's Oil Spill Contingency And Response (OSCAR) software. Oil spill computer modelling predicts the fate and effect of oil in the environment. In this risk assessment two types of modelling using the OSCAR model have been utilised.

Deterministic modelling is used to predict the route of a hydrocarbon slick over time, and to estimate the oil weathering profile, under specific meteorological conditions. It investigates potential beaching under a constant (worst case) wind speed and direction.

Stochastic modelling is used to estimate the likelihood of particular trajectories occurring, based on historical wind speed and direction data. This is then calculated to provide a probability range of oiling representative of the prevailing conditions.

Six reference scenarios have been identified (see the document: *"Ghana OTCP Block. Hazard Identification for Oil Spill Analysis"*), two for each of the three response Tiers. Such an approach covers a wide range of events, as a combination of different release points, spill duration, oil characteristics, and total volume spilt. Among each response Tier, the most probable (i.e. highest frequency) and the most severe (i.e. largest volume spilt) have been simulated as worst cases.

Two additional diesel spill scenarios have been simulated, covering diesel spills from impacts involving the FPSO or a supply vessel.

8.5.1.1 Tier 3 Scenarios

To represent possible Tier 3 oil spills, the following three scenarios have been simulated:

- **Most severe case**: blowout through the main bore and atmospheric discharge from the OP-Camp1 well. This is not only due to the total volume of oil that could be released (due to lack of backpressure of the water-column), but also from the point of view of the potential slick, since the oil does not disperse into the water, while rising from the seabed to the sea surface.
- **Most probable case**: blowout through the main bore and atmospheric release from the OP5-Cenom well. Again, the lack of water backpressure and dispersion into seawater maximize the volume spilt.
- **Diesel spill from FPSO**: diesel release from FPSO fuel tank due to collision with another vessel.

8.5.1.2 Tier 2 Scenarios

To represent possible Tier 2 oil spills, the following two scenarios have been simulated:

- **Most severe case**: topside (atmospheric release at FPSO) leak from an oil-producing riser through a 70 mm hole.
- **Most probable case**: release at seabed from an oil-producing flowline through a 22 mm hole.
- **Diesel spill from Supply vessel**: diesel release from a supply vessel fuel tank due to collision with another ship.

8.5.1.3 Tier 1 Scenarios

To represent possible Tier 1 oil spills, the following two scenarios have been simulated:

- **Most severe case**: leak from a condensate-producing riser in shallow water under the FPSO, resulting from complete breakage of the riser.
- **Most probable case**: release at seabed from a condensate-producing flowline through a 70 mm hole.

The exact characteristics of Campanian and Cenomanian crudes do not exist in the OSCAR modelling database, therefore a match has been made within OSCAR using intermediate values for the API and specific gravity. 'STÆR 2010, 5C' crude has an API of 31.7 and specific gravity of 0.867 has been subsequently used for modelling purposes. For the gas condensate releases the fluid 'TRYM KONDENSAT, 13C, 2011' (45.7 °API, SG: 0.798) has been used. Diesel spills have been simulated with the fluid 'MARINE DIESEL' (36.4 °API, SG:0.843)

Table 25 summarizes the modelling parameters OSCAR has been fed with. For the Tier 3 most severe case (atmospheric blowout from OP-Camp1 well) the modelling was performed taking into account well depletion and the flowrate has been therefore declining over time. Days 0-5 were modelled with a flowrate of 22,053 m^3/day, days 6-30 were modelled with a flowrate of 9,762 m^3/day and days 31-94 were modelled with a flowrate of 7,264 m^3/day.

OSCAR blowout scenarios have been simulated, both in the stochastic and in the deterministic approach, assuming a release duration of 95 days (the maximum period necessary to bring the well under control), and for a further 25 days after the source had stopped discharging in order to examine the full extent of the fate of the oil in the marine environment. For the same reason, the fate of leaks from risers and flowlines, having a duration of approximately 1-2 hours, have been modelled for 30 days.

Modelling has been carried out with the assumption that no intervention measures have been implemented on the spill after the release.

Table 25 OSCAR modelling parameters

Tier	Case	Release site	Phase	°API	Latitude (WGS84)	Longitude (WGS84)	Release Depth	Release duration	Simulation duration (days)	Volume spilt (m^3)
Tier 3	Most severe	OP-Camp1	Drilling	31.7	4°28’28.52’’ N	2°36’39.12’’ W	Sea level	95 d	120	819,175
	Most probable	OP5	Completion	31.7	4°28’25.33" N	2°30’19.64’’ W	Sea level	95 d	120	121,311
	Diesel spill	FPSO	Production	36.4	4°28’9.68’’ N	2°33’12.14’’ W	Sea level	2 h	45	8,304
Tier 2	Most severe	OP riser @ FPSO	Production	31.7	4°28’9.68’’ N	2°33’12.14’’ W	Sea level	2 h	30	329.9
	Most probable	OP flowline @ seabed	Production	31.7	4°28’9.68’’ N	2°31’2.34’’ W	Seabed	2 h	30	230.9
	Diesel spill	Supply vessel	Production	36.4	4°28’9.68’’ N	2°33’12.14’’ W	Sea level	2 h	45	1,000
Tier 1	Most severe	GP riser in shallow water	Production	45.7	4°28’9.68’’ N	2°33’12.14’’ W	100 m	1 h	30	37.7
	Most probable	GP flowline @ seabed	Production	45.7	4°28’42.27’’ N	2°33’44.57’’ W	Seabed	1 h	30	30.8

8.5.2 Stochastic Modelling Output

The results of the stochastic modelling are detailed in the following sections. For each Tier and for each scenario, the following statistical maps are given:

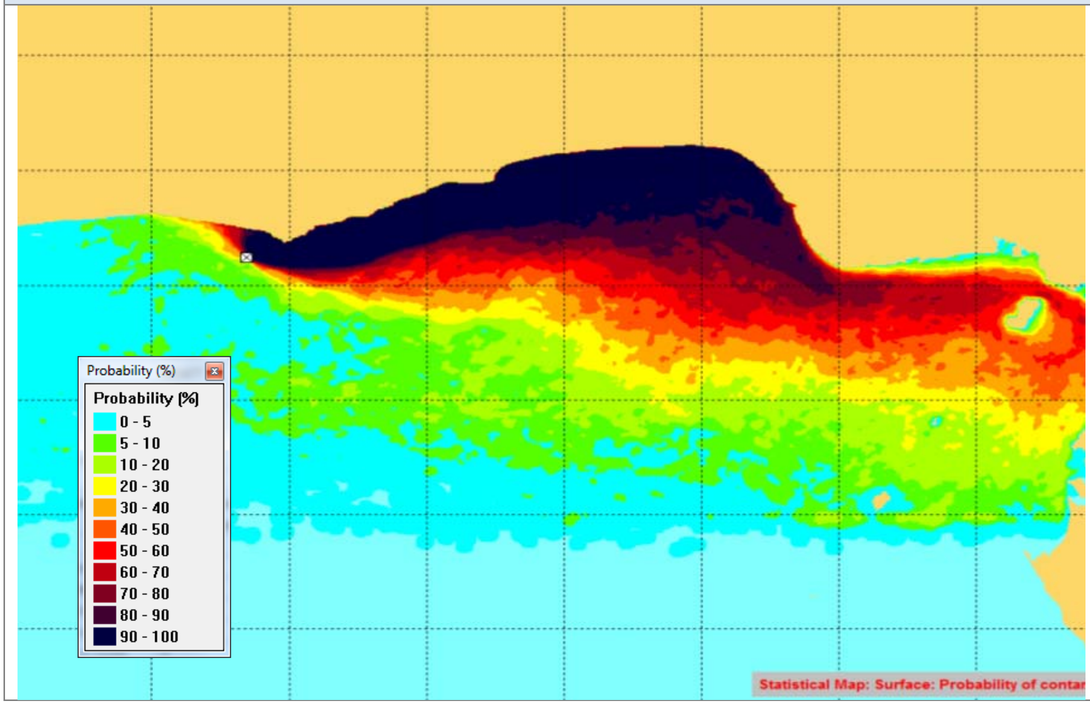
- Probability of contamination, offshore;
- Probability of contamination, ashore;

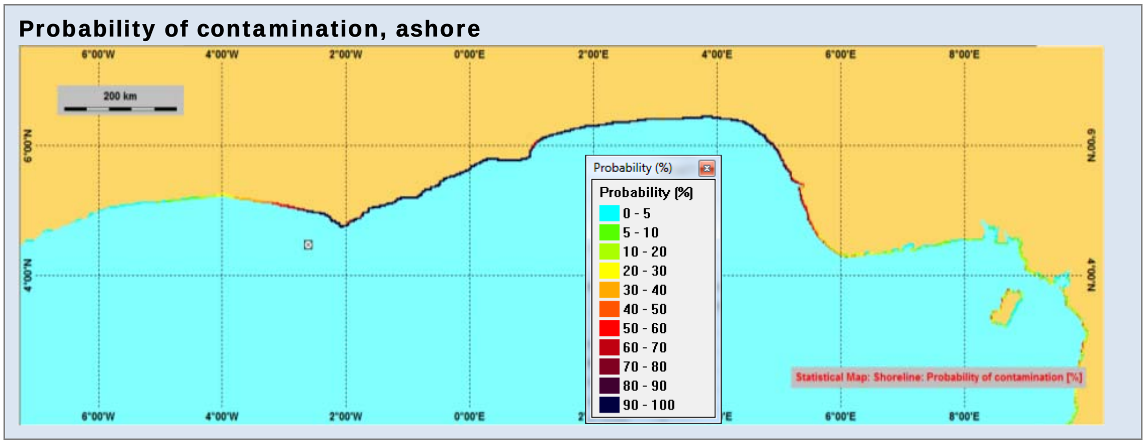
8.5.2.1 Tier 3 Scenarios

Most severe scenario: atmospheric blowout from OP-Camp1 well.

Table 26 shows the probability of contamination from oil on the sea surface and from oil stranded ashore. The probability of contamination is more than 90% from 3° W (West of Cape Three Points) to 5° E, then decreases. The maximum thickness of the emulsion of oil expected in this length of shore is approximately 10-11 cm. The same pattern in shown also by stranded oil.

Table 26 Stochastic simulation. Tier 3 – most severe scenario. Probability of contamination

Probability of contamination, offshore


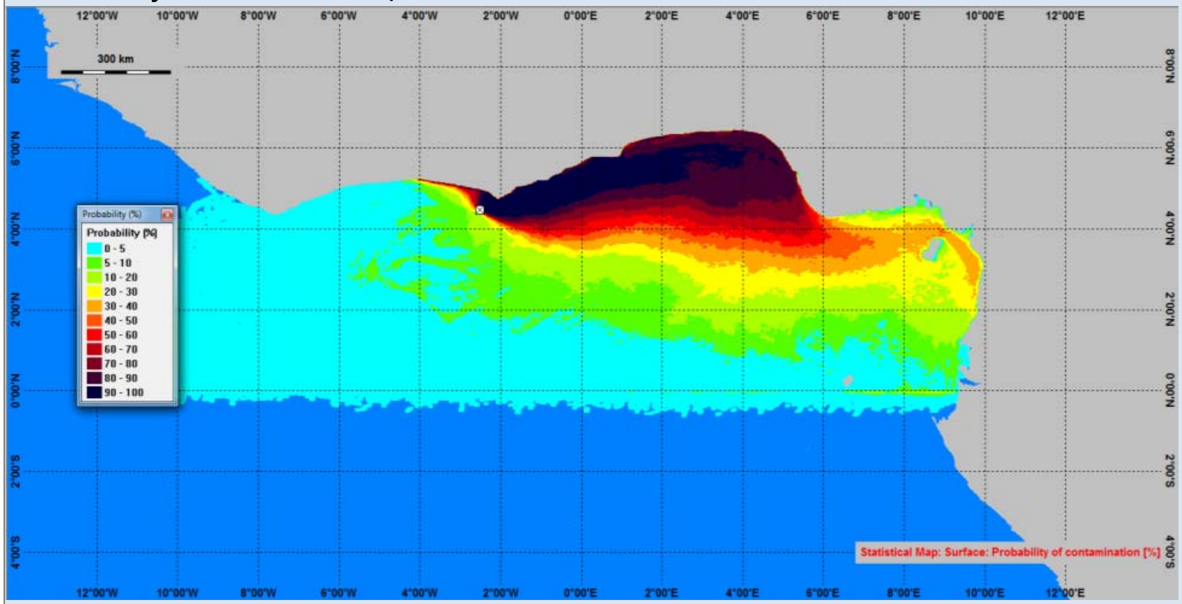


Most probable scenario: atmospheric blowout from OP5 well.

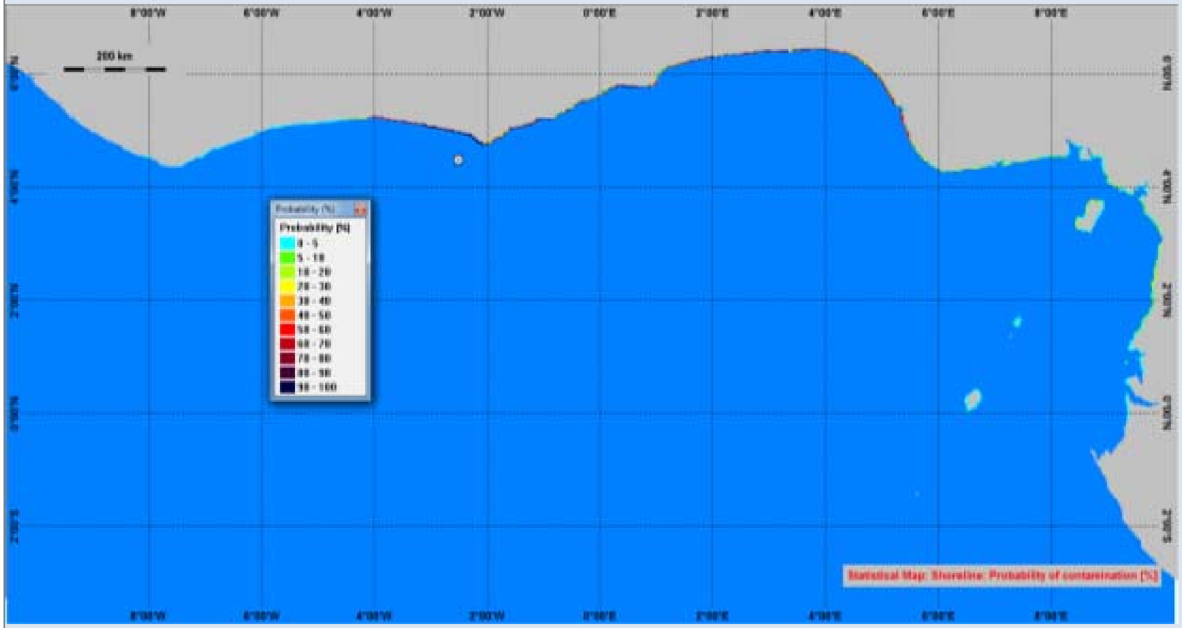
Table 27 shows the probability of contamination from oil on the sea surface and from oil stranded ashore. Released oil, driven by wind and marine currents, drifts mainly eastwards, giving an area in which the probability of contamination is over 90 % off the coasts of Ghana, Togo, Bénin and Nigeria.

Table 27 Stochastic simulation. Tier 3 – most probable scenario. Probability of contamination

Probability of contamination, offshore



Probability of contamination, ashore

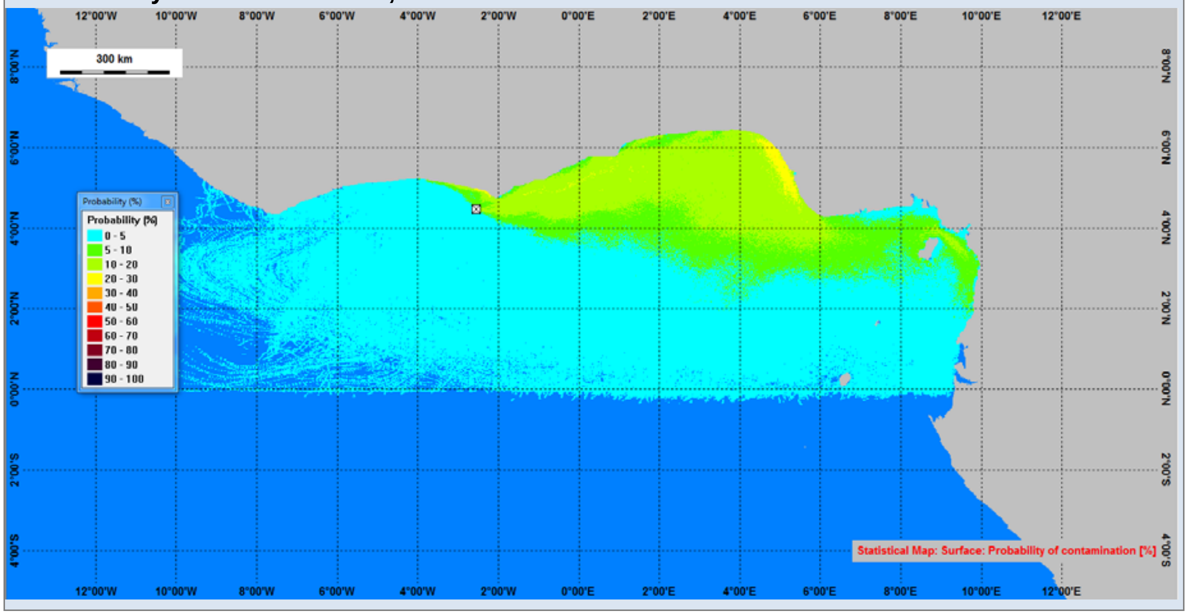


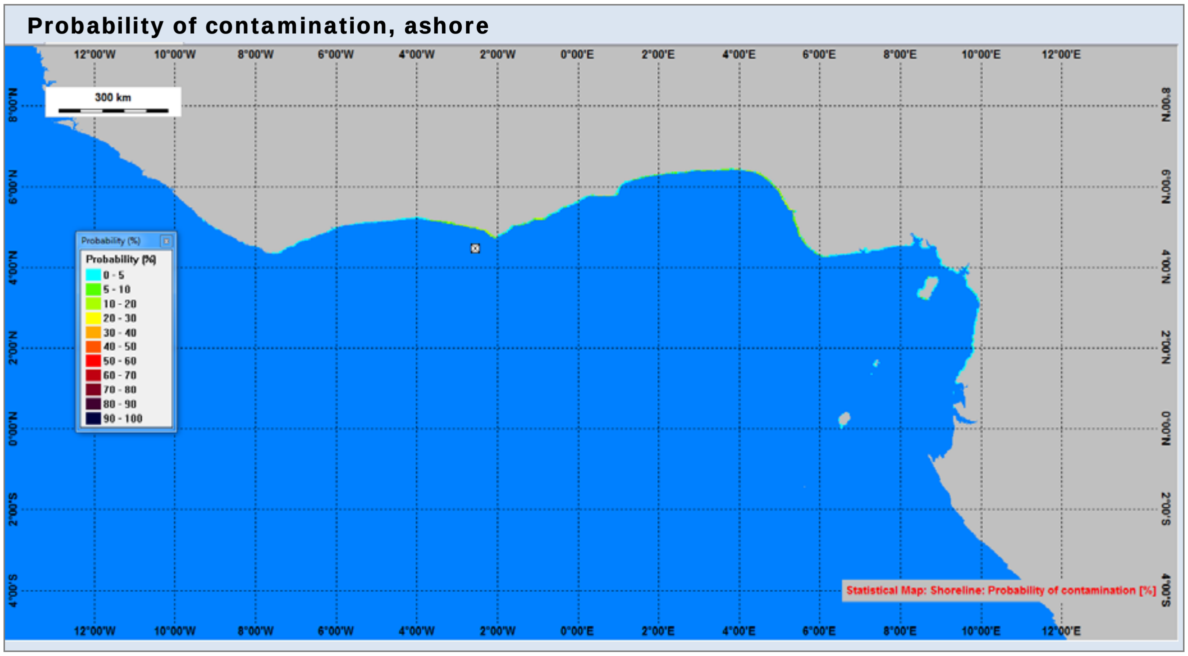
Diesel spill: diesel spill from FPSO following an impact.

Table 28 shows the probability of contamination from oil on the sea surface and from oil stranded ashore. Released oil, driven by wind and marine currents, drifts mainly eastwards, reaching a maximum probability of contamination of 30 %.

Table 28 Stochastic simulation. Tier 3 – diesel spill. Probability of contamination

Probability of contamination, offshore





Probability of contamination, ashore
300 km
Probability (%)
0 - 5
5 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
Statistical Map: Shoreline: Probability of contamination [%]
12°00'W
10°00'W
8°00'W
6°00'W
4°00'W
2°00'W
0°00'E
2°00'E
4°00'E
6°00'E
8°00'E
10°00'E
12°00'E
8°00'N
6°00'N
4°00'N
2°00'N
0°00'N
2°00'S
4°00'S

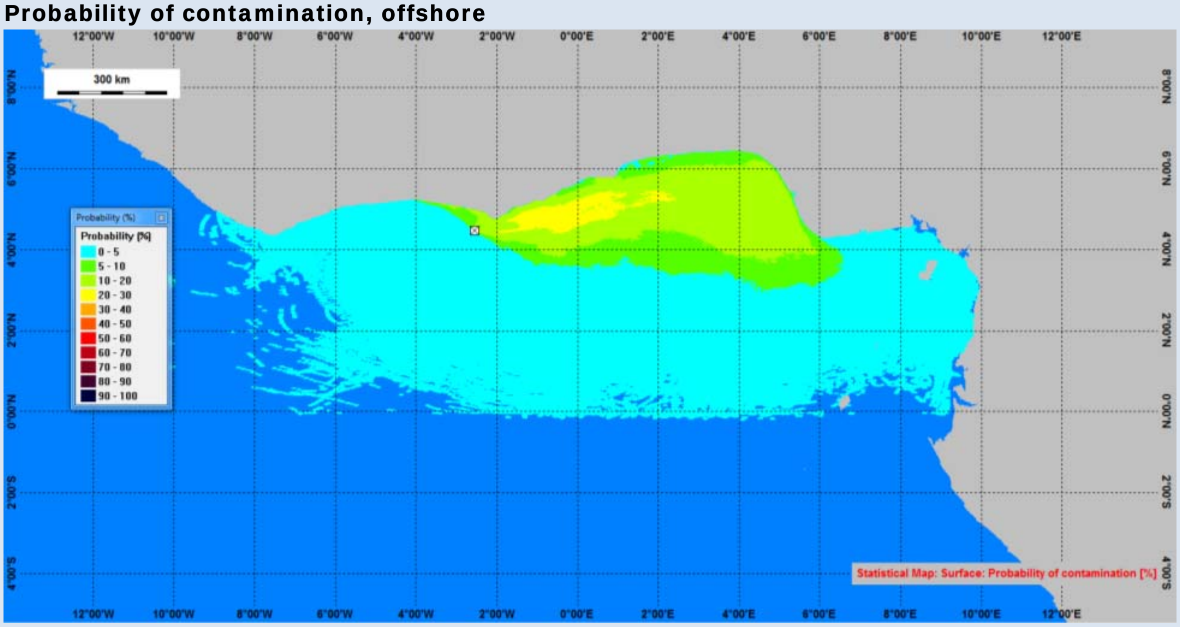
8.5.2.2 Tier 2 Scenarios

Most severe scenario: OP leak from riser at FPSO.

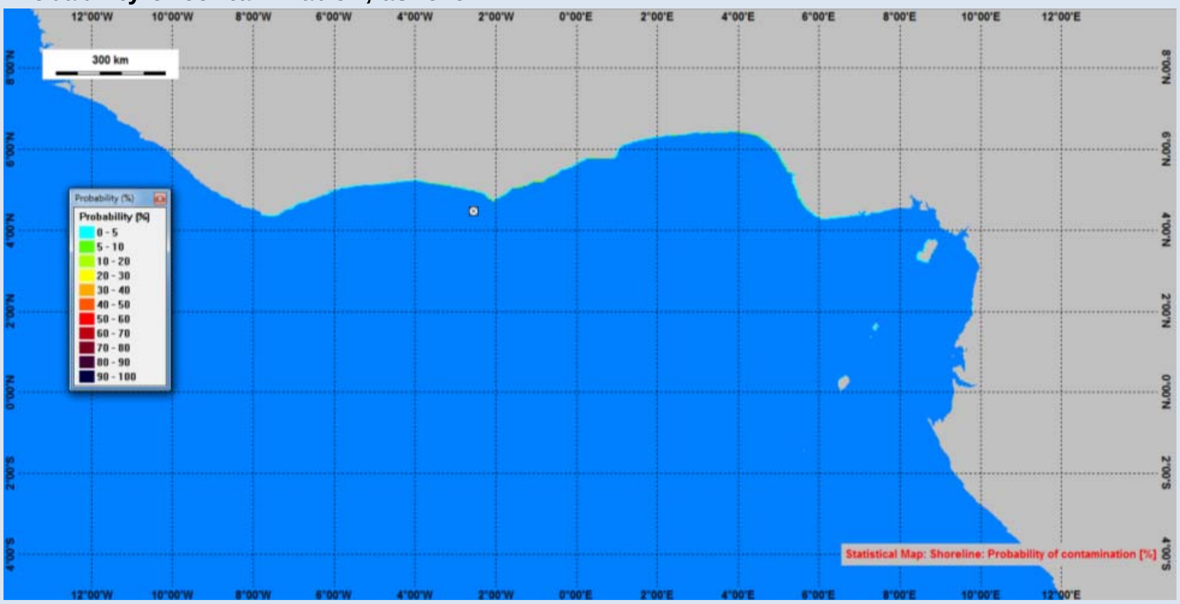
Table 29 shows the probability of contamination from oil on the sea surface and from oil stranded ashore. Released oil, driven by wind and marine currents, drifts mainly eastwards and, given the volume of oil released, the sea surface probability of contamination does not exceed 30 %. The probability of contamination ashore is expected to be lower than 20 %.

Table 29 Stochastic simulation. Tier 2 – most severe scenario. Probability of contamination

Probability of contamination, offshore



Probability of contamination, ashore

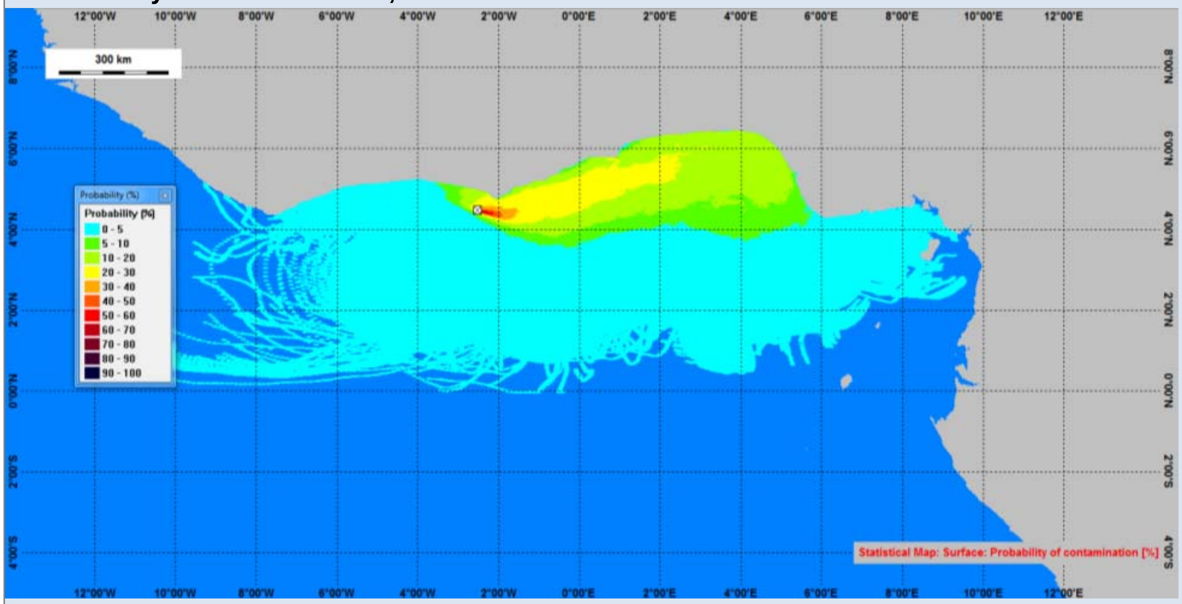


Most probable scenario: OP flowline leak at seabed.

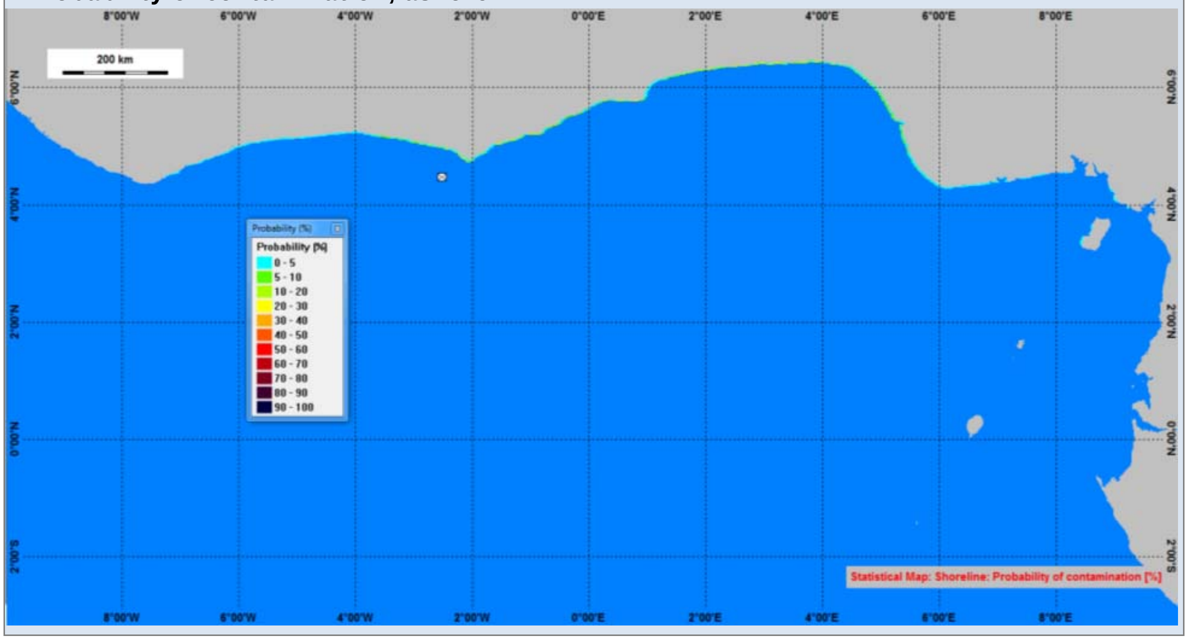
Table 30 shows the probability of contamination from oil on the sea surface and from oil stranded ashore. Released oil, driven by wind and marine currents, drifts mainly eastwards and, given the volume of oil released, the sea surface probability of contamination near the shore ranges between 0 and 30 %. The probability of contamination ashore is predicted to be lower than 20 %.

Table 30 Stochastic simulation. Tier 2 – most probable scenario. Probability of contamination

Probability of contamination, offshore



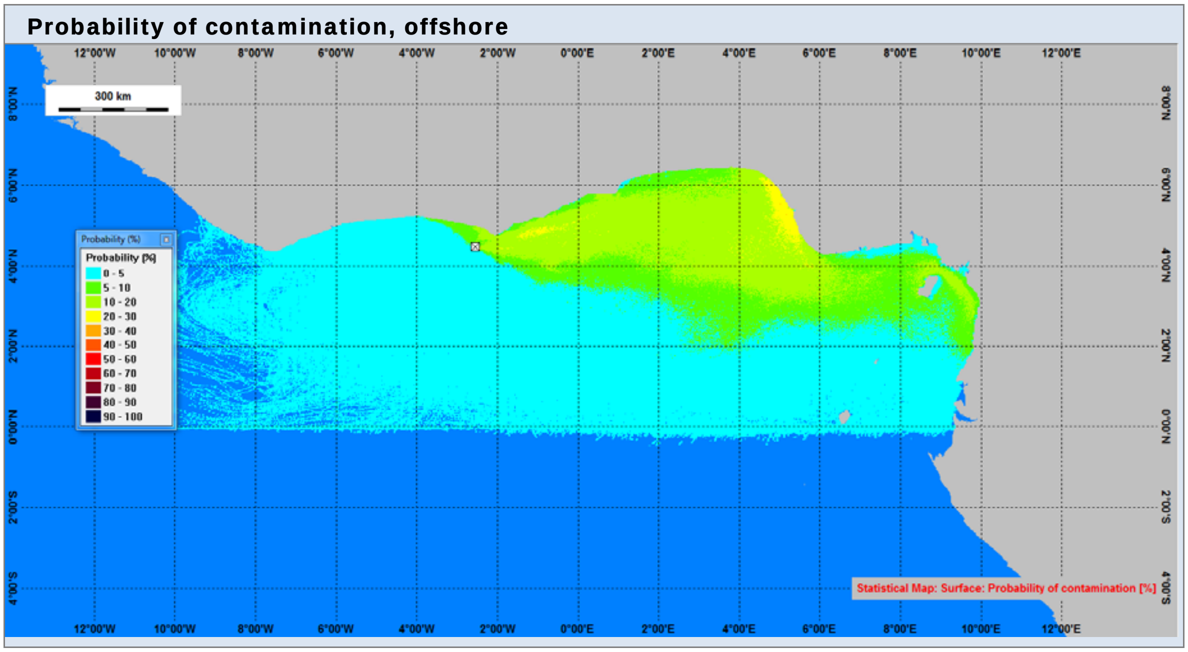
Probability of contamination, ashore



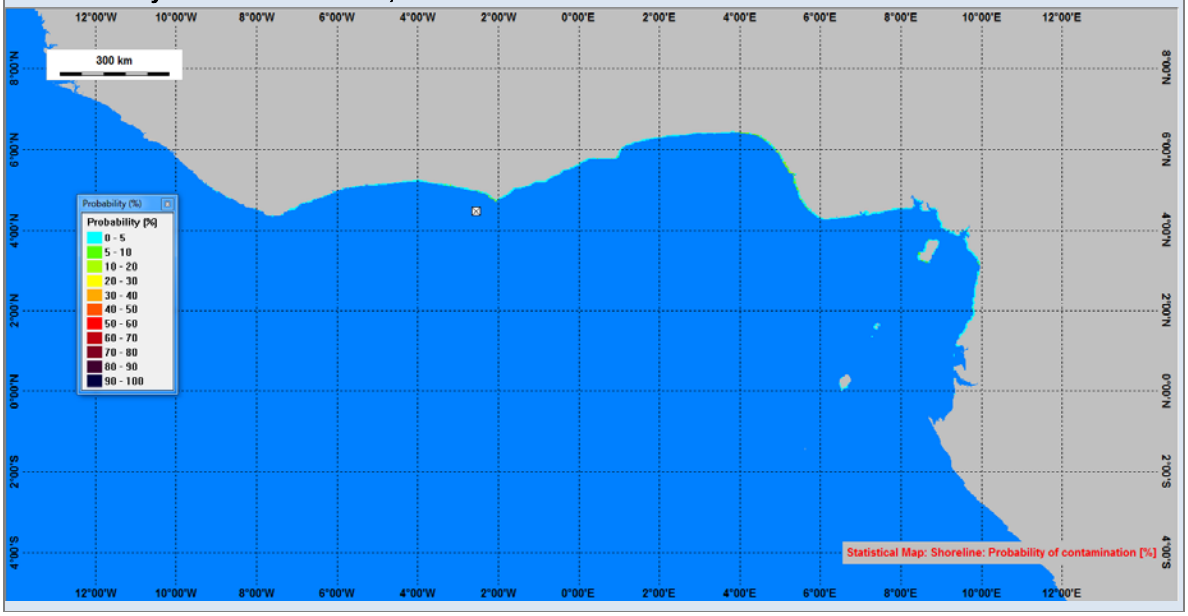
Diesel spill: diesel spill from a supply vessel following an impact.

Table 31 shows the probability of contamination from oil on the sea surface and from oil stranded ashore. Released oil, driven by wind and marine currents, drifts mainly eastwards, reaching a maximum probability of contamination of 30 %.

Table 31 Stochastic simulation. Tier 2 – diesel spill. Probability of contamination



Probability of contamination, ashore



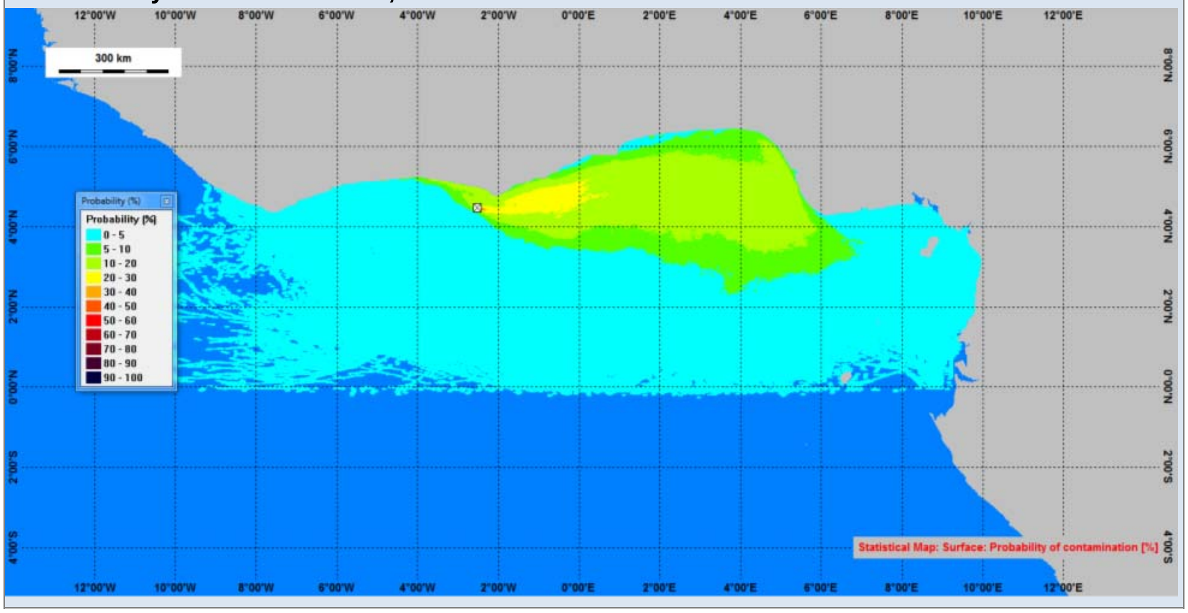
8.5.2.3 Tier 1 Scenarios

Most severe scenario: GP riser leak in shallow water.

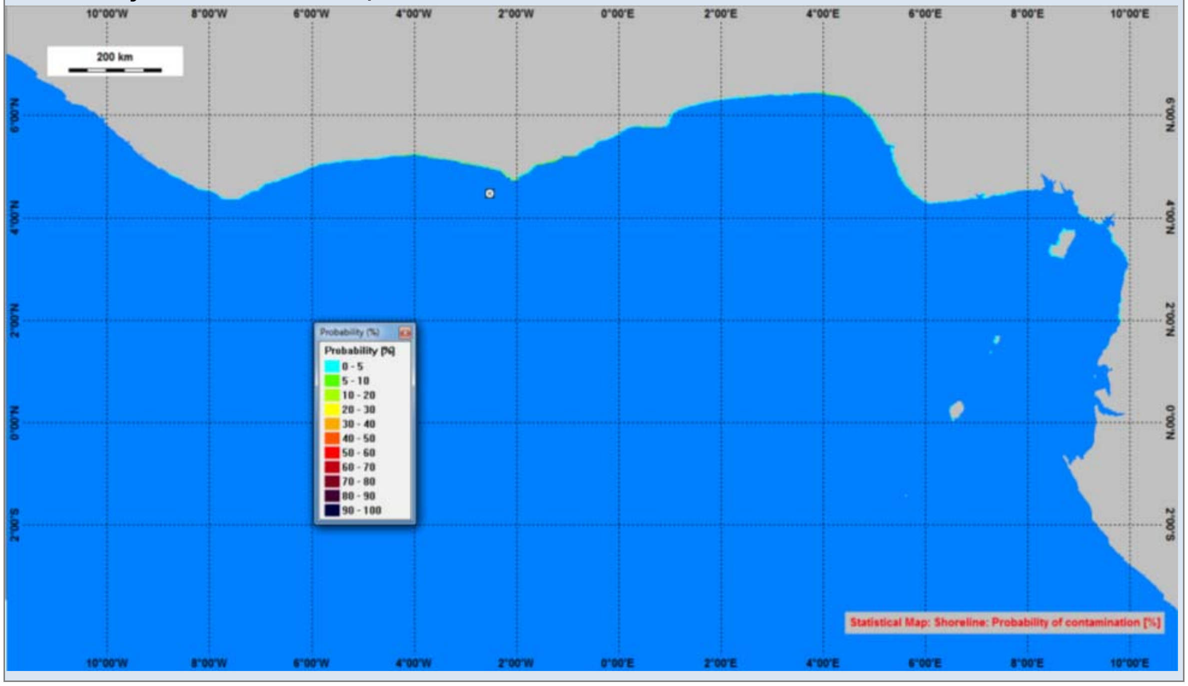
Table 32 shows the probability of contamination from oil on the sea surface and from condensate stranded ashore. The area of probability of sea surface contamination over 30 % is located approximately 50 km away from the coastline and the probability of condensate reaching close proximity to the coast is less than 20 %.

Table 32 Stochastic simulation. Tier 1 – most severe scenario. Probability of contamination

Probability of contamination, offshore



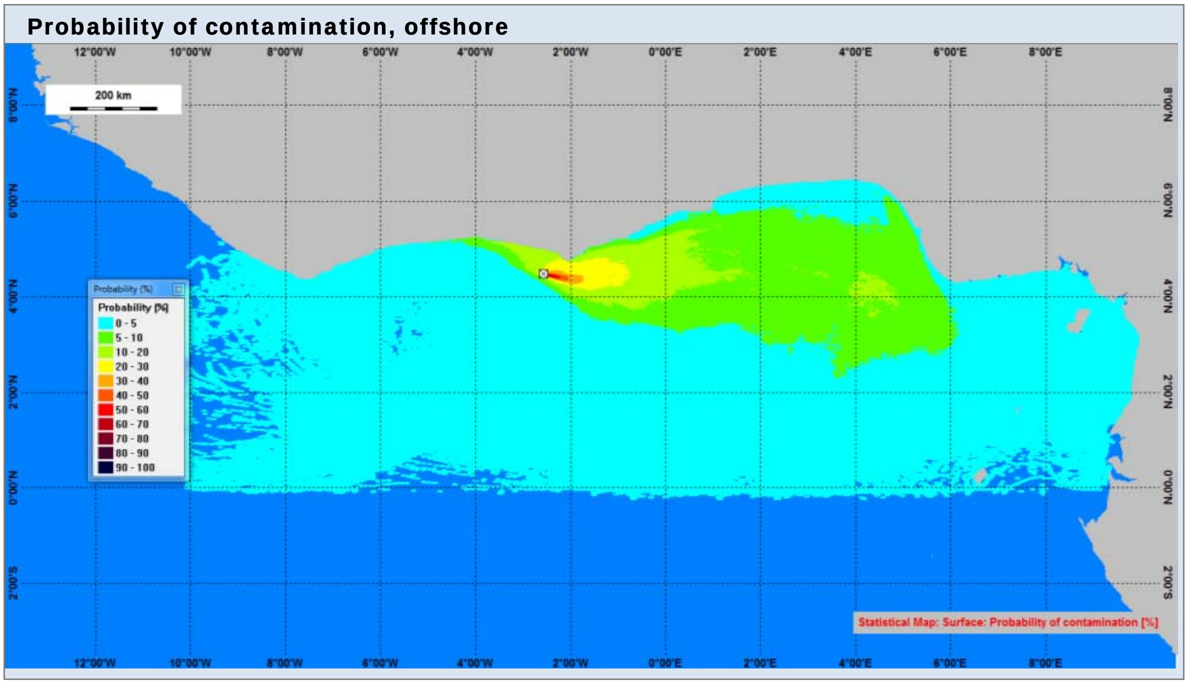
Probability of contamination, ashore



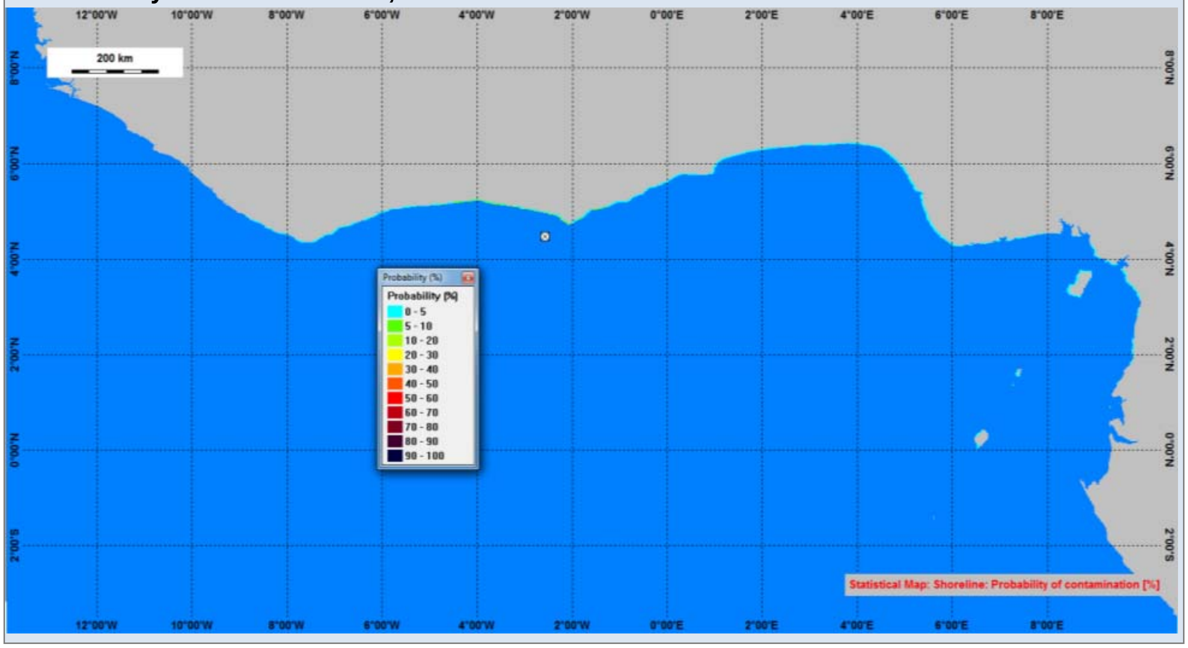
Most probable scenario: GP flowline leak at seabed.

Table 33 shows the probability of contamination from oil on the sea surface and from oil stranded ashore. Gas condensate, released at seabed, is primarily driven by marine currents, and drifts underwater eastwards, leading to a lower probability of sea surface contamination near the shore than in other scenarios. The probability of gas condensate reaching the shore is lower than 20 %.

Table 33 Stochastic simulation. Tier 1 – most probable scenario. Probability of contamination



Probability of contamination, ashore



8.5.3 Trajectory Modelling Output

The results of the trajectory (deterministic) modelling are detailed in the following sections. The modelling of a release scenario under specific metocean conditions defines an event. For each Tier and for each scenario, two events have been simulated:

- The event leading the maximum mass of oil ashore;
- The event having the minimum time for oil to get ashore;

For each of the two events, trajectory maps are presented, showing respectively the picture at the end of the simulation and at the time the first oil reaches the coastline. Furthermore, for the most severe scenario among each Tier, a chart of the fates of oil through time is shown.

The results of the Tier 3 most severe scenario (the overall most severe scenario) have been further detailed, giving a sort of time-lapse of the oil fate throughout the simulated period.

8.5.3.1 Tier 3 Scenarios

Most severe scenario: atmospheric blowout from OP-Camp1 well.

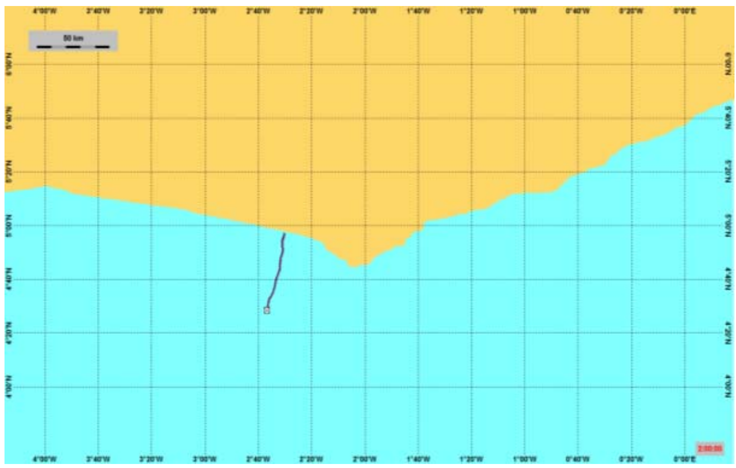
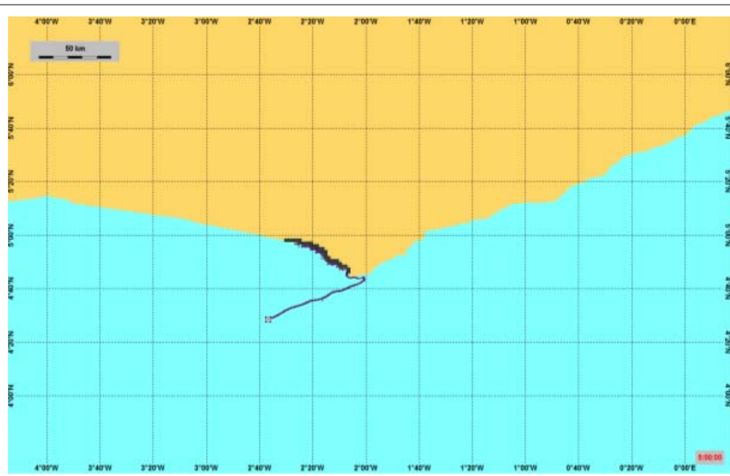
Table 34 and Table 35 show the fates of oil in the events simulated, respectively:

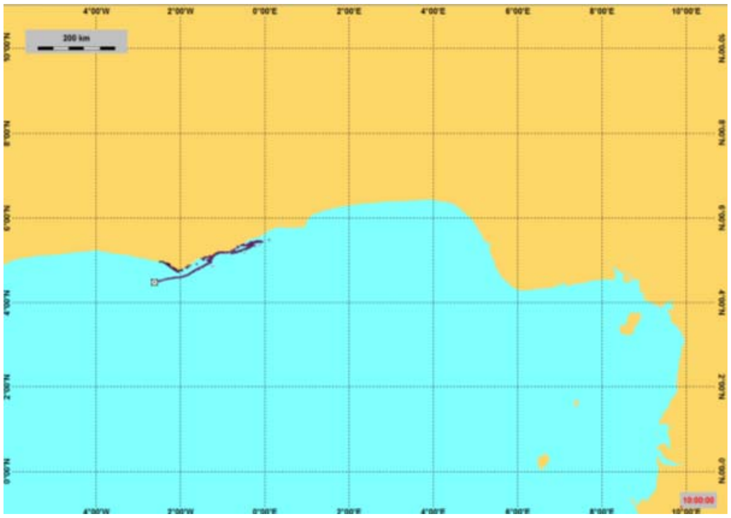
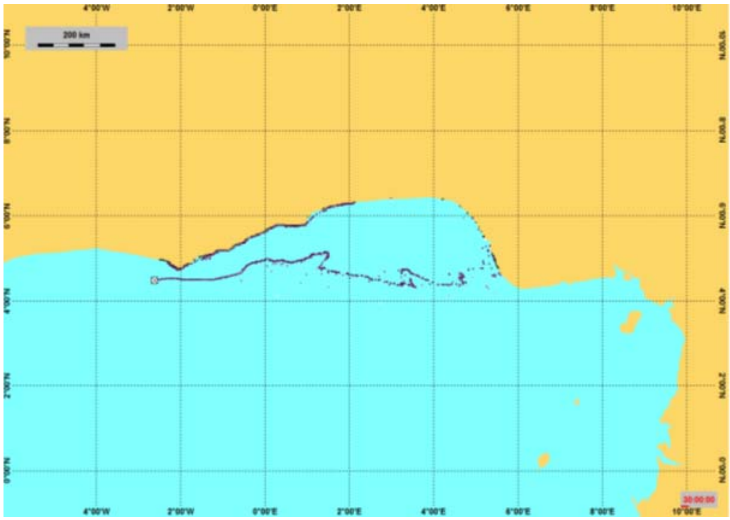
Maximum amount of oil ashore;

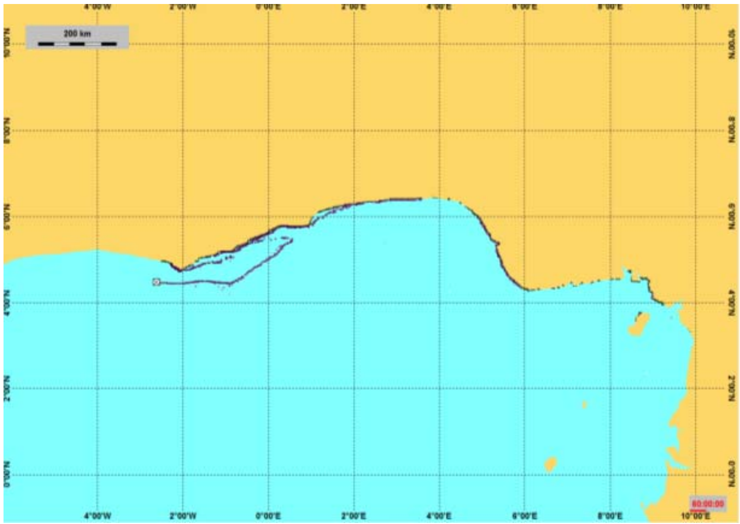
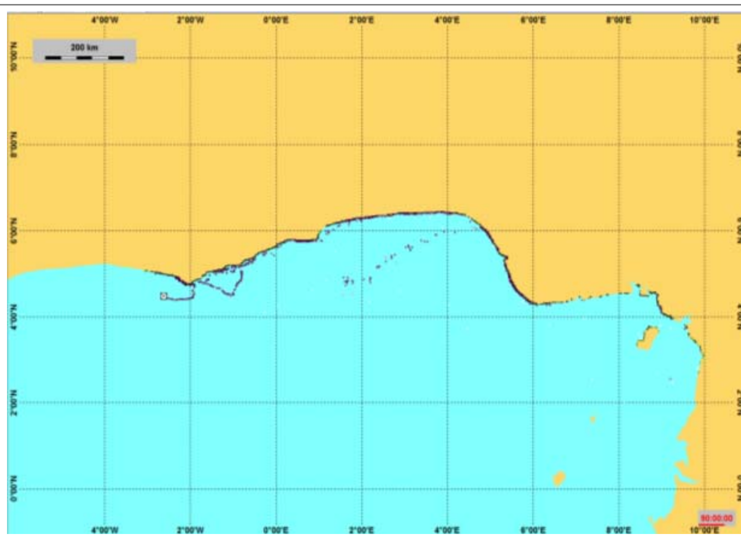
Minimum time for oil to get ashore.

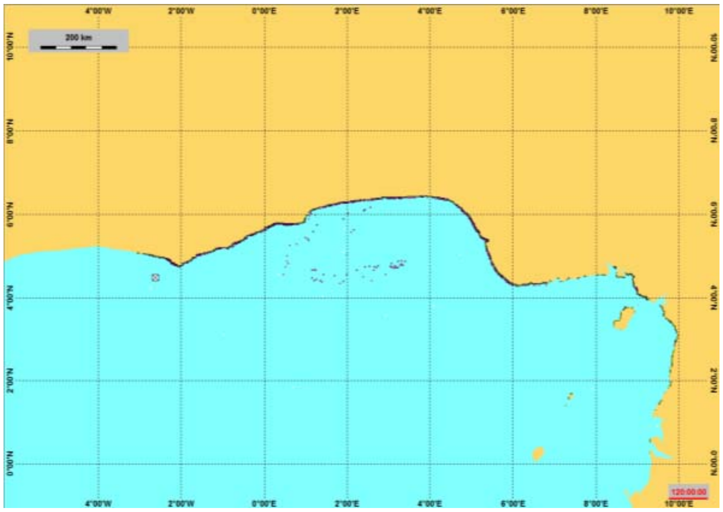
The maximum amount of oil ashore, after 120 days, is 63960 tons, while 35.2% evaporates, 33.2% remains on the surface of the ocean and the remaining oil is in the water column or biodegrades. Figure 8 shows the fate of the oil.

Table 34 Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)

Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)	
Situation	The evolution of the slick in the case of a maximum amount of oil ashore is shown in the following series of modeling results. The affected shore is from 3°W to the estuary of Gabon, if no response actions are undertaken.
48 hrs (first shoreline oiling)	
5 days (arrival of oil to the Keta Lagoon)	

<table>
<tr><th colspan="2">Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)</th></tr>
<tr><td>10 days (oil spreading towards Togo)</td><td>
</td></tr>
<tr><td>30 days</td><td>
</td></tr>
</table>

Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)	
60 days	
90 days (end of spill)	

Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)	
120 days	

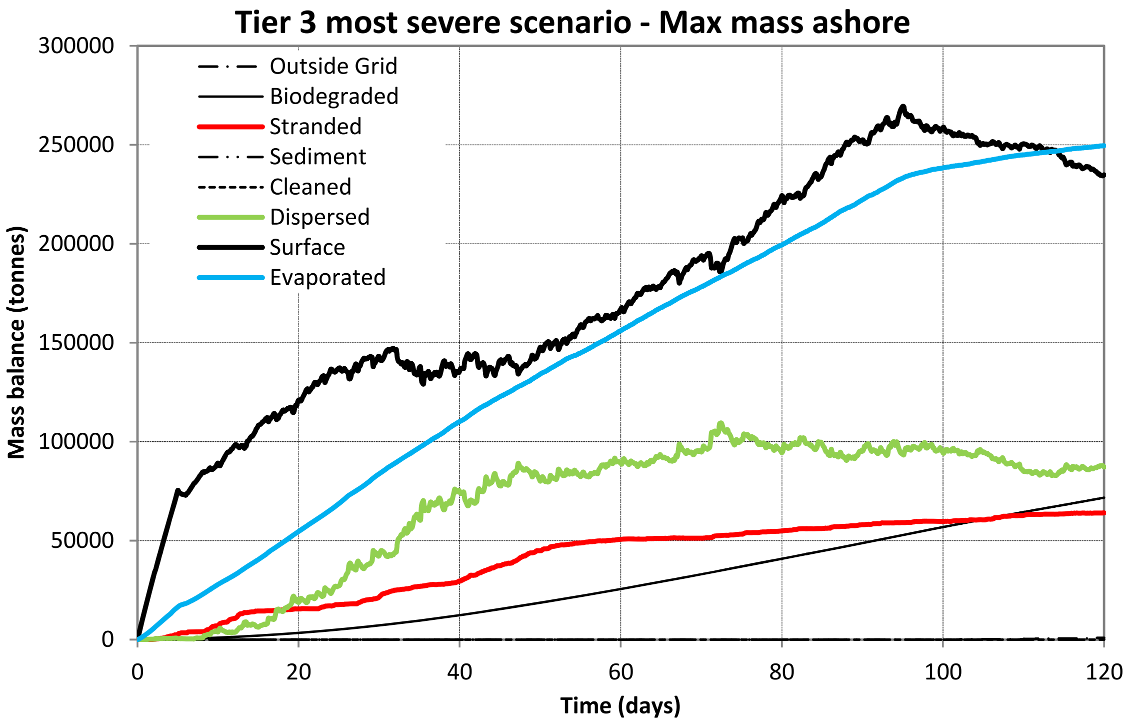
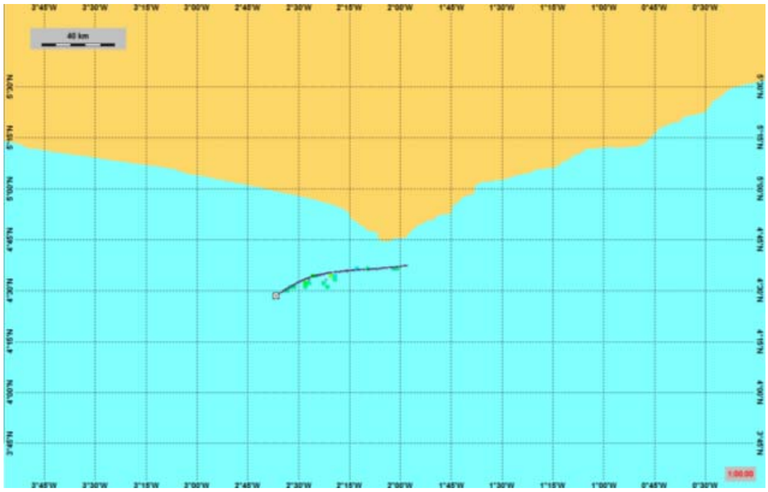
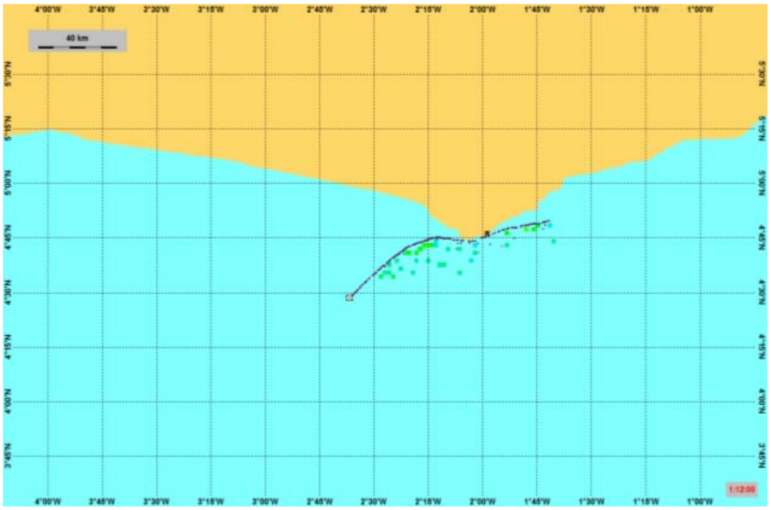


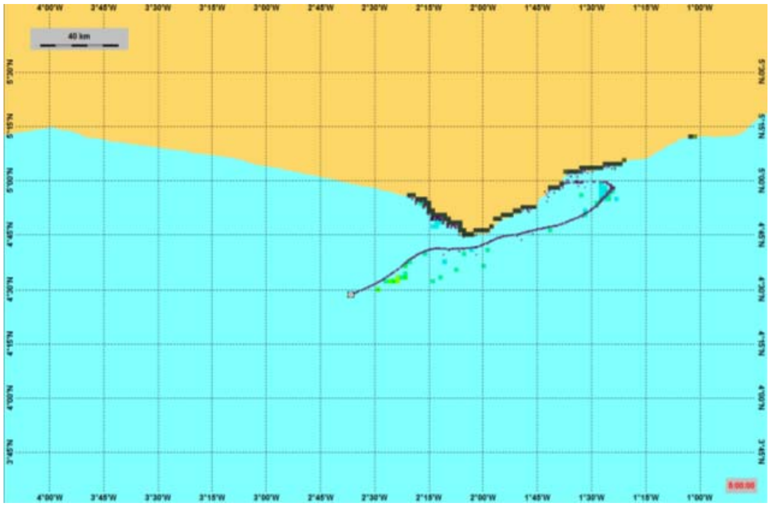
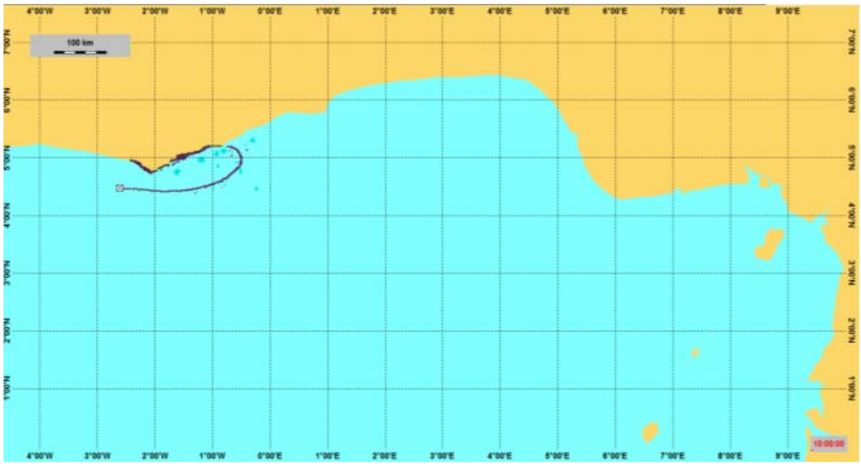
Figure 8 Tier 3 most severe scenario, max amount ashore. Mass balance plot.

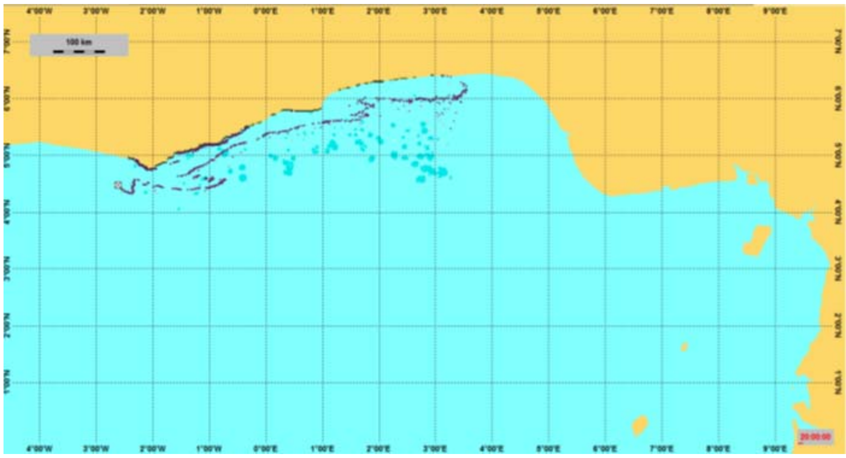
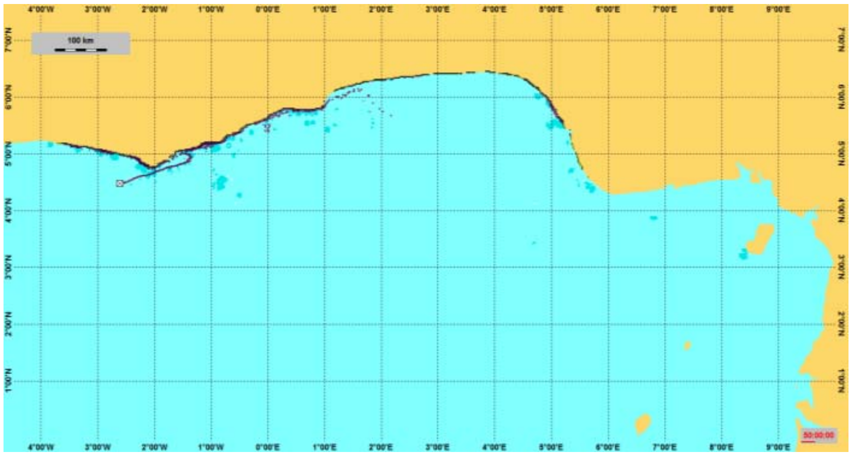
The minimum time of arrival ashore modeling details that first oil reaches the shoreline in 1 day and 12 hours.

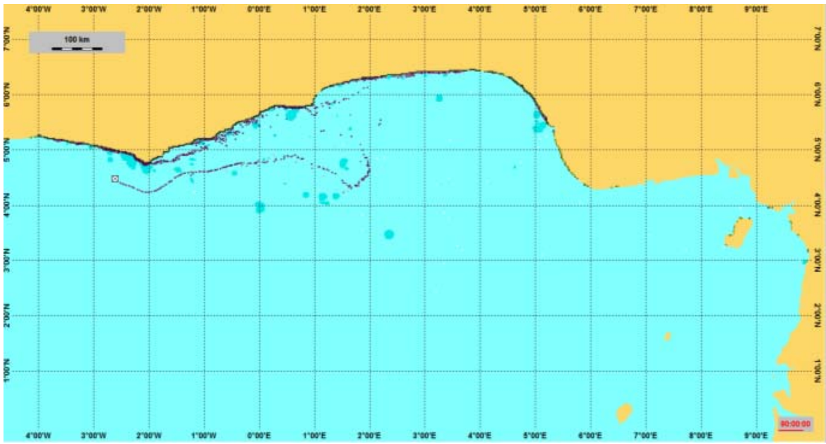
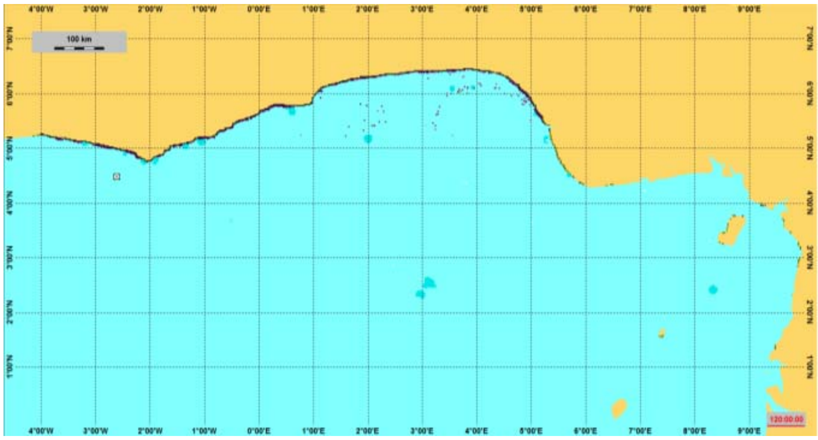
The mass of oil reaching the shore, after 120 days and in the worst case (minimum time to get ashore), is 48640 tons (6.9% of the total oil spilled), while 34.3% evaporates and 43.5% remains on the surface of the ocean. The remaining oil remains in the water column or biodegrades. The fate of the oil is shown in the Figure 9.

Table 35 Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)

Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)	
Situation	The first hours and the end of simulation is shown hereafter. The oil hits the shore firstly at Keta Lagoon after 2 days, then extending towards Maximum extension ashore is from 2°W to Port Harcourt.
1 day	
1 day and 12 hours	

Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)	
5 days	
10 days	

Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)	
20 days	
50 days	

Trajectory Results Scenario: OP – Camp1 well blowout (over 95 days)	
90 days (end of spill)	
120 days	

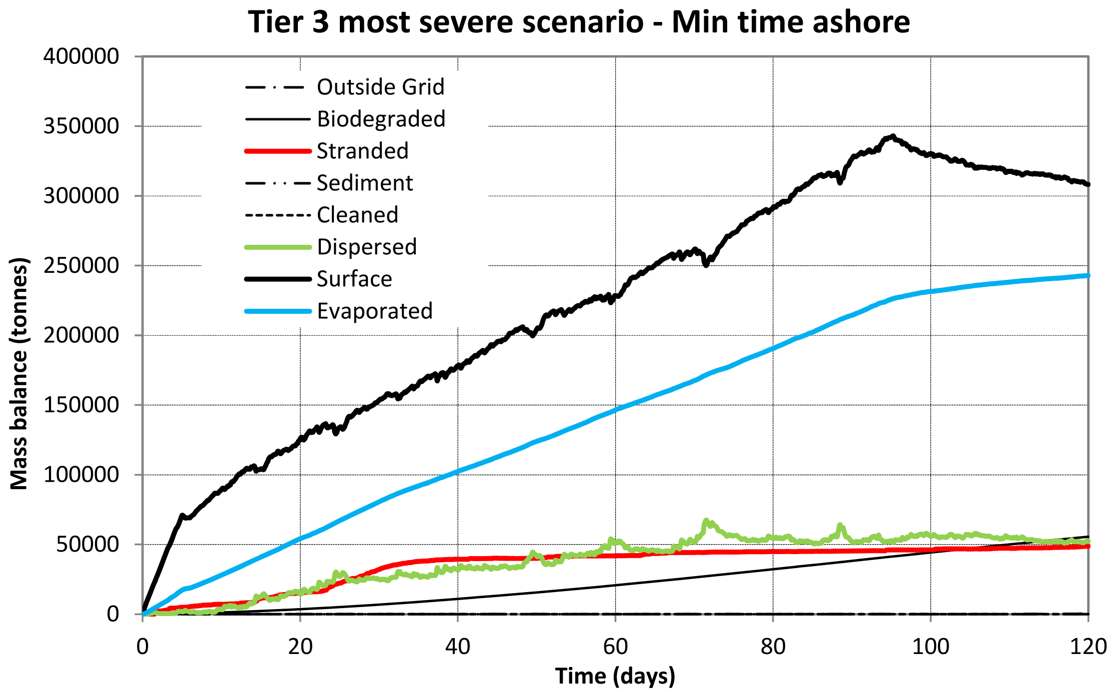


Figure 9 Tier 3 most severe scenario, min time ashore. Mass balance plot.

Most probable scenario: atmospheric blowout from OP5 well.

Table 36 shows the fates of oil in the events simulated, respectively:

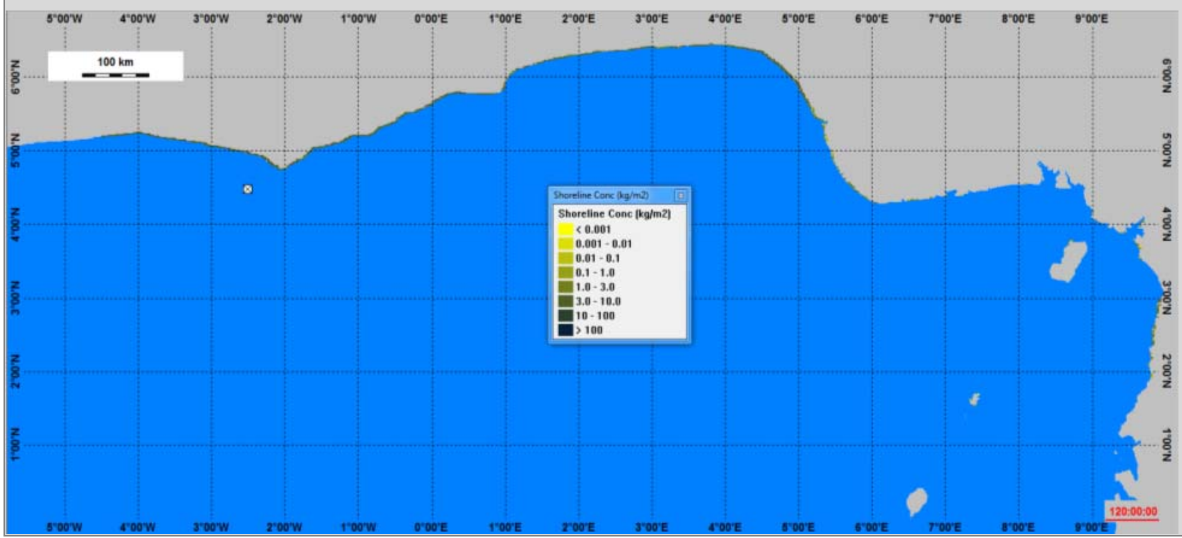
- Maximum amount of oil ashore;
- Minimum time for oil to get ashore.

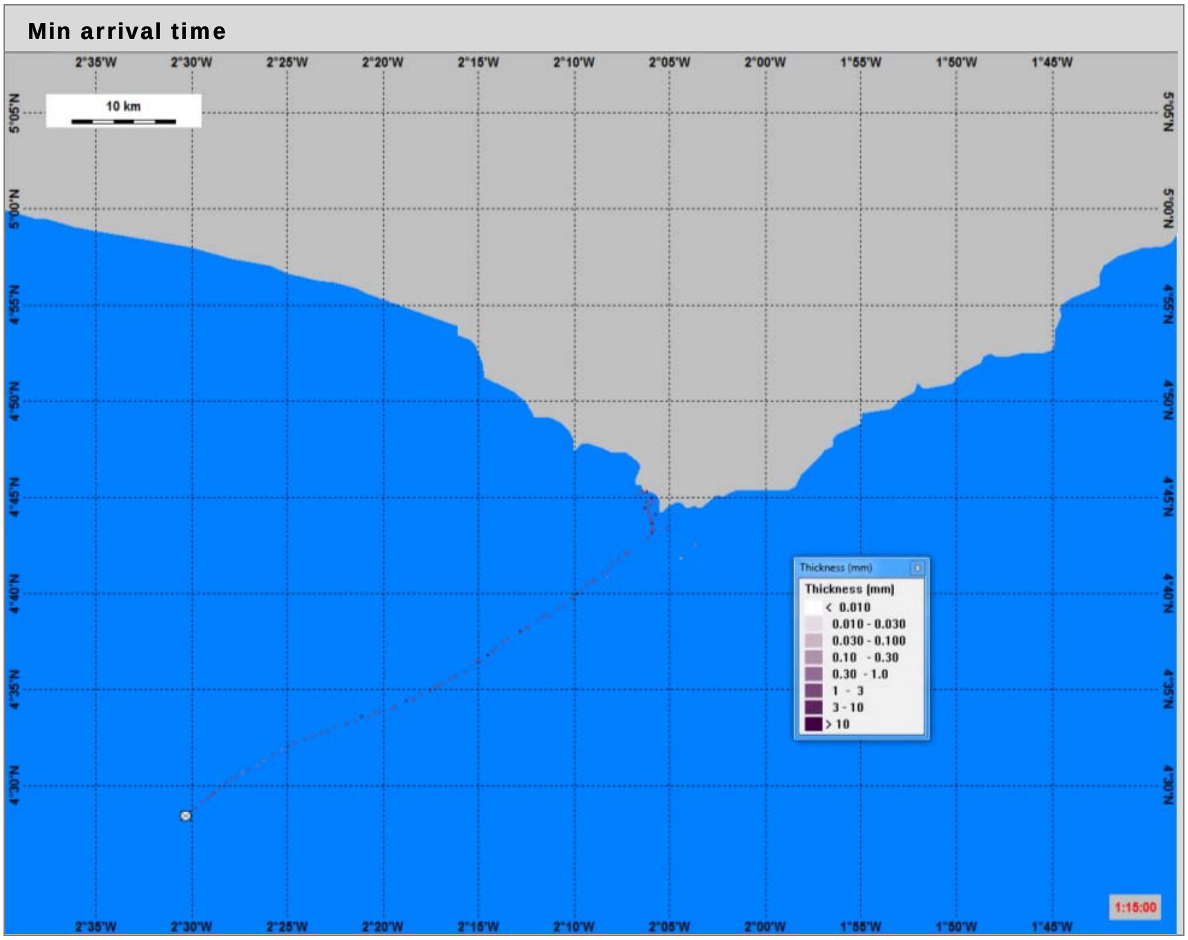
The maximum mass of oil ashore, after 120 days, is 27132 tons, while 40.5 % evaporates, 25.9 % remains on the surface of the ocean and the remaining oil is in the water column or biodegrades.

The minimum time for the oil to reach the shore is 1 day and 15 hours. The mass of oil reaching the shore in this event is 18245 tons (17.4 % of the total oil spilled), while 38.3 % evaporates, 24.0 % remains on the surface of the ocean and the remaining oil is in the water column or biodegrades.

Table 36 Tier 3 most probable scenario – maximum mass of oil ashore, minimum arrival time.

Max mass of oil ashore





Diesel spill: diesel spill from FPSO following an impact.

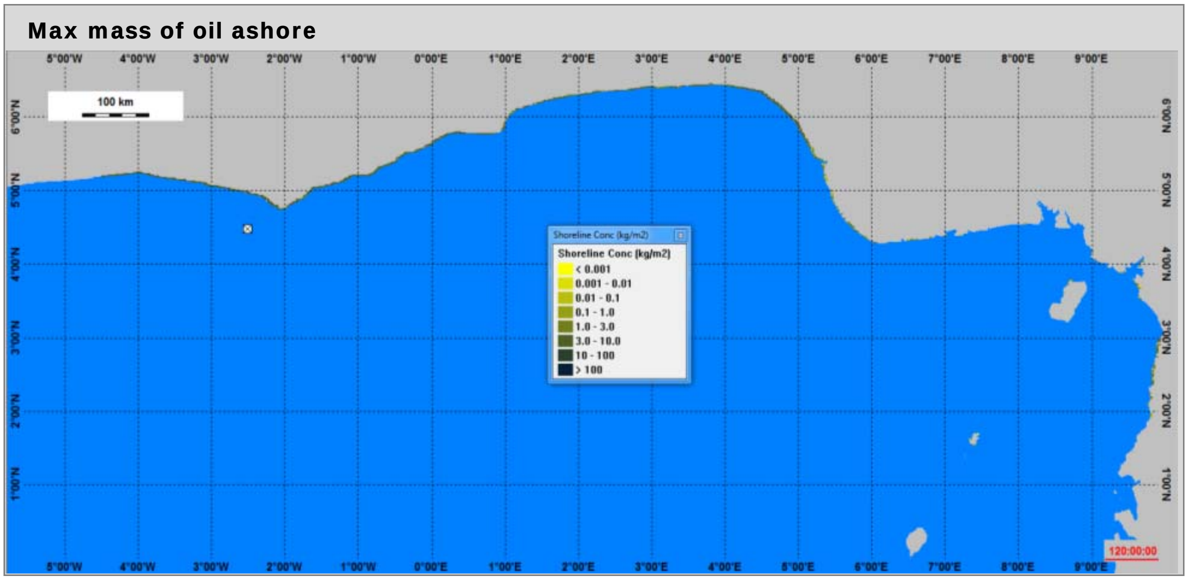
Table 37 shows the fates of oil in the events simulated, respectively:

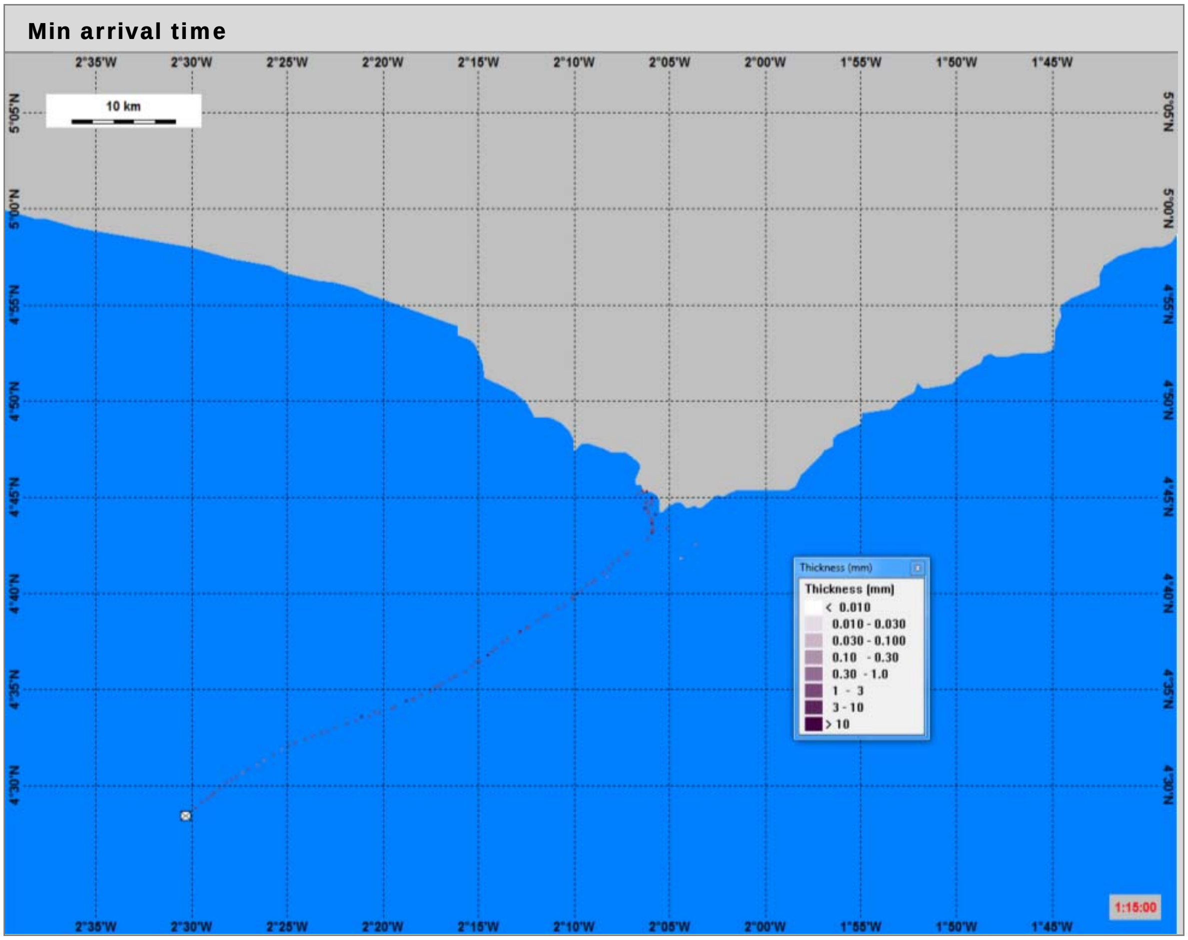
- Maximum amount of oil ashore;
- Minimum time for oil to get ashore.

The maximum mass of oil ashore, after 45 days, is 2532 tons (36.2 % of the whole spill), while 27.2 % evaporates and 36.3 % biodegrades. No diesel is left in the water column.

The minimum time for the oil to reach the shore is 1 day and 18 hours. The mass of oil reaching the shore in this event is 1575 tons (22.5 % of the total oil spilled), while 39.6 % evaporates and 31.6 % biodegrades. No diesel is left in the water column.

Table 37 Tier 3 diesel spill – maximum mass of oil ashore, minimum arrival time.




Min arrival time
2°35'W
2°30'W
2°25'W
2°20'W
2°15'W
2°10'W
2°05'W
2°00'W
1°55'W
1°50'W
1°45'W
10 km
5°05'N
5°00'N
4°55'N
4°50'N
4°45'N
4°40'N
4°35'N
4°30'N
Thickness (mm)
Thickness [mm]
< 0.010
0.010 - 0.030
0.030 - 0.100
0.10 - 0.30
0.30 - 1.0
1 - 3
3 - 10
> 10
1:15:00

8.5.3.2 Tier 2 Scenarios

Most severe scenario: OP leak from riser at FPSO.

Table 38 shows the fates of oil in the events simulated, respectively:

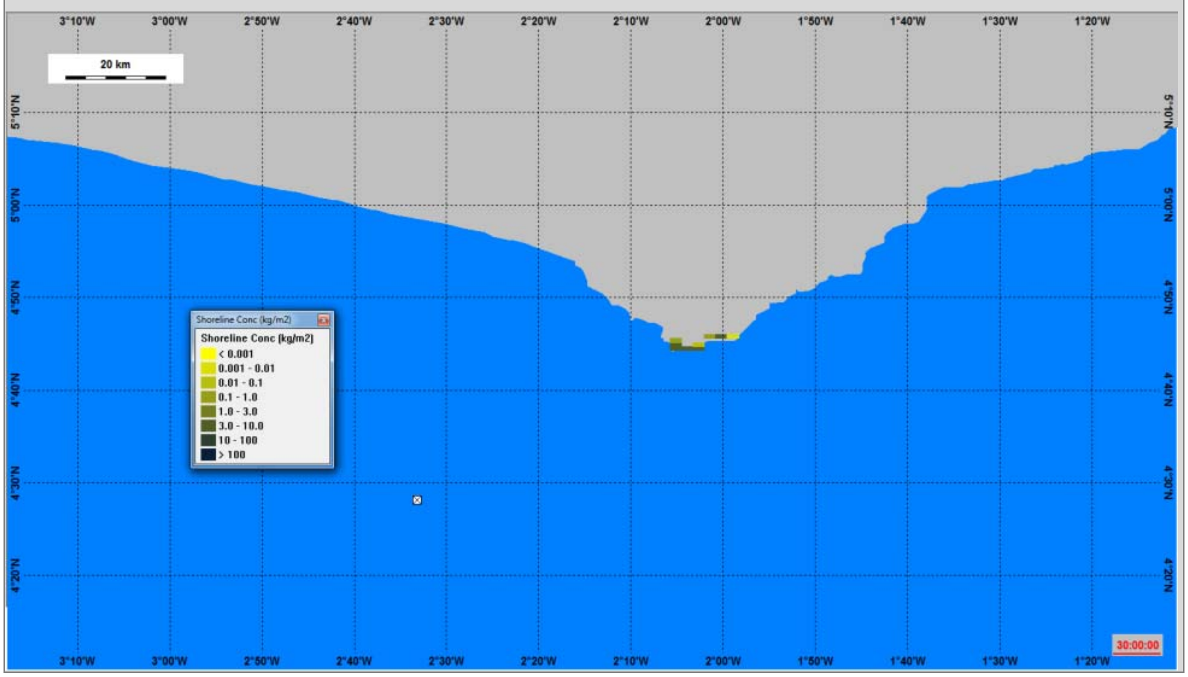
- Maximum amount of oil ashore;
- Minimum time for oil to get ashore.

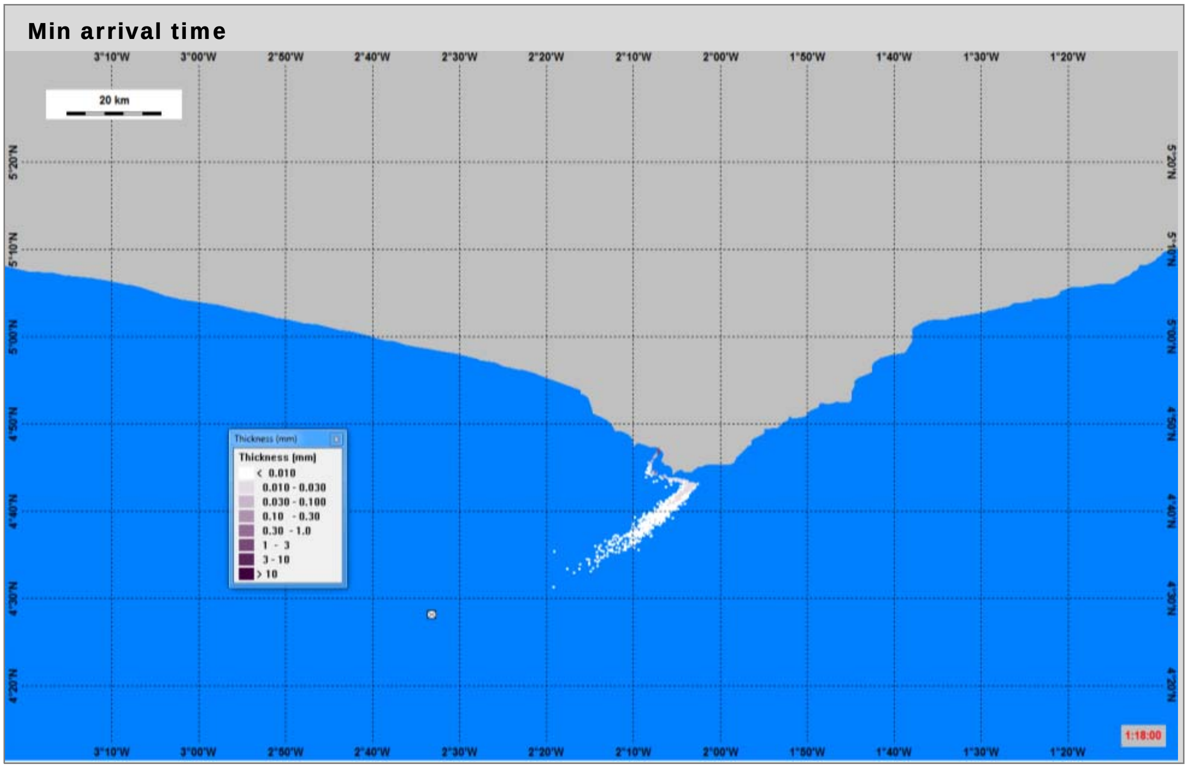
The maximum mass of oil ashore, after 30 days, is 158.3 tons, while 23.9 % evaporates, no oil remains on the surface of the ocean and the remaining oil is in the water column or biodegrades. The maximum mass of stranded oil, approximately 209 tons, is reached 5 days after the end of the release. Figure 10 shows the fate of the oil.

The minimum time for the oil to reach the shore is 1 day and 18 hours. The mass of oil reaching the shore in this event is 8 tons (2.8 % of the total oil spilled), while 49.3 % evaporates, 0.4 % remains on the surface of the ocean and the remaining oil is in the water column or biodegrades. Figure 11 shows the fate of the oil.

Table 38 Tier 2 most severe scenario – maximum mass of oil ashore, minimum arrival time.

Max mass of oil ashore




Min arrival time
20 km
Thickness (mm)
Thickness [mm]
< 0.010
0.010 - 0.030
0.030 - 0.100
0.10 - 0.30
0.30 - 1.0
1 - 3
3 - 10
> 10
1:18:00

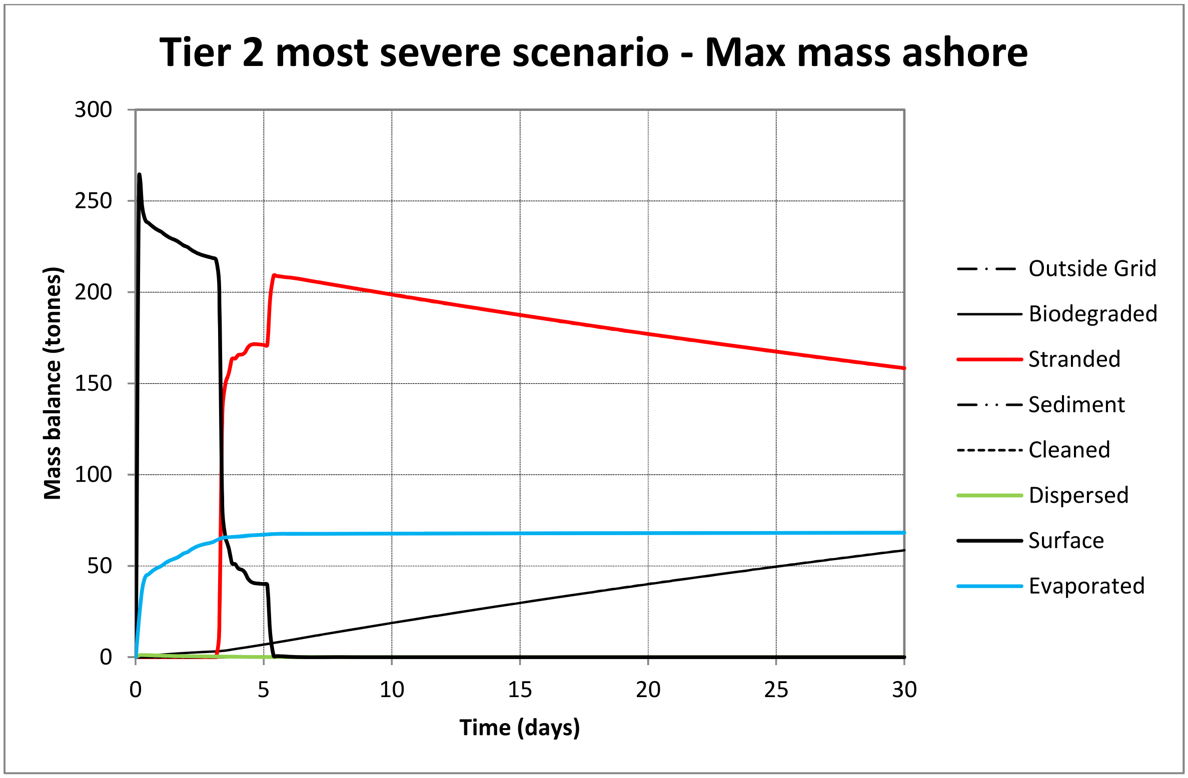


Figure 10 Tier 2 most severe scenario, max mass ashore. Mass balance plot.

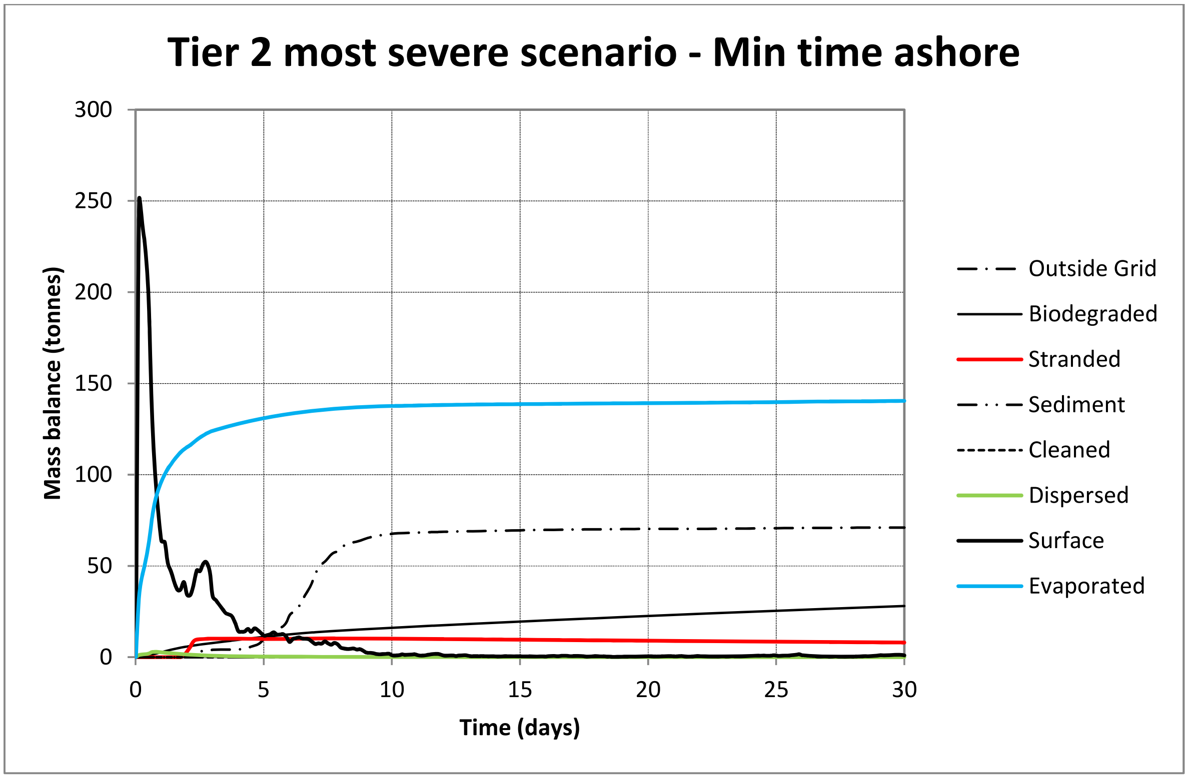


Figure 11 Tier 2 most severe scenario, min time ashore. Mass balance plot.

Most probable scenario: OP flowline leak at seabed.

Table 39 shows the fates of oil in the events simulated, respectively:

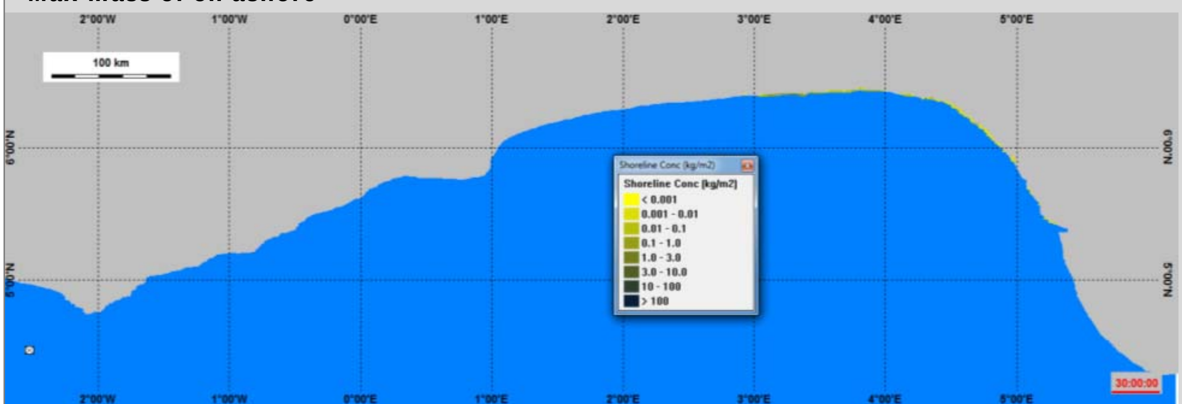
- Maximum amount of oil ashore;
- Minimum time for oil to get ashore.

The maximum mass of oil ashore, after 30 days, is 54.4 tons, while 37.5 % evaporates, 0.1 % remains on the surface of the ocean and the remaining oil is in the water column or biodegrades.

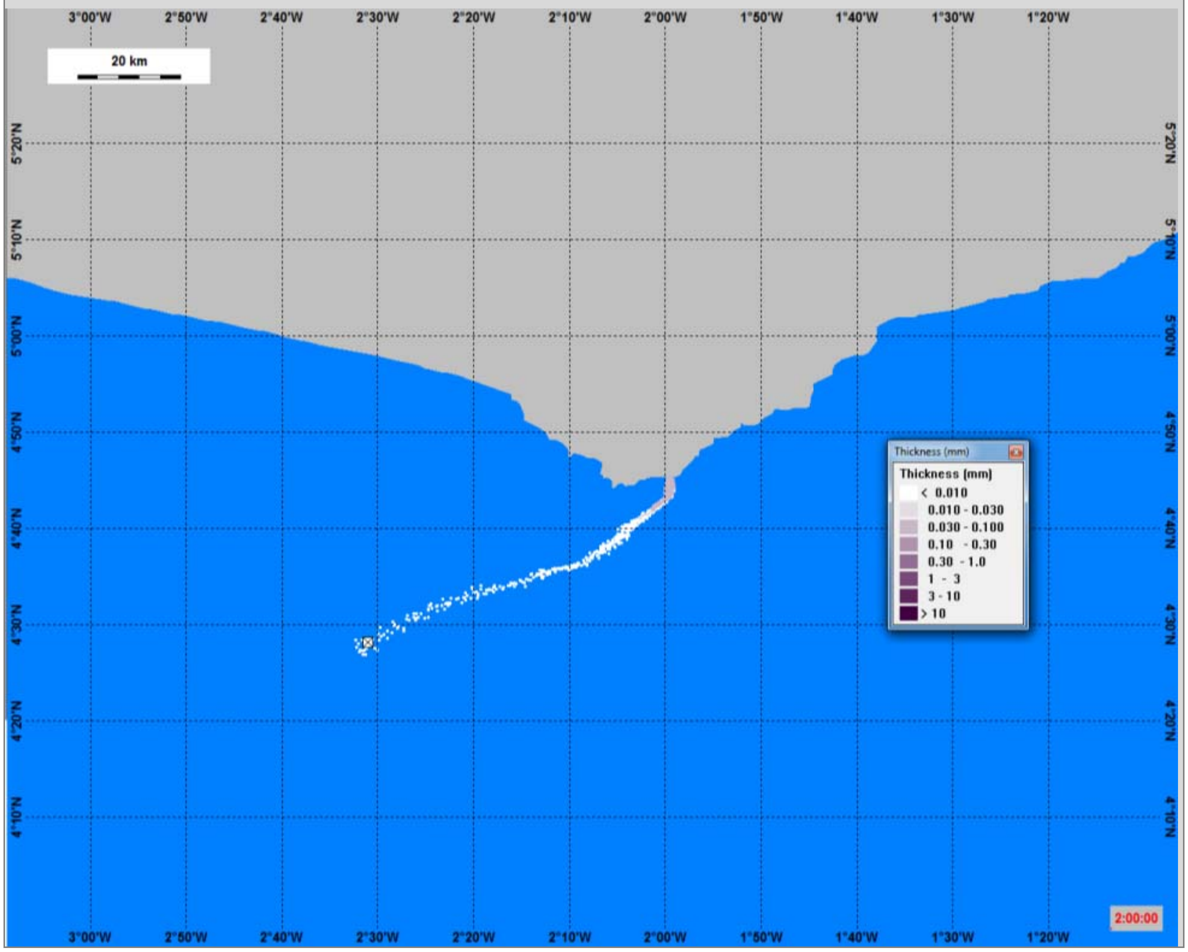
The minimum time for the oil to reach the shore is 2 days. The mass of oil reaching the shore in this event is 4 tons (2 % of the total oil spilled), while 21.7 % evaporates, 0.1 % remains on the surface of the ocean and the remaining oil is in the water column or biodegrades.

Table 39 Tier 2 most probable scenario – maximum mass of oil ashore, minimum arrival time.

Max mass of oil ashore



Min arrival time



Diesel spill: diesel spill from a supply vessel following an impact.

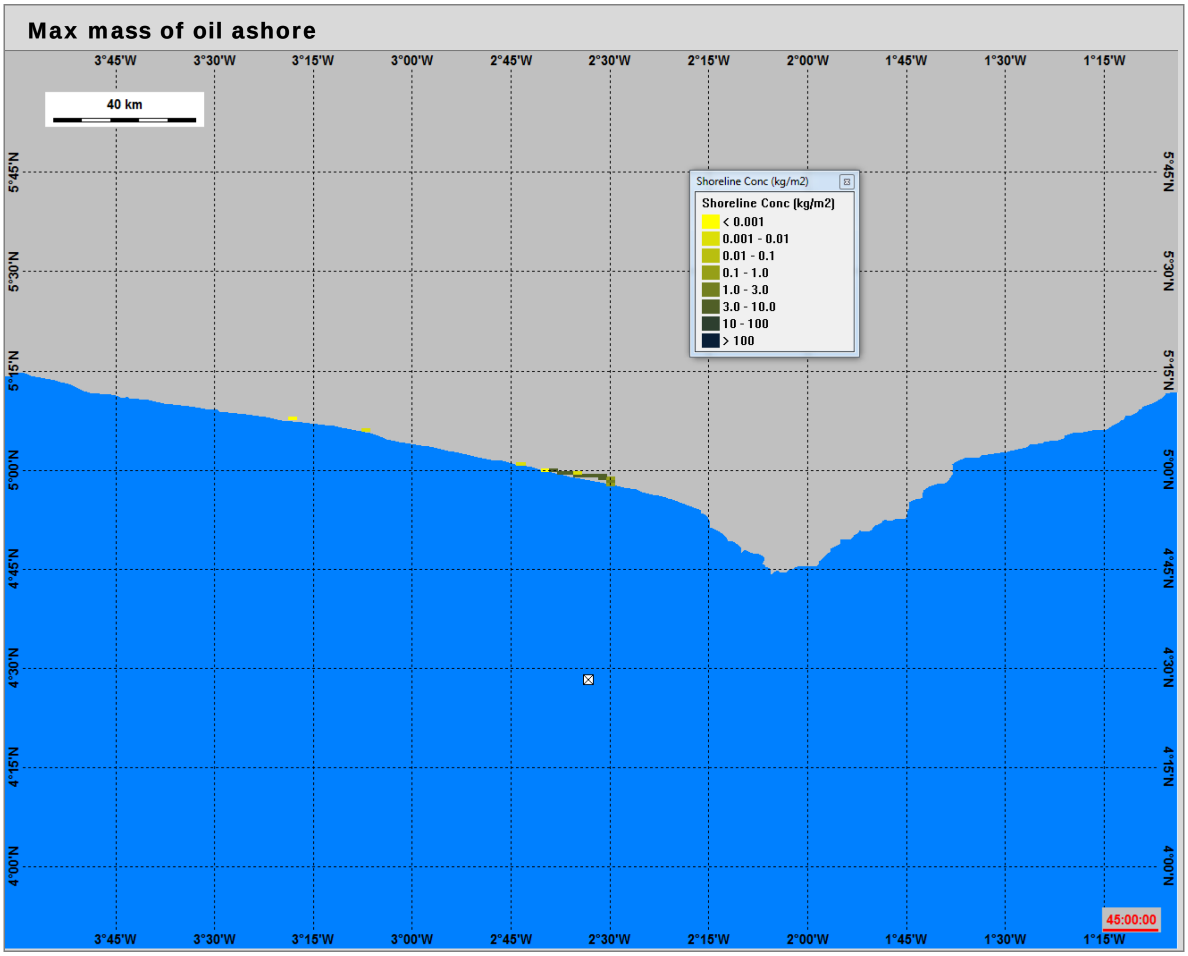
Table 40 shows the fates of oil in the events simulated, respectively:

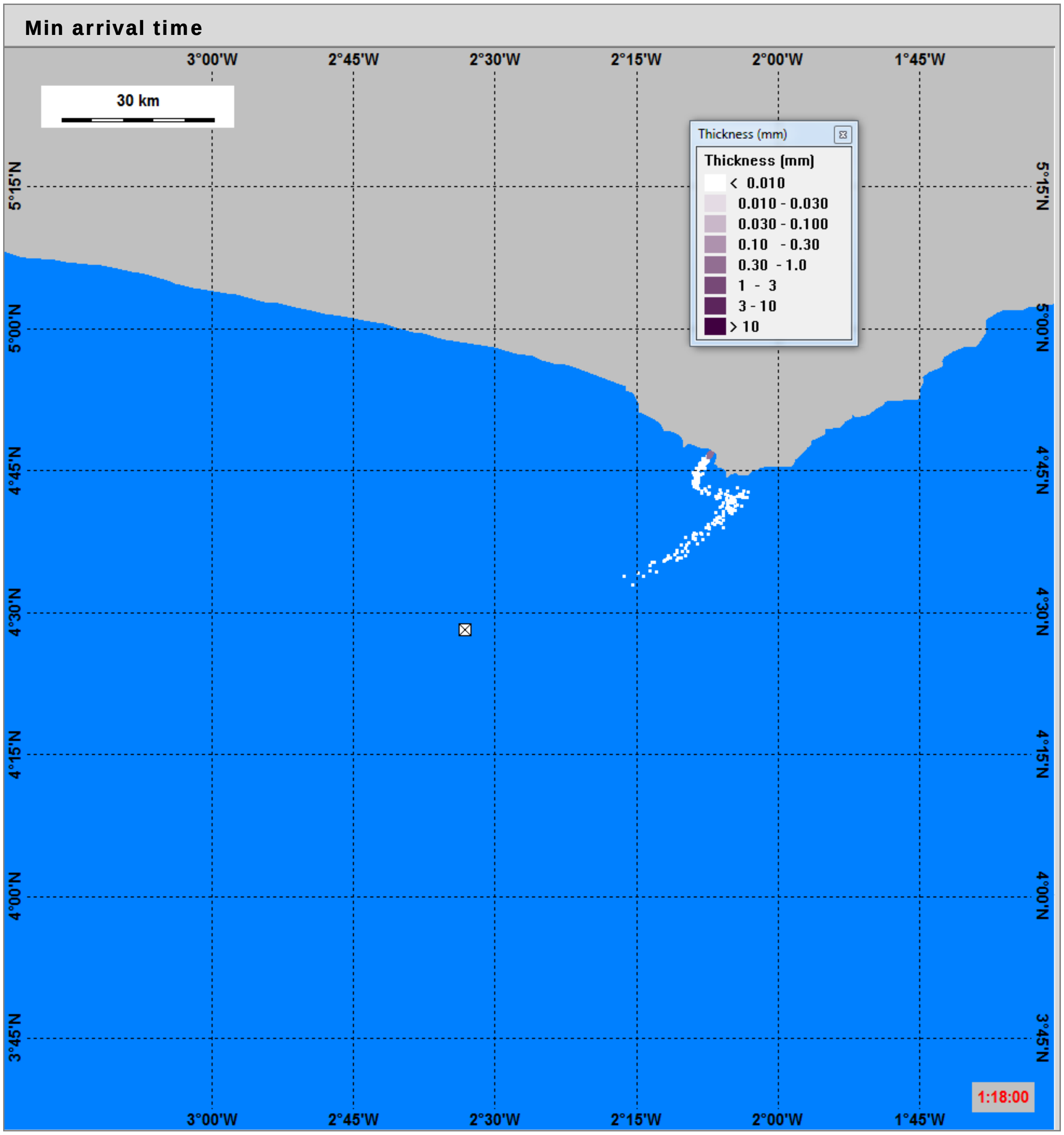
- Maximum amount of oil ashore;
- Minimum time for oil to get ashore.

The maximum mass of oil ashore, after 45 days, is 287.7 tons (33.1 % of the whole spill), while 32.5 % evaporates and 34.0 % biodegrades. No diesel is left in the water column.

The minimum time for the oil to reach the shore is 1 day and 18 hours. The mass of oil reaching the shore in this event is 86.1 tons (9.9 % of the total oil spilled), while 50.2 % evaporates and 29.4 % biodegrades. No diesel is left in the water column.

Table 40 Tier 2 diesel spill – maximum mass of oil ashore, minimum arrival time.




Min arrival time
30 km
Thickness (mm)
Thickness (mm)
< 0.010
0.010 - 0.030
0.030 - 0.100
0.10 - 0.30
0.30 - 1.0
1 - 3
3 - 10
> 10
3°00'W
2°45'W
2°30'W
2°15'W
2°00'W
1°45'W
5°15'N
5°00'N
4°45'N
4°30'N
4°15'N
4°00'N
3°45'N
1:18:00

8.5.3.3 Tier 1 Scenarios

Most severe scenario: GP riser leak in shallow water.

Table 41 shows the fates of condensate in the events simulated, respectively:

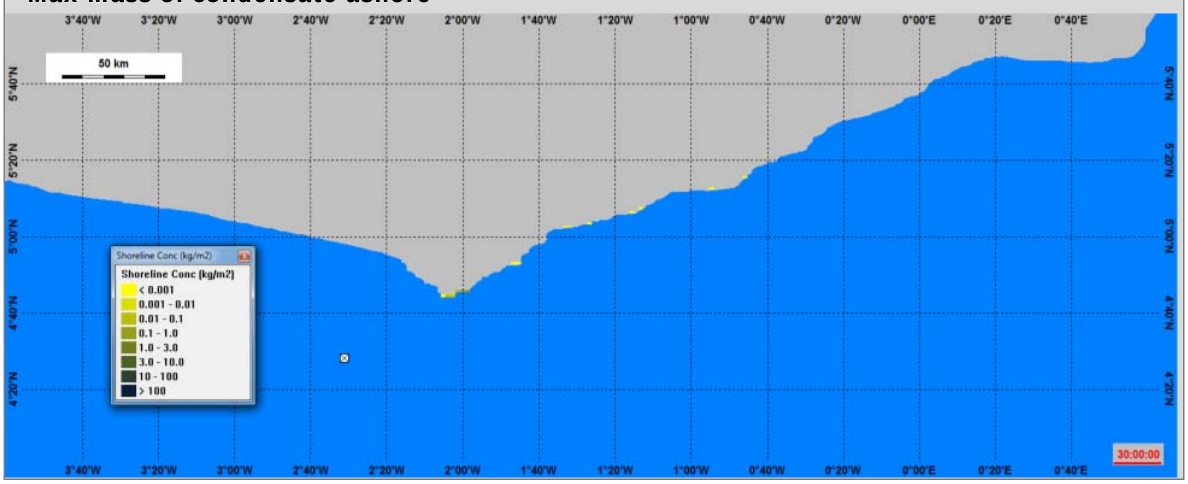
- Maximum amount of condensate ashore;
- Minimum time for condensate to get ashore.

The maximum mass of condensate ashore, after 30 days, is 7.6 tons, while 45 % evaporates, no condensate remains on the surface of the ocean and the remaining condensate is in the water column or biodegrades. The maximum mass of stranded condensate, approximately 10 tons, is reached 4 days after the end of the release. Figure 12 shows the fate of the condensate.

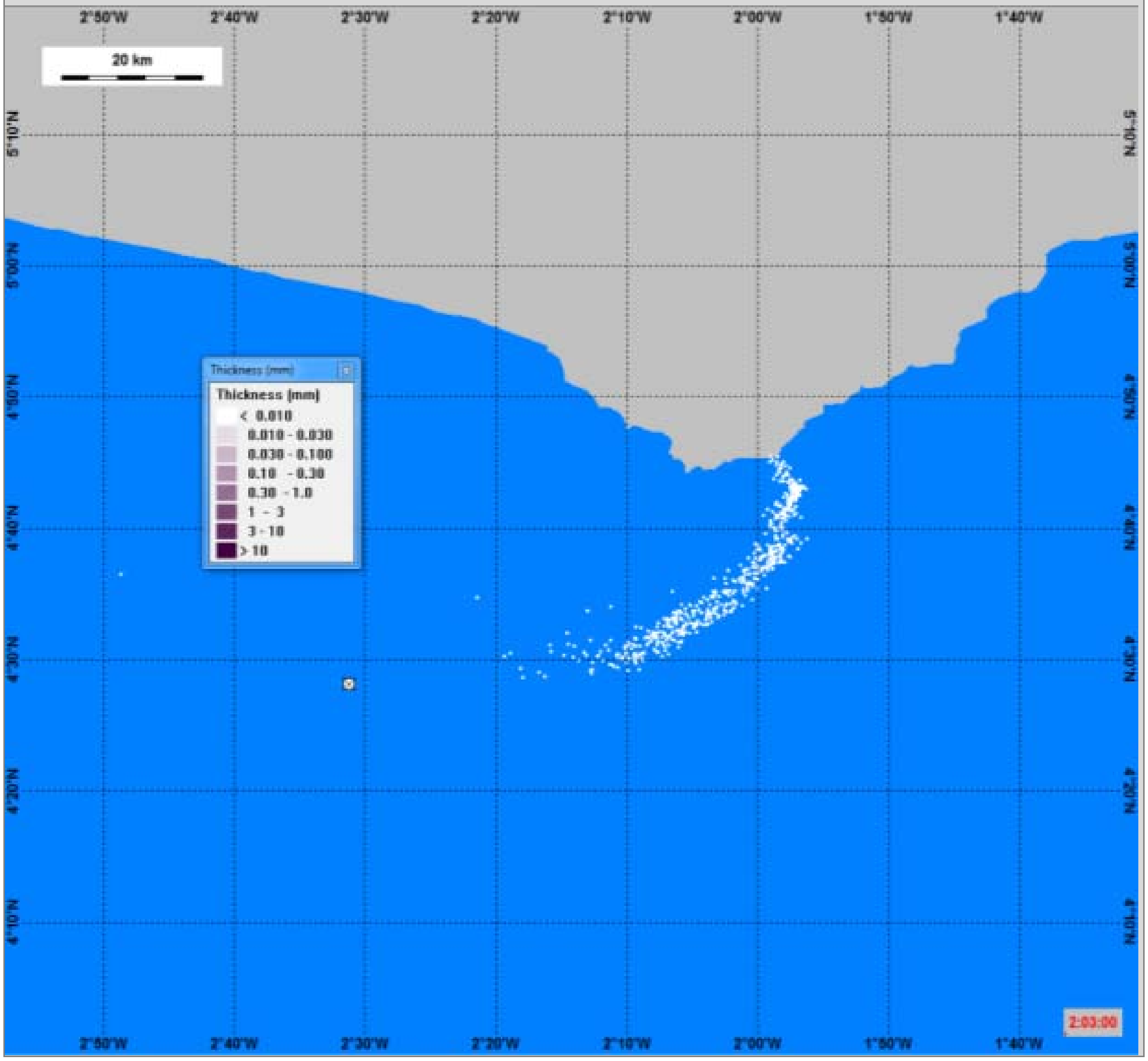
The minimum time for the condensate to reach the shore is 2 days and 2 hours. The mass of condensate reaching the shore in this event is 2.5 tons (0.1 % of the total condensate spilled), while 31.6 % evaporates, 0.5 % remains on the surface of the ocean and the remaining condensate is in the water column or biodegrades. Figure 13 shows the fate of the condensate.

Table 41 Tier 1 most severe scenario – maximum mass of condensate ashore, minimum arrival time.

Max mass of condensate ashore



Min arrival time



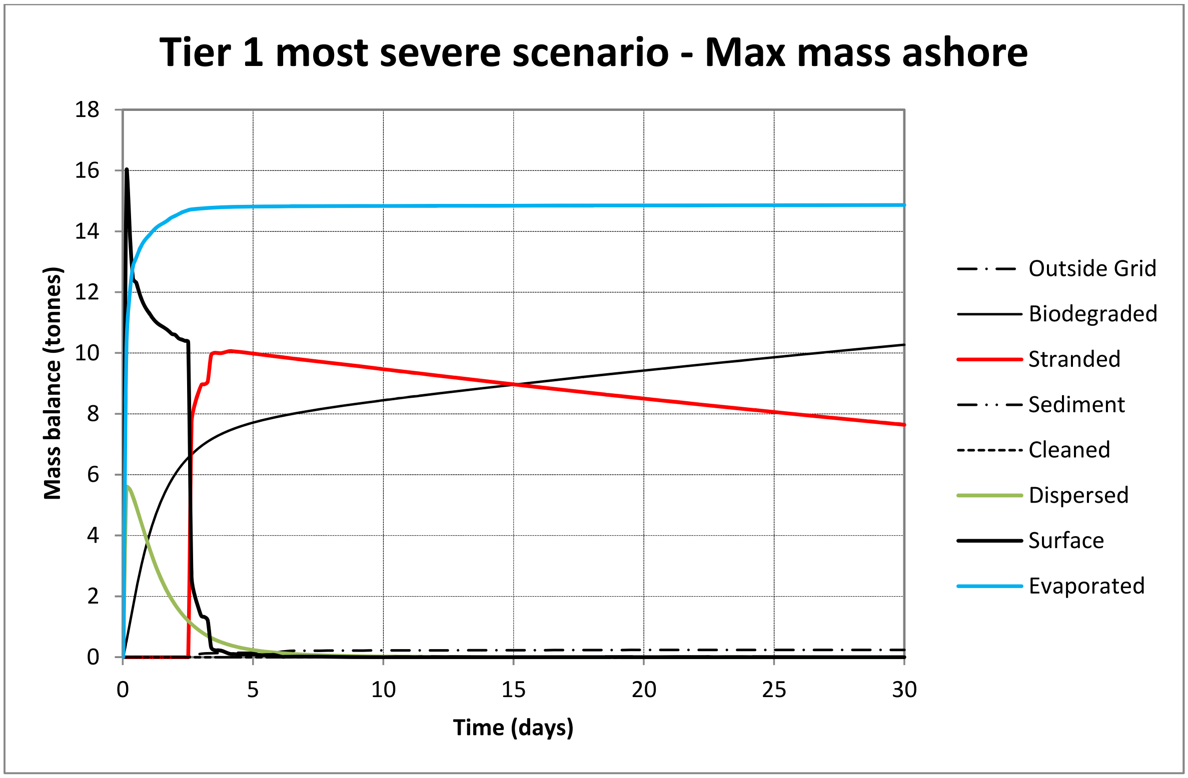


Figure 12 Tier 1 most severe scenario, max mass ashore. Mass balance plot.

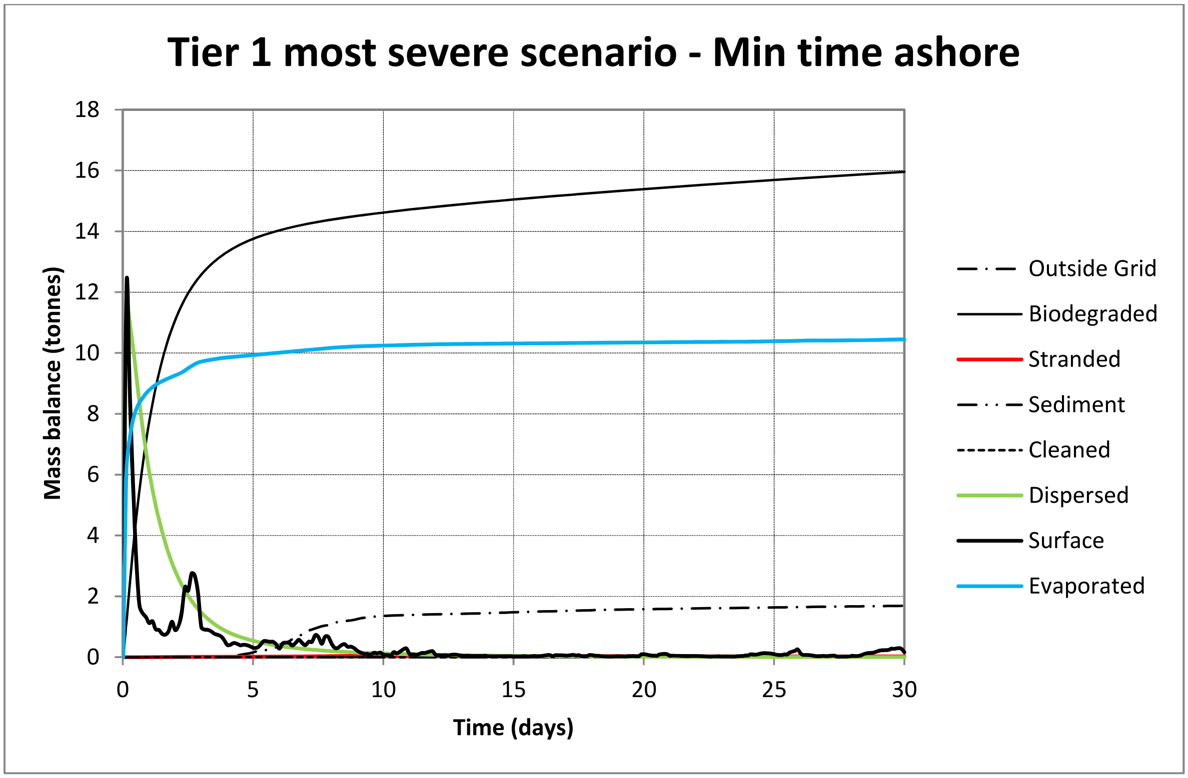


Figure 13 Tier 1 most severe scenario, min time ashore. Mass balance plot.

Most probable scenario: GP flowline leak at seabed.

Table 42 shows the fates of condensate in the events simulated, respectively:

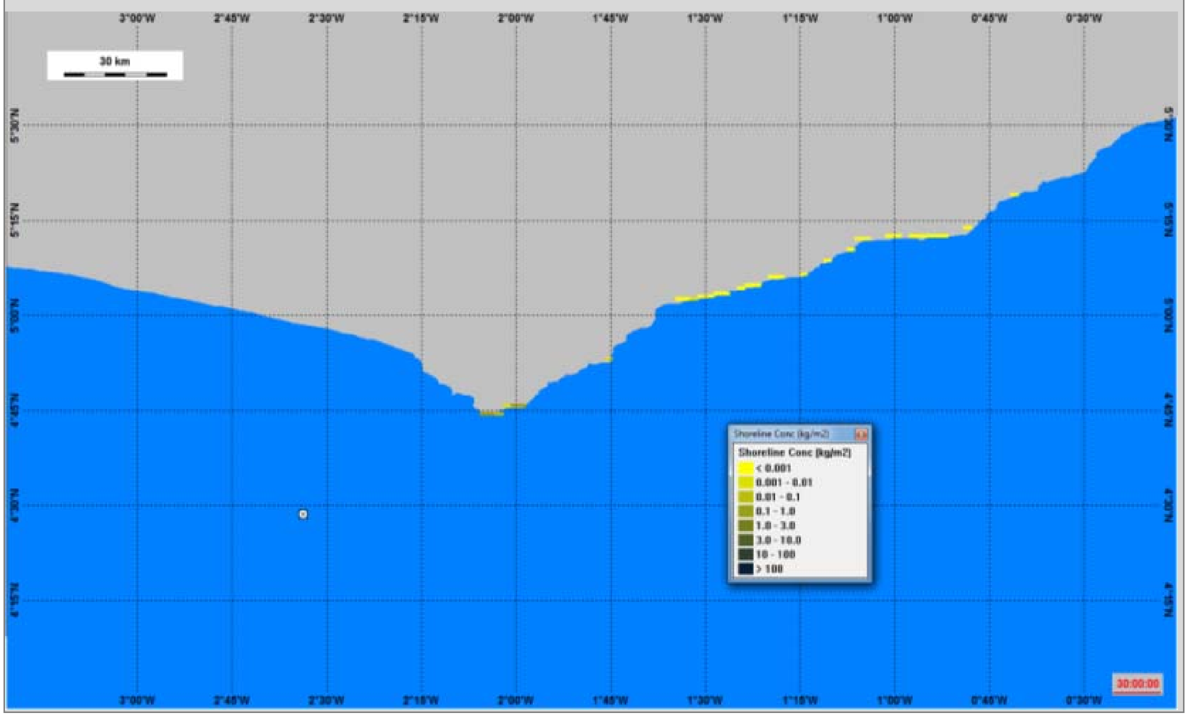
- Maximum amount of condensate ashore;
- Minimum time for condensate to get ashore.

The maximum mass of condensate ashore, after 30 days, is 4.4 tons, while 22.8 % evaporates, no condensate remains on the surface of the ocean and the remaining condensate is in the water column or biodegrades.

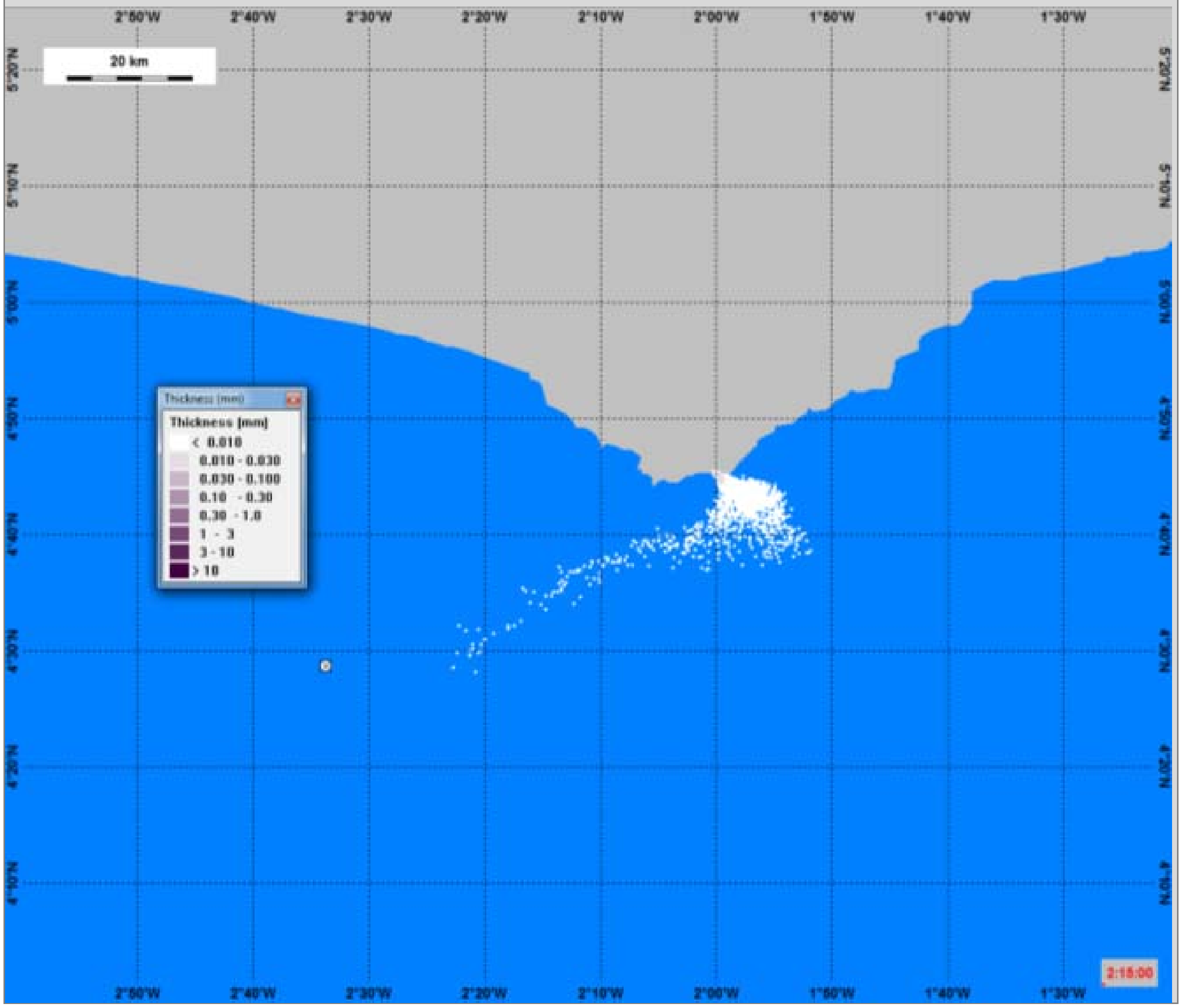
The minimum time for the condensate to reach the shore is 2 days and 15 hour. The mass of condensate reaching the shore in this event is 2.3 tons (8.5 % of the total condensate spilled), while 22.1 % evaporates, 0.2 % remains on the surface of the ocean and the remaining condensate is in the water column or biodegrades.

Table 42 Tier 1 most probable scenario – maximum mass of condensate ashore, minimum arrival time.

Max mass of condensate ashore



Min arrival time



9. ANNEXES

Annex A – Contact Details

Annex B – Forms

Annex C – Oil Spill Training and Exercises

Annex D – Legislative and Regulatory Framework

Annex E – Eni Health, Safety & Environmental (HSE) Guidelines

ANNEX A –CONTACT DETAILS SAMPLE

eni Ghana ERT Contact Details				
	Emergency Response Team		Alternate Emergency Response Team	
POSITION	**NAME**	**MOBILE**	**NAME**	**MOBILE**
Emergency Response Manager	*F. Cavanna*	*0544 347 057*	*F. Roncarolo*	*0540 109 269*
Emergency Coordinator	*F. Roncarolo*	*0540 109 269*	*E. Lago*	*0544 334 994*
Logistics Manager	*R. Costantini*	*0544 347 058*	*K. Amankwah - Poku*	*0544 343 270*
Well Operations Manager	*K. Rrokaj*		*S. Borra*	*0544 347 056*
HSE&CI Manager	*J. Deffis*	*0544 334 993*	*M. Bartels-Kodwo*	*0261 600 666*
Public Affairs Coordinator	*R. Crivari*	*0544 311 690*	*A. Renzulli*	*0540 119 718*
Health Manager	*S. Grazia*	*0544 339 148*	*J. Deffis*	*0544 334 993*
HR&T Manager	*M. Ruscio*	*0544 311 692*	*F. Osei-Bonsu*	*0540 115 399*
Log Keeper	*M. Bartels-Kodwo*	*0261 600 666*	*F. Osei-Bonsu*	*0540 115 399*
Emergency Response Room		*0302 761 941*		

GOVERNMENT AUTHORITIES

Navy / Environmental Protection Agency (EPA)

Designation	Mobile Phone
EPA Switchboard	+233 (0) 0302 664697-8
Navy Operations Room Navy Headquarters (Accra)	+233 (0) 21 777991 / 233 21 766850 / 233 21 777621

Petroleum Commission (PC)

Designation	Office Phone
Switchboard	+233 (0) 0302 953 392 / 393

Ghana National Petroleum Corporation (GNPC)

Designation	Office Phone
Head Office	+233 (0) 303 206020 / 204654

OSRL

Designation	Direct Ph.
UK/Bahrain Emergency	+44 (0)23 8033 1551
Regional Director (UK)	+44 23 8033 1551 +44 23 8072 4303
Regional Representative, West Africa	+447881342182 +233244635583

OTHER OIL AND GAS OPERATORS

Designation	Office	Mobile	Fax	Email
VITOL Ian McNeil **Asset Manager (Primary Contact)**		+44 078 1398 3838		imn@vitol.com
GNPC **Engineering Manager**	+233 (0) 22 202824	+233 (0) 20 8132579	+233 (0) 22 202854	ap.kwarteng@gnpcghana.com
TULLOW				
Logistics Base Manager Takoradi	+233 (0) 244 342671	+233 (0) 31 27847		gh_logisticsbasemanager@tullowoil.com
EHS Advisor Takoradi	+233 (0) 244 342103	+233 (0) 31 27847		Ehsadvisoe.ghana@tullowoil.com
EHS Manager Accra	+233 (0) 244 342096	+233 (0) 21 763600 ext. 116		cesar.molina@tullowoil.com

ANNEX B – FORMS

1. Oil Spill Report Forms
2. Marine Pollution Report Form
3. Situation Report Form (SITREP)
4. Personal log
5. Modelling request form for oil spill release
6. Modelling request form for uncontrolled blowout
7. Aerial Surveillance Form
8. *OSRL* – Notification Form
9. *OSRL* – Mobilisation Authorisation Form
10. Vessel dispersant application log

1. OIL SPILL REPORT FORMS

In the event of an oil spill occurring or if pollution is seen in the vicinity of eni Ghana's operations the following forms/checklists must be completed and distributed as specified. Instructions for use are as follow:

Pollution Report Form	**From**	Eni OSC/PIC (for example Vessel Master)
	To	Emergency Response Team (Accra) (for Tier 1, 2 and 3 spills)
	When	All oil spills
	How	Early facts by phone to Duty Manager, full facts by email (primary) or Fax (secondary) to ERT
Situation Report	**From**	Eni OSC/PIC (for example Vessel Master)
	To	Emergency Response Team (Accra)
	When	All oil spills
	How	Early facts by phone, full facts by Email/Fax to ERT
OSRL Notification Form	**From**	Emergency Response Team (Accra)
	To	*OSRL* Duty Manager
	When	As and when required
	How	Email /Fax
OSRL Mobilisation Form	**From**	The eni Ghana Nominated Call-out Authority
	To	*OSRL* Duty Manager
	When	For Tier 2 / 3 Spills
	How	Email /Fax

2. MARINE POLLUTION REPORT FORM

Marine Pollution Report Form			
☐ Urgent		☐ Critical	
Date/Time of Report:			
Date/Time of Incident:			
Location of Incident:			
Latitude:		Longitude:	
Original Report Source:			
Contact:	Phone/Mobile:	Fax/Email:	
Nature of incident and spill source (if source unknown give identity and position of adjacent vessels):			
Point of Discharge from Source:			
Cause of Discharge:			
Oil Type or Description:			
Has Discharge Stopped/Temporarily Stopped?			
Extent of Spill:			
Projected Trajectory of Spill:			
Samples Taken: ☐ Yes ☐ No	Photographs Taken: ☐ Yes ☐ No		
Weather / Sea / Tide Conditions:			
Initial Response Actions:			
Corrective Actions Taken			
Additional Information:			
Report Prepared By:	Phone/Mobile:	Fax/Email:	

3. SITUATION REPORT FORM (sitrep)

Situation Report Form (SITREP)		
Report number:	Report date:	Time issued:
Incident name:		
Incident location:		
Latitude:	Longitude:	
Date of incident:	Time of incident:	
Type of incident:		
Brief account of incident:		
Assets affected:		
Nature and extent of spill:		
Third parties involved:		

Incident objectives:	
Summary of events since last report:	
Expected developments:	
Planned course of action:	
Other pertinent information:	
Report Prepared By:	Position:
Phone/Mobile:	Fax/Email:

4. PERSONAL LOG

Time: ____

Place: ____

Author: ____

Time	CONTACT Telephone N° of contacted person or external body	T/R*	COMMUNICATION AND ACTION

*T: Transmitted R: Received

5. MODELLING REQUEST FORM FOR OIL SPILL RELEASE

For the Attention of:				
Date/Time :				
From:	Name			
	Organisation/Company			
	Tel Number			
	Fax Number			
	Email Address			
Spill Release:	Date			
	Start Time			GMT/Local Time
	Latitude PLEASE MAKE FORMAT CLEAR			
	Longitude PLEASE MAKE FORMAT CLEAR			
Release Rate:	Instantaneous Release (i.e. Total Amount) **PLEASE STATE UNITS**			
	OR Continuous Release PLEASE STATE UNITS	Per Hour	For __________ Hours/Days	**Total Amount** to be Released __________
Oil Type: PLEASE STATE UNITS	Oil Name			
	API			
	Specific Gravity			
	Pour Point			
	Wax Content			
	Sulphur Content			
Wind Data:	Date/Time of Wind Data			
	Wind Direction (wind direction given from)			
	Wind Speed PLEASE STATE UNITS			
Sea Temperature:		°C/°F		
Air Temperature:		°C/°F		
Notes:				

6. MODELLING REQUEST FORM FOR UNCONTROLLED BLOWOUT

Blow-out Scenario Characterization Data		
Parameter	Value/Range	unit of measurement
Water deep (for underwater blow-out)		m
Top Reservoir depth (see note 1)		m sea level for offshore location, m RT for onshore location
Reservoir temperature (see note 1)		°C
Static pressure (see note 1)		Bar_g (see note 2)
Static pressure datum		m sea level for offshore location, m RT for onshore location
Oil gravity (see note 1)		°API
Bubble point (for crude oil wells) (see note 1)		Bar_g at T reservoir (see note 2)
Dew point (for dry gas and gas condensate wells) (see note 1)		Bar_g at T reservoir (see note 2)
Solution G.O.R. (for crude oil wells) (see note 1)		Sm^3/m^3
Blow-out G.O.R. (see note 1)		Sm^3/m^3
H_2S (see note 1)		ppm
Surface gas molecular weight stock tank condition (see note 1)		g/mole
Productivity index (for crude oil wells) (see note 1)		Sm^3/d/bar
Bottom absolute open flow (BAOF for dry gas and gas condensate wells)		$MMSm^3$/d
Release point elevation with reference to:	Land level (for atmospheric onshore blow-out) ☐ Sea level (for atmospheric offshore blow-out) ☐ Sea bottom (for underwater blow-out) ☐	
Rotary table/Rig floor elevation with reference to:	Land level (for atmospheric onshore blow-out) ☐ Sea level (for atmospheric offshore blow-out) ☐	
Type of hydrocarbons:	crude oil ☐ dry gas ☐ gas condensate ☐	

Note 1) in case of uncertainty about the value please supply the range of possible variation
Note 2) barg is "gravitational" pressure that doesn't include atmospheric pressure

Blow-out Scenario Characterization Data			
Event	Flow through	Description	Selection
During drilling	Casing	Well cased. Flow through open hole and internal casing/liner sections without drilling string inside	☐
	Annulus (including outside casing)	Well cased and with drilling string. Flow through the annulus generated between the drilling string and open hole/casing/liner sections or inside different casing/liner/gaps (outside casing)	☐
	Drilling string	Well cased and with drilling string inside pipe. Flow through drilling string only	☐
	Drilling string and annulus	Well cased with drilling string inside. Flow through the annulus between open hole/casing/liner sections and drilling string and inside drilling string itself	☐
During production	Tubing	Flow through liner section from the perforated intervals top to the tubing bottom and through the production tubing up to wellhead	☐
	Annulus	Flow through liner section from the perforated intervals top to the tubing bottom and through the annulus between the casing/liner sections and the tubing up to wellhead	☐
	Annulus and tubing	Flow through liner section from the perforated intervals top to the tubing bottom and both through the annulus and production tubing up to wellhead	☐

Contents

- Depth data must be supplied both in Measured depth (MD) and True Vertical Depth (TVD)
- Diameter data must be expressed both in term of Inner Diameter (ID), Outer Diameter (OD)
- Component data must be supplied both in term of Nominal Diameter (ND) and Linear Weight (LW)
- Please specify measurement units (into round parentheses)
- Please specify the reference of the depth data (Rotary Table, Sea Level, Sea Bottom, Rig Floor, etc.) together the measurement units (into round parentheses)

The following list of data be supplied (in quoted well sketch) if present in the well:

- Casing/Liner shoes depth
- Top liner depth
- Top and Bottom depth each type of drill pipe composing the drilling string
- Top and Bottom of each tubing section
- ID and OD of each section
- Bit depth
- Open hole bottom depth and ID
- Perforation interval(s) top and bottom depth

TYPE	ND (")	ID (")	OD (")	LW ( )	TOP DEPTH		BOTTOM DEEP	
					MD ( ) [ ]	TVD ( ) [ ]	MD ( ) [ ]	TVD ( ) [ ]

QUOTED WEEL SKETCH

7. AERIAL SURVEILLANCE FORM

Aerial Surveillance Form			
Incident		**Aerial Surveillance Report No.**	

Date and time	Day	Month	Year	**Takeoff time**	
				Landing time	

Type of Aircraft		**Aircraft Company**	

Eni Ghana Observer		**Short description of route**	**Weather**	
Eni Ghana Assistant Observer			**Wind Direction**	
Photos	☐		**Wind Speed**	
Use of GPS	☐		**Sea State**	
Video	☐		**Weather**	☐ Sunny ☐ Cloudy ☐ Rainy

Observations												
Time	**Position**		**Dimensions**		**Oil appearance / Coverage (%)**					**Volume**	**Slick Movement**
Local	Latitude (N)	Longitude (E)	Length (m)	Width (m)	1	2	3	4	5	m^3 / km^3	Direction
Comments / Remarks											

8. OSRL – NOTIFICATION FORM

Oil Spill Response

Notification Form

(Initial Incident Information)

Warning! Please telephone the Duty Manager before e-mailing or faxing this completed form

To	Duty Manager		
OSRL Base	Southampton, UK	Loyang, Singapore	Fort Lauderdale, USA
Telephone	+44 (0)23 8033 1551	+65 6266 1566	+1 954 983 9880
Emergency Fax	+44 (0)23 8072 4314	+65 6266 2312	+1 954 987 3001
Email	dutymanagers@oilspillresponse.com		

Safety and Security: Oil Spill Response Limited's safety policy requires us to work closely with the mobilising party to ensure all aspects of safety and security are addressed for our personnel.

Guidance: Please ensure the information given on this form is accurate at the time of completion. This information will be used to develop and recommend the most appropriate response strategy. If new information should become available, or the situation changes, please inform the Duty Manager as soon as possible.

Section 1 – Contact Details	Mandatory Information Required
Member Company	
Name of Person Notifying OSRL	
Position in Incident	
Direct Phone Number	
Mobile Number	
Fax Number	
Email Address	
Command Centre Address	
Date and Time of Notification	
Section 2 – Location	
Country / Region of Spill	
Latitude / Longitude of Spill Position	
Area Affected	☐ Inland ☐ River ☐ Estuary ☐ Shoreline ☐ Port ☐ Harbour ☐ Offshore ☐ Subsea ☐ Other
Depth of Water (if applicable)	
Section 3 – Spill Details	
Date and Time (of spill – GMT)	
Source of Spill	
Cause of Spill	
Status of Spill	☐ Secured ☐ Uncontrolled ☐ Unknown

Product Properties	Product Name / Type		State Units Alternatively, provide an Assay sheet ☐ Assay sheet provided
	SG or API		
	Pour Point		
	Wax Content		
	Asphaltene		
	Sulphur Content		
	Viscosity		
Release Rate	Instantaneous Release		State Units
	OR		
	Continuous Release	per hour for ☐ Hours ☐ Days	

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Section 3 – Spill Details cont.		Mandatory Information Required	
Description of Observed Spill	Estimated Quantity		State Units
	Size		
	Appearance		
	Direction of Travel		

Section 4 – Weather		
Wind Direction (wind direction given from)		State Units Alternatively provide a local weather forecast ☐ Weather forecast provided
Wind Speed		
Air Temperature		
Sea Temperature		
Sea State		
Visibility		
Cloud Base		

Section 5 – Oil Spill Model Request			
Information you supply in Section 3 (Spill Details) and 4 (Weather) will be used for the modelling			
Do you require Oil Spill Trajectory Modelling?	☐ Surface 2D	☐ Sub-surface 3D*	☐ Not at this time
Additional Information (please include start date and time)			
*Separate model request form required. Sub-surface models require additional time and costs.			

Section 6 – Safety and Security		
Highlight any known Safety or Security Risks		☐ N/A
Describe Security arrangements for OSRL staff (if applicable)		☐ N/A

Additional information if available

Section 7 – Resources at Risk	
Environmental or Socio-economic sensitivities that may be impacted (If possible provide the relevant oil spill contingency plan)	

Section 8 – Equipment	
Equipment already deployed or being mobilised (other than OSRL resources)	

9. OSRL – MOBILISATION AUTHORISATION FORM

Oil Spill Response

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Mobilisation Authorisation Form

Warning! Please Telephone the Duty Manager before e-mailing or faxing this completed form

Safety and Security

Oil Spill Response Limited's safety policy requires us to work closely with the mobilising party to ensure all aspects of safety and security are addressed for our personnel.

To	Duty Manager		
OSRL Base	Southampton, UK	Loyang, Singapore	Fort Lauderdale, USA
Telephone	+44 (0)23 8033 1551	+65 6266 1566	+1 954 983 9880
Emergency Fax	+44 (0)23 8072 4314	+65 6266 2312	+1 954 987 3001
Email	dutymanagers@oilspillresponse.com		

Details of Authorised Contact	
Subject	Mobilisation of Oil Spill Response Limited (OSRL)
Incident Name	
Mobilising Company	
Name of Person Authorising OSRL	
Position in Incident	
Direct Phone Number	
Mobile Number	
Fax Number	
Email Address	

Invoice Address	
Purchase Order Number	

I, authorise the activation of Oil Spill Response Limited and its resources in connection with the above incident under the terms of the Agreement in place between above stated Company and Oil Spill Response Limited.				
Signature:		Date / Time:		

If Oil Spill Response Limited personnel are to work under another party's direction please complete details below;

Additional Details	
Company	
Contact Name	
Position in Incident	
Direct Phone Number	
Mobile Number	
Fax Number	
Email Address	

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10. VESSEL DISPERSANT APPLICATION LOG

Vessel Dispersant Application Log

Incident:			Date:		
Location:			Vessel Name:		
Operator :		Port Name:		Vessel Type :	
				Vessel Imo Reg. No.:	
Launch Time From Port:		Time Arrived At Spray Site:		Remote Sensing Used:	Yes / No

Observed Conditions In Spray Area

Wind Direction:		Sea State:		Visibility:		Weather Conditions:	

Oil & Dispersant Information

Oil Type:		Oil Volume:		Dispersant Type:		Manufacture Date:	

Run No.	Start Time	Position Lat/ Long Start	Position Lat/ Long Finish	Course Bearing	Spray Run Duration	Quantity Dispersant Remaining	Observed Effects of Dispersant	Comments / Actions Required

ANNEX C – OIL SPILL TRAINING AND EXERCISES

Training

Individual training requirements will be dependent on the role of the person involved. For example, members of the ERT are isolated from the scene of the actual incident. It is their responsibility to co-ordinate and make strategic decisions, so even though they do not physically use oil spill response equipment they should be aware of all the issues surrounding the response operation. On the other hand, the Offshore ERT will not need to be concerned with crisis management issues, liability, finance and incident analysis. Their duty and purpose is to prepare spill response equipment, liaise with on site local and national authorities, monitor plant function and deploy equipment for clean-up phase. Therefore, eni Ghana must ensure that there are sufficient personnel trained in first aid, oil spill response, oil spill response management and waste management.

Table 43 IMO Course Levels

Course Level	Content and Issues
Level 3 Senior Managers and Administrators	Provides an overview of the roles and responsibilities of senior personnel in the management of incidents, cause and effect of oil spills, response policy and strategies, contingency planning, crisis management, public affairs and media relations, administration and finance and liability and compensation.
Level 2 Supervisors and On-Scene Commanders	Provides detailed training in oil spill behaviour, fate and effects, spill assessment, operations planning, containment, protection and recovery, dispersant use, shoreline cleanup, site safety, storage and disposal of waste, media relations, record keeping, command and control management, communications and information, liability and compensation, response termination and post incident review / briefing.
Level 1 First Responder	Provides training on practical aspects of oil properties, response techniques, health and safety, boom and skimmer deployment, dispersant application, use of sorbents, shoreline cleanup, debris / waste handling and disposal and wildlife casualties.

Typical levels of training recommended for eni Ghana personnel involved in an oil spill response are provided in Table 44.

Table 44 Training Levels for Oil Spill Response

Emergency Response Role / Job Title	Oil Spill Incident Response Personnel Course			
	IMO Level 3	IMO Level 2	IMO Level 1	Requirement
ER Manager (Managing Director or Deputy)	✓			Recommended
ER Coordinator	✓			Recommended
Logistic Manager	✓			Recommended
HSE Manager	✓			Compulsory
Environmental Department Head	✓			Compulsory
On-Scene Commander		✓		Compulsory
Eni and Contractor Oil Spill Responders			✓	Compulsory

Training Records

It is recommended that eni Ghana database is maintained containing a record of oil spill training, for all company personnel who have attended training (or participated in oil spill response exercises).

Recommended Exercises

It is recommended that eni Ghana exercises the procedures and systems outlined in the OSCP. The various components may be practised separately to minimise disruption to normal operations. As well as improving people’s skills and maintaining their awareness, exercises would provide management with an opportunity to assess equipment, familiarise personnel with their roles, measure performance, obtain feedback from participants, update and correct the contingency plans and give a clear message about the company’s commitment to oil spill prevention and response.

Exercises may involve any or a combination of the following:

- Oil Spill Contingency Plan orientation;
- Table top scenarios for the ERT;
- Notification procedures and callouts;
- Equipment deployment;
- Workshops on specific aspects of response, e.g. health and safety, media management, logistics;
- Joint exercises with other oil companies and local authorities;
- Full-scale emergency management exercises.

Oil Spill Contingency Plan Orientation: best conducted as an informal workshop, which focuses on familiarising with roles, procedures and responsibilities. The aim is to review each section of the plan, encourage discussion and make useful and practical improvements to the plan by using local knowledge and expertise.

Tabletop Exercise: uses a simulated oil spill incident to test teamwork, decision-making and procedures. The exercise needs to be properly planned with a realistic scenario, clearly defined objectives for participants, exercise inputs, and a well-briefed team in control of the running and debriefing of the exercise. A tabletop exercise will typically last from 2-8 hours.

Notification and Callout Exercise: practises the procedures to alert and call out the oil spill response teams. They are usually conducted over the telephone or radio, depending on the source of initial oil spill report. Callout exercises test communications systems, the availability of personnel, travel options and the ability to transmit information quickly and accurately. This type of exercise will typically last 1-2 hours and can be held at any time of the day or night.

Equipment and Personnel Deployment Exercise: Exercises or deployments for the marine terminal or joint deployment exercises with the ERT may be simply designed to give personnel a chance to become familiar with equipment, or they may be a part of a detailed and specific emergency response scenario where maps, messages, real-time weather and other factors can be included. Exercises are designed to test or evaluate the capability of equipment, personnel or functional teams within the wider oil spill response. Teams could be located at different places in the field with each team practising different skills. This type of exercise also verifies the availability of oil spill response equipment and that it is in good working order. In deployment exercises the level of difficulty can be varied by increasing the pace of the simulation or by increasing the complexity of the decision-making and co-ordination needs. A deployment exercise would typically last from 4-8 hours. It is recommended that these exercises are carried out every 6 months.

Full-Scale Incident Management Exercise: provides a realistic simulation by combining all of the elements of the tabletop exercise (maps, communications, etc.) as well as the actual mobilisation and deployment of related personnel and equipment. This complexity requires the response to be more integrated and co-ordinated than in basic tabletop or deployment exercises. The effort and expense in organising a realistic full scale exercise means that it is recommended that they be run only once every three years. It may also be cost effective to run full-scale exercises in partnership with other organisations in the local area.

Full-scale exercises can create a very intense learning environment that tests co-operation, communications, decision making, resource allocation and documentation. People involved in full-scale incident management exercises should have attended earlier tabletop exercises. Organising a realistic full-scale exercise could take many months, requires an experienced planner and a large support team to run the exercise. They generally last at least one day and often carry on overnight into a second or third day.

Training and Awareness – Site Induction

All Contractor employees and subcontractors involved in the project will be given a comprehensive induction before they start work. This environmental training will take place in conjunction with safety awareness training. The environmental aspects will include:

- An overview of the Environmental Management Plan, goals and objectives.
- Awareness in relation to the risk, consequences and methods of avoiding noise pollution, hydrocarbon spills, disturbance to wildlife and disturbance to fisher-folk on the high sea.
- Awareness of individual environmental responsibilities and environmental constraints to specific jobs.
- Location and sensitivity of the proposed OCTP Block project.

All personnel who have attended the Environmental Induction will sign a Register which will be kept on the Project Files. Toolbox talks, based on the specific activities being carried out, will be given to personnel by the nominated project representative. These will be based on the specific activities being carried out. These talks will take place either on the appropriate off-shore vessel or on-site and will include environmental issues particular to the proposed OCTP Block Project, namely:

- Hydrocarbon spill prevention offshore including safe refuelling practice.
- Emergency response procedures used to deal with hydrocarbon spills.

ANNEX D – LEGISLATIVE AND REGULATORY FRAMEWORK

INTERNATIONAL CONVENTIONS

Ghana is a signatory to following international conventions;

- MARPOL 73/78 (Annex I&II);
- Convention on Civil Liability for Oil Pollution Damage (CLC 1992);
- Protocol Of 1992 To Amend The International Convention On The Establishment Of An International Fund For Compensation For Oil Pollution Damage, 1971 (Fund 1992); and
- United Nations Convention on the Law of the Sea (1982).

International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)

The Convention includes regulations aimed at preventing and minimising pollution from ships, both from accidental pollution and from routine operations. There is a requirement for ships to have a SOPEP, in accordance with IMO guidelines and approved by the government of the state under whose authority the ship is operating.

The SOPEP must include

- Procedures for reporting oil pollution incidents;
- List of authorities and persons to be contacted in the event of an incident;
- Detailed description of immediate action to be taken to reduce or control discharge of oil following an incident;
- Procedures and point of contact for co-ordinating spill response actions with national and local authorities

MARPOL 73/78 also provides guidelines for reporting pollution incidents to the authorities and outlines standard reporting procedures. However, most countries have developed their own national guidelines which must be used when reporting an oil spill incident.

Compensation and Liability Conventions

Ghana is a signatory to CLC 92 and Fund 92 providing a higher level of compensation. The Convention on Civil Liability for Oil Pollution Damage (CLC 1992) deals with compensation for damages from spills of persistent crude and fuel oil from tankers. It does not cover oil spills from offshore installations.

Eni Ghana does not have any oil tanker interests, however if an incident occurs in the Ghanaian Exclusive Economic Zone there may be strong business, political and ethical reasons for eni Ghana to play an active role in the oil spill response.

The United Nations Convention of the Law of the Sea (1982)

The United Nations Convention on the Law of the Sea (1982) also referred to as the Law of the Sea Convention or the Law of the Sea treaty, is the international agreement that defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine resources. UNCLOS came into force in 1982.

REGIONAL CONVENTIONS

Abidjan Convention

Ghana is a contracting party and has ratified the Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (the Abidjan Convention) and its Protocol Concerning Co-operation in Combating Pollution in Cases of Emergency. The provisions cover the development of legislation and contingency plans, exchange of information, reporting of incidents and mutual assistance. The Emergency Protocol describes how governments in the region should work towards co-operation in responding to marine pollution incidents, including oil spills.

NATIONAL LEGISLATION

The EPA Act 490 designated the Minister for Environment & Science responsible for the implementation of the National Oil Spill Contingency Plan (NOSCP) and enforcement of relevant laws relating to the protection of the Marine Environment, inland waterways including Lake Volta, and terrestrial eco-systems.

National Response System

A Model National Response System to oil spills comprises of the following:

- National Competent Authority (NCA);
- National Contingency Plan (NCP);
- National Notification Point(s).

This comprises of the following:

- Emergency response staff that are trained and exercised;
- Emergency equipment for salvage, search & rescue and counter pollution;

- National budget:

  a) The lead agency is the Environmental Protection Agency (EPA), which works in conjunction with the Ministry of Transport & Communications. The Chief of Naval Operations would provide the On-Scene Commander (OSC) to coordinate military involvement in reconnaissance and clean-up.

  b) A NOSCP has been issued. Containment and recovery is reported as the preferred response strategy. Dispersant use is permitted in some cases. The risk assessment reports the high risk of shoreline oiling due to onshore winds.

  c) The National notification point for oil spills is the Operations Room, Navy Headquarters, Burma Camp, Accra. Alternatively notification may be made via Coast or Port radio to the stations at Tema or Takoradi.

  d) IMO Model Training Courses have been conducted with the relevant agencies. The IMO/IPIECA Global Initiative program has also been actively raising the awareness and capability of both Government and Industry up to IMO Level 3 standard.

  e) The Ghana Ports & Harbour Authority have two tugs in Tema and one tug in Takoradi fitted with booms, skimmers and temporary storage for recovered oil*. Also some vacuum trucks are also available. Military sources under the control of the OSC would provide aircraft for surveillance and monitoring duties. (*information source slightly out of date, accuracy to be confirmed).

Ghana National Oil Spill Contingency plan

Ghana has documented a NOSCP which covers minor and major spills for both coastal and inland waters. The NOSCP details the government response to a spill, reporting requirements and in the case of an oil spill not having an owner, the oil spill response. The NOSCP requires the government to have sufficient oil spill equipment to respond to an oil spill of 25,000 tonnes. This equipment is based at the Tema Port.

Detailed in the NOSCP and the National Oil Spill Strategy Document, the Ghanaian government expects industry to fulfil the following requirements and responsibilities:

- prevent possible oil spills during normal operations;

- Develop and maintain oil spill contingency plans appropriate to their industry, location and risk profile;
- Provide, at least, an initial response to oil spills they are responsible for, and more if practical;
- Develop, actively promote and audit an oil spill prevention philosophy and practice to a high standard among all those associated with handling oils;
- Develop and maintain approved, site-specific OSCPs, including:
  - identifying locally sensitive environments;
  - identifying a means to rescue and rehabilitate oiled wildlife;
  - nominating suitably qualified persons to act as the industry representative to the National Oil Spill Centre.
- Develop and maintain an operational response capacity to oil spills, as specified in the site OSCP;
- Ensure the safety of industry personnel;
- Be a party to the national response effort as agreed to in the NOSCP;
- Assist the National Oil Spill Centre with the salvage, storage, disposal and recycling of recovered oil;
- Assist the Oil Spill Centre as required with skills, resources and expertise; and
- Support Role to the National Competent Authority.

Support Role to the National Competent Authority

The role of eni Ghana is to support the National Competent Authority (i.e. EPA) towards the successful conclusion of any oil spill with eni Ghana interest.

- In cases where eni Ghana holds the lead response organisation role (100% interest), eni Ghana will employ all such reasonable dedicated and opportunity combat resources as are available by company access, mutual aid, contract or opportunity (market) to mitigate the impacts of the oil spill.
- In cases where eni Ghana does not hold the lead response organisation role i.e. third party spills; eni Ghana must be prepared to offer proactive support to help remedy the emergency situation. Proactive support includes offering all such resources available to eni Ghana that would be considered for stand-by/mobilization if eni Ghana held the lead response organisation role. Proactive support will stop short of taking overall command.

ANNEX E – ENI HEALTH, SAFETY & ENVIRONMENTAL (HSE) GUIDELINES

eni ghana exploration
and production ltd

Health, Safety & Environmental (HSE) Guidelines

GUIDELINES

eni ghana is committed to guarantee a sustainable Exploration & Production of Oil & Gas in Ghana by applying its best standards in order to achieve and maintain excellence in all aspects of its operations. As a responsible corporate citizen, the Company recognizes and accepts a duty to conduct its operations in such a way that protects the health and safety of its employees, contractors, visitors, and the general public, while preventing pollution and minimizing any adverse effects on the environment and the greater community.

The Company shall, in all of its operations and in all of its locations where work is being carried out under its control, promote the highest standards for the protection of health, safety & and the preservation of the environment.

PRINCIPLES

The Company's HSE Guidelines are based on the following principles:

- To comply with the appropriate legal requirements of the Republic of Ghana, including but not limited to the upstream rules and regulations for oil & gas exploration and production activities, as well as other requirements which eni ghana voluntarily subscribes to, and those international standards which the Company intends to follow.
- To adopt and be fully compliant with all the eni s.p.a Policies.
- To prevent illness and injury and promote both health & safety of the Company staff, Contractors and Subcontractors and other persons involved in the Company business activities.
- To minimise/avoid workplace incidents and continuously improve the Company's HSE performances.
- To prevent pollution and minimise any negative impacts on the environment.
- To take into account the social impact of the Company's business activities.
- To be fully prepared to respond to any HSE emergency event.
- To promote a culture in which all employees of the Company share this commitment.
- To manage Health, Safety,Environment and Sustainable Development issues in the same manner as any other critical business activities.

METHODS

In order to guarantee the practical application of these principles, the Company shall:

- Identify, evaluate and manage risks for both human health and environment from the Company's operations and take appropriate and timely actions.
- Establish accountability & responsibility for Health, Safety, Environment and Sustainable Development within the organization and its management.
- Ensure that its contractors and their HSE Management Systems are in line and consistent with this document.
- Provide HSE awareness training to all personnel and promote the exchange of experience and information and encourage the active involvement of employees in the management of HSE aspects.
- Include HSE performances in the appraisal of all staff.
- Maintain externally certified Health, Safety and Environmental Management Systems.
- Take into account the expectations of local community stakeholders in the Environmental Impact Assessments of all new operational activities.
- Require and fully support its staff to intervene and stop an activity in case they believe it is unsafe or fails to meet the Company's HSE Guidelines.
- Measure, appraise and report on HSE and Sustainable Development performances and implementation of the HSE Management System and ensure adequate feedback of information in order to facilitate continuous improvement.
- Establish and maintain, effective Emergency Response Plans (ERP's), where appropriate, in conjunction with the competent local authorities.

In this way the Company aims to ensure and maintain the highest level of HSE standards and performances and to be proud of, to earn the confidence of its stakeholders and society at large, and to promote Sustainable Development.

This document shall be reviewed at least every 12 months or when considered necessary to verify its on-going relevance and adequacy in light of changes in the nature and scale of the Company's activities, legal and other requirements to which the Company subscribes, and the expectations of the Company's stakeholders.

Fabio Cavanna

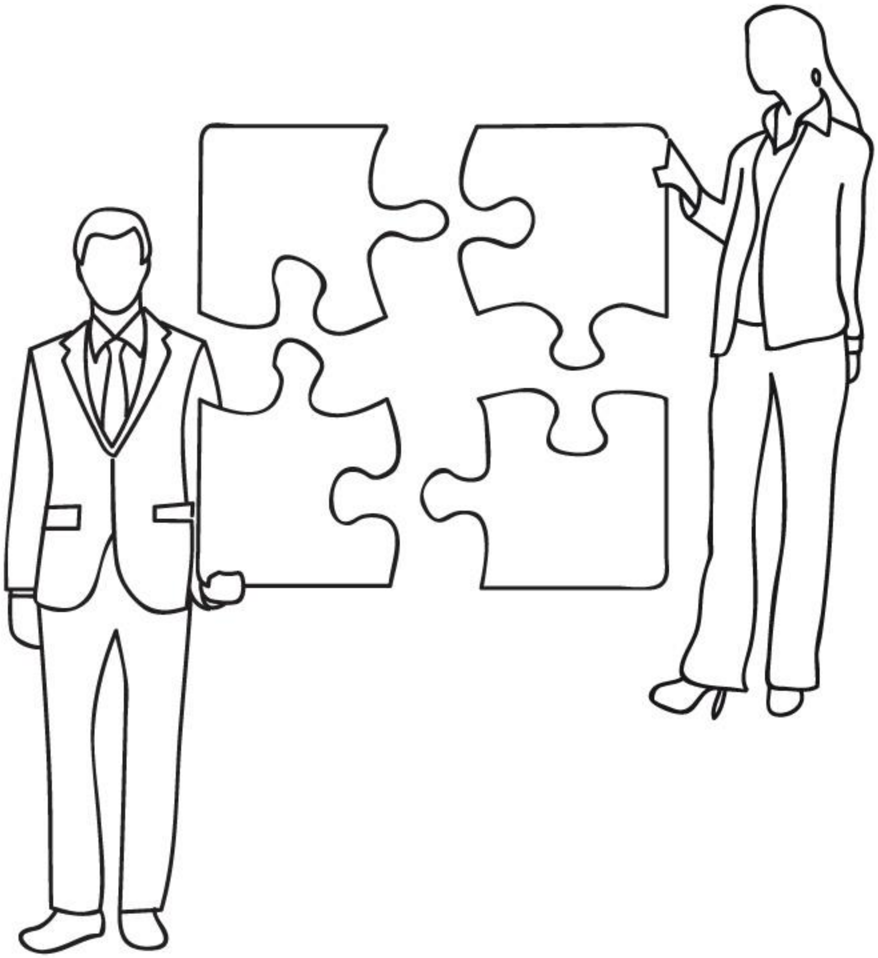
Managing Director **March 2013**

ANNEX F – ENI REFERENCES UTILISED

- Eni GHANA OCTP DEVELOPMENT PROJECT BASIS OF DESIGN (Company Document ID 351400FGRB09400)
- Eni GHANA OCTP DEVELOPMENT PROJECT HAZID Reort (Company Document ID 351400BFRB09952)
- Eni GHANA OCTP DEVELOPMENT PROJECT SSIV (Sub Sea Isolation Valve) Study (Company Document ID 351400BFRF09501)
- Eni GHANA OCTP DEVELOPMENT PROJECT BLOWOUT AND DYNAMIC KILLING STUDY IN THE GHANA OCTP BLOCK (Company Document ID 000000AAAA00000)
- Eni HSE-PLAN-003 "DRILLING OIL SPILL CONTIGENCY PLAN – OCTP Block" rev.02
- Eni Ghana OCTP Block Phase 1 Environmental Social and Health Impact Assessment (ESHIA) (Doc. 000415_DV_CD.HSE.0208.000_00)
- Eni Guidelines for Oil Spill Contingency Planning Process (opi sg hse 013 e&p r01)

Plan

HSE-PLAN-001 “HSE Plan”



TITLE:		
HSE Plan		
NOTE:		
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PREPARED BY:	**CHECKED BY:**	**APPROVED BY:**
Maame Bartels-Kodwo *HSE Engineer*	Francesco Manglaviti *HSE & Comm. Inv. MGR*	Fabio Cavanna *Managing Director*

eni

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REVISION SHEET

Rev.	Date	N. pages	Change Description	Prep.	Ver.	Appr.
3	15/03/2013	16	Annual revision and template change	M. Bartels-Kodwo	F. Manglaviti	F. Cavanna
2	18/12/2011	12	Annual revision	F. Manglaviti	F. Manglaviti	F. Conticini
1	18/11/2010	12	Annual revision	F. Manglaviti	F. Manglaviti	F. Conticini
0	30/08/2010	9	First Issue	F. Manglaviti	F. Manglaviti	G. Moscato

CONTENTS

1. Purpose

The purpose of this Plan is to define strategic HSE objectives and HSE performance targets of eni Ghana exploration and production limited, as well, the key actions, resources, organization and schedules to achieve them. The HSE Plan represents the application of the Company HSE Guidelines and Protocols to the scope of the Company's operations and activities in the Republic of Ghana.

Specifically, this Plan defines the:

- HSE objectives;
- HSE performance targets for 2013.
- Actions, roles & resources required.
- Performance monitoring & reporting process.

The target audience for this document is eni Ghana Exploration and Production Limited staff. The Company's Contractors are also asked to ensure that their HSE objectives and targets reflect, or better, those defined in this Plan.

2. Basis

The Company is obliged and committed to complying with all of the HSE related laws of the Republic of Ghana, the HSE related conditions of the Agreement between the Company and the Government that pertain to our activities, and the obligations imposed by our stakeholders.

The above mentioned requirements are cascaded into the organization via the Company's Guideline, Protocols, Standards, Procedures and all the other HSE Management System documentation.

This HSE Plan sets out the key actions and responsibilities for meeting and tracking compliance with these requirements.

The HSE requirements of the Petroleum Commission, Ghana National Petroleum Corporation (GNPC), the Environmental Protection Agency (EPA), and all applicable laws and regulations shall be fully complied with during the performance of the eni Ghana operations. This Plan has been revised and updates based on the outcomes of the management review and will be revised at least **annually** through to project completion, demobilization and site restoration.

3. Operations

Following the farm-in executed on September 22nd 2009, the Company completed the handover and transfer of operatorship, for the OCTP Block, from Vitol Upstream Ghana Limited on 31st October 2009.

On 25th October 2011 eni Ghana completed the Keta Block farm-in acquiring the operatorship of the Keta Block exploration by Afren. In 2012, eni Ghana performed 1 exploratory drilling and 1 seismic data acquisition activity in the Keta block.

The 2013 approved Work Program and Budget for eni Ghana considers inclusion in OCTP Block exploration efforts, to carry out the drilling of an additional well aimed to appraise the Cenomanian oil discover made in 2012 by the of Sankofa East-1X exploratory well .

For 2013 the following operation activities are foreseen:

- Routine logistic support for drilling operation at the Takoradi base;
- Drilling of Sankofa East-3A Exploratory well in OCTP Block by middle of April;
- In addition, the Company will reinforce its commitment to maintain its certifications in compliance with ISO 14001 and OHSAS 18001. Compliance Audit has been scheduled for October 2013.
- Continuous improvement of the defined system will be an objective for 2013 as well.

4. Strategic HSE Objectives

The Company's strategic HSE objectives are focused on achieving the commitments of our HSE Guidelines and Protocols. They reflect the risk profile for the nature and scope of our activities and those of our Contractors, as well as those expressed by our Stakeholders through their own Policies.

The strategic 4Y HSE objectives are defined directly from eni E&P division, and cascading, adopted by the Company within the HSE-PLAN-007 "HSE 4YPlan".

The 2013 HSE performance targets have been developed to enable the Company to demonstrate, in a quantitative way, positive movement towards achieving each strategic objective. The performance targets are set **annually** to allow values to be agreed each year that are realistic but challenging in light of the prevailing technical, economic, legal and operational environments.

5. HSE Targets

Below are the target overview foreseen for 2013.

Key Performance Indicator (KPI)	**Unit**	**2011 Target**	**2012 Target**	**2013 Target**
LAGGING INDICATORS				
Worked Hours (eni Ghana staff + contractors)	**Hours**	**-**	**-**	**1,000M**
Total Recordable Injury	**No.**	**-**	**1**	**1***
Lost Time Injury Frequency (LTIF) (per million WH)	**Rate**	**1.54**	**-**	**1***
Total Recordable Incident Rate (TRIR)	**Rate**	**7**	**-**	**-**
Fatal Accident Rate (FAR) (per 100 million hrs)	**Rate**	**0**	**0**	**0**
Lost Time Occupational Illness Frequency (LTOIF)	**Rate**	**0**	**0**	**0**
Total Recordable Occ. Illness Frequency. (TROIF)	**Rate**	**0**	**0**	**0**
Lost Workday Cases (LWDC)	**Days**	**28**	**28**	**28**
LEADING INDICATORS				
Non conformances closed/non conformances opened	Rate	0.70	0.75	0.80
Non conformance opened	No.	N/A	20	25
PA/CA closed timely manned / # Actions	Rate	0.70	0.75	0.80
% Audit planned vs achieved 100* (not including cert. audits)	%	100	100	100
Chopper average passengers on-board	p/t	4.81	4.90	5.15
m3 industrial waste produced / # days of activities	m3/d	2.45	2.35	0.45
Hours of training performed *1000 / # man-hours	Rate	1.40	0.8	0.8
Number of oil spill exceeding 1 bbl	No.	0	0	0

Conduct Field Medical inspections on Company (or potential) facilities	No.	1	1	1
HSE Steering Committee - held regular monthly meetings.	No.	10	10	5**
Fitness to Work Assessments on Company staff completed	%	100	100	100
Conduct Management Lead HSE Inspections (rig and TKD Base)	No.	2	4	20***
Conduct Emergency Response exercises	No.	2	2	1+1
Obtain timely EIA approval from the respective authority (Sankofa East 3A)	Date	Jan	March	March
Complete the 50% of the 2013-14 Training matrix	On/off	-	-	

* 1 LTI occurred on 8th January 2013

** Agreement to have HSE SC on a bi-monthly bases

** Formalized through the HSE Leadership W/I

In order to ensure that there is no confusion regarding the final assessment of performance against the planned targets, each **Lagging Indicator** KPI is defined below:

Lost Time Injury Frequency (LTIF)

The sum of Fatalities plus Lost Workday Cases per million man-hours worked.

Total Recordable Incident Rate (TRIR)

The sum of Fatalities, Lost Workday Cases, Restricted Workday Cases and Medical Treatment Cases per million man-hours worked. It does not include First Aid Cases.

Fatal Accident Rate (FAR)

The number of fatalities per 100 million man hours worked.

Lost Time Occupational Illness Frequency (LTOIF)

The sum of all occupationally related illnesses per million working hours.

Total Recordable occupational Illness Frequency (TROIF)

The sum of all occupational illnesses whether or not they have resulted in deaths, Lost Workday Case, or Restricted Workday Case per million working hours.

Road Traffic Accident Frequency (RTAF)

Total number of road traffic accidents that result in either an injury or more than $1,000 in asset damage per million kilometers driven.

Lost Workday Case Severity (LWDCS)

The sum of any work related injury other than a fatal injury which results in a person being unfit for work on any day following the day of occurrence of the occupational injury. "Any day" includes rest days, leave days, weekend days, public holidays, or days after ceasing employment per million working hours.

6. Strategy

The Company to achieve the HSE objectives and performance targets,shall act for a continuous development & implementation of a rigorous HSE Management System (HSE IMS).

Also for 2013, all potential hazards to HSE related to the Company's operations to be performed by eni Ghana and its Contractors shall be systematically identified, the associated risks assessed and appropriate preventative controls & recovery measures implemented to reduce the risk to a pre-determined acceptable level by:

- A constant involvement of all Company and contractors managerial levels;
- Identifying all HSE hazards, assessing the related risks, & defining the minimum controls to reduce the risks to below that of the Company's risk tolerability Standard (i.e. the ALARP position).
- Defining Minimum Standards of performance for all "high risk" activities, plant & equipment (i.e. HSE Standards).
- Communicating our requirements and expectations to all staff and Contractors, and assisting them to meet these via advice and training.
- Application of a Contractor HSE Management process from pre-selection through contract award and mobilization, execution and demobilization.
- Constant monitoring via audits, inspections and reviews to assure that the primary preventative controls & recovery measures defined against all major HS risks and significant environmental aspects are functioning effectively.
- Investigating the factors and causes that lead to unsafe situations or incidents and making changes to prevent the likelihood of recurrence.

7. Critical Success Factors

There are a number of factors which are seen to be critical to the success of the Company in implementing the strategy and move towards the performance targets in the specified timeframes. These are:

- Managerial commitment;
- Informed involvement by the Management Team
- Regular & fully attended HSE SC
- Fully staffed organization
- Employees commitment
- Contract Holder commitment
- Regular 'face to face' meetings
- Integrated Operations & HSE
- Approved budget

8. Organization and Resources

The Company recognizes that to achieve the HSE targets, investment is required, therefore, adequate human and financial resources to execute this Plan will be provided by the Company. Budget allowance will be made to ensure that activities specified within this Plan are able to be completed on time given the concurrent work activities and operational programme.

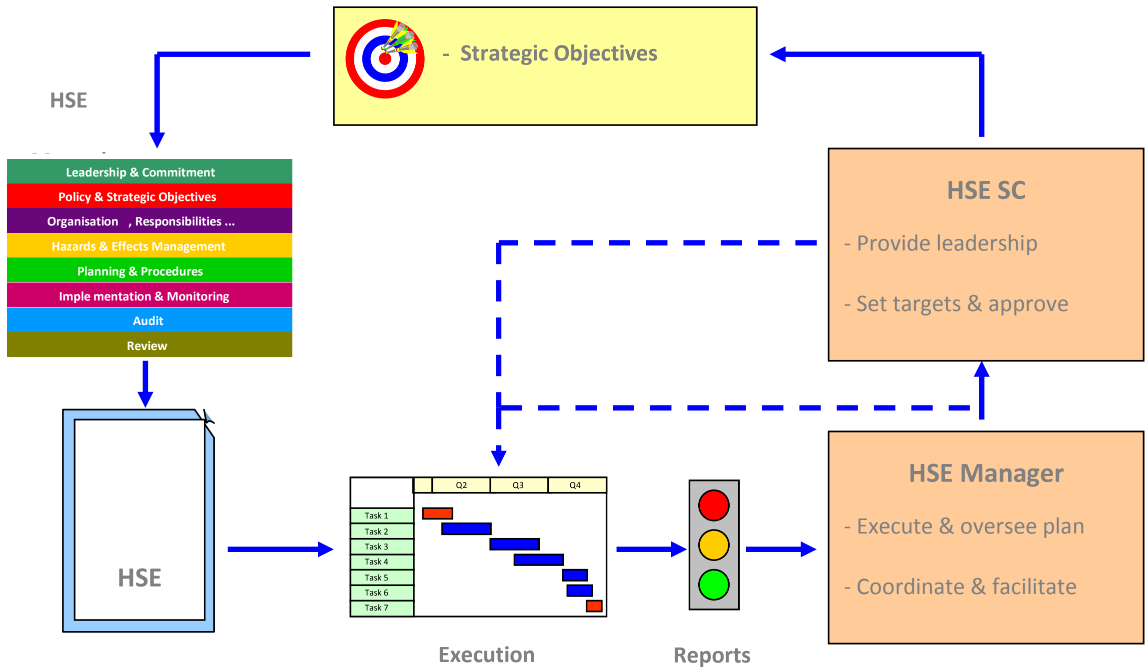
The Company dedicated HSE budget items include but are not limited to:

- HSE professionals
- External service providers
- Training
- Conferences & meetings
- IT hardware & software
- Videos & publications

- Equipment, facilities & tools
- Travel & mission expenses
- HSE IMS Certification

The HSE Manager will efficiently coordinate the implementation of this HSE Plan under the oversight and direction of the HSE Steering Committee (HSE SC) chaired by the MD. The HSE Manager will report progress to the MD and to the HSE SC on a monthly basis.

Organization and Resources Diagram



9. HSE Steering Committee

The highest level forum in the Company dedicated to HSE issues is the HSE Steering Committee (HSE SC). The HSE SC is composed of the Company senior managers including the HSE Manager who will act as the secretary.

The mission of the HSE SC is to:

- Involve all departments in the achievements of the strategic objectives;
- show leadership on HSE issues;
- demonstrate commitment to HSE Policy;
- provide oversight of the HSE Plan.

The aims of the HSE SC are to:

- Sponsor effective implementation of the HSE Plan.
- Monitor execution of the HSE Plan.
- Identify problems and issues that could be better resolved collectively.
- Ensure appropriate resources (staff, funding, etc.) are available to achieve objectives.
- Review incident investigations & make recommendations.
- Undertake annual review of the HSE Policy & HSE performance against target.

9.1 HSE & Comm. Inv. Steering Committee Participation

MD	**EXPL M**	**WOPs M**	**HRO M**
HSE&S M	**PROC M**	**FIN M**	**LOG M**
	BDM	**HEA M**	

9.2 Other meetings

Other meetings are held on the regular basis:

Meetings	Who	Frequency
Management meeting	MD & line managers	Weekly
Operations	EM, WOM, HSEM	If required
Toolbox Talk (TDI base)	Takoradi base staff (incl. Visitors, if any)	As per working instructions
HSE daily meeting	All others operational sites (e.g. off-shore)	Daily
HSE Management Review	Management Team	Annually

10. Audits and Inspections program

The audits foreseen for the 2013 are listed below. Any modification/revision of the program will be reported on the system document: HSE-PROG-001 "Audit Program 2012-2014".

2013												
Audit Type	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
HSE Internal Audits				X					X			
HSE Contractors Compliance Audit		X			X							
External Audits - Certifications ISO 14001 & OHSAS 18001										X		

11. HSE Leadership visits

HSE Leadership visits are not audits, inspections or technical reviews. Visits should address the ‘’people’’ aspects of workplace HSE through discussion with a range of staff to establish their familiarity with HSE procedures and requirements. They are also an opportunity for management to engage dialogue with employees and contractors and extract valuable learning from the ‘’end user’’ of the Organisation’s processes and procedures.

Trip to area of operations for the purposes of:

- Addressing HSE issues;
- Gaining direct feedback from people of any problems & concerns;
- Understand first-hand the nature of problems, issues or concerns;
- Demonstration to all employees and contractors of Senior Management commitment to HSE matters;
- Support HSE culture development.

A minimum twenty (20) trips, to be formalized through the HSE-INSTR-006 “Management HSE leadership visits” are foreseen for 2013, to eni Ghana Operational Sites. Trips will be facilitated by the HSE Manager.

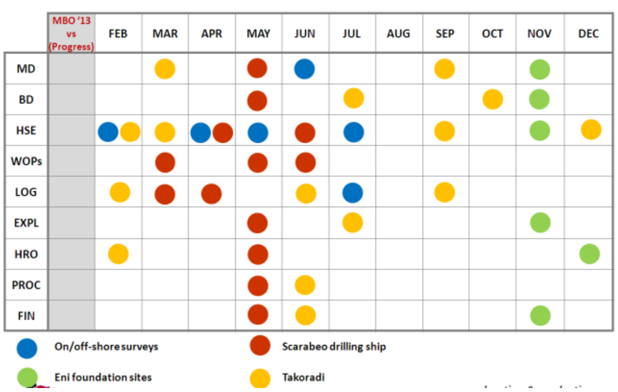


Figure 1 - Sample of Management HSE Leadership schedule

12. Training Program

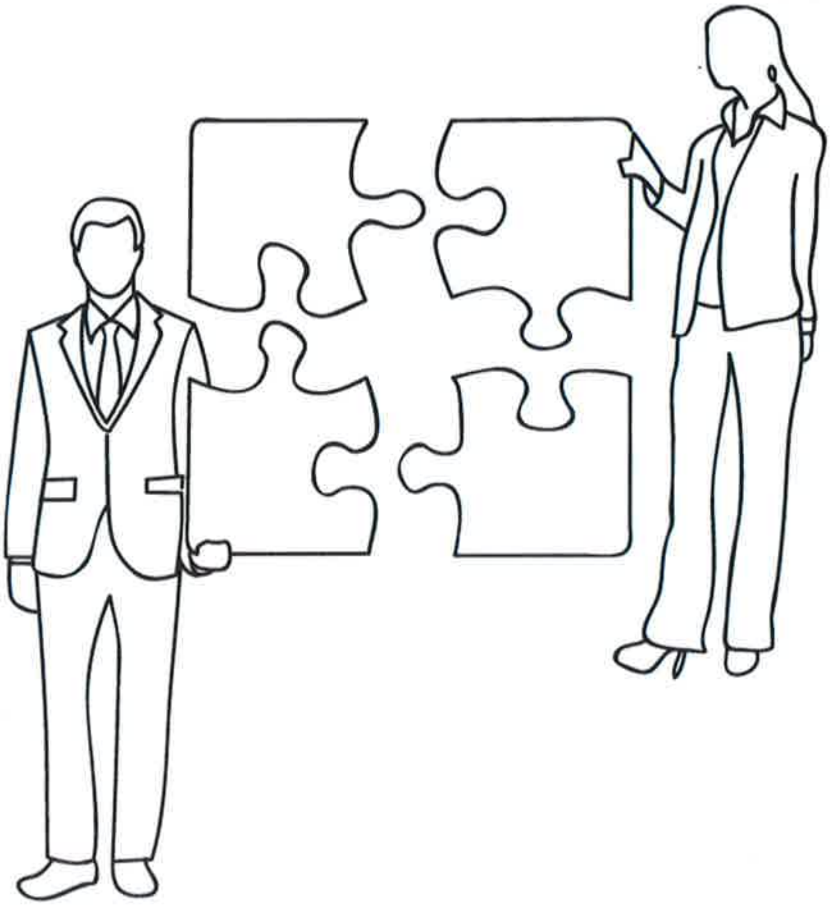
The HSE SC will determine dates and attendants to the training program. Details are contained in the Training Matrix document: HSE-PROG-002.02.

Additional HSE course have been scheduled for the Takoradi base personnel as per follow:

- Lifting operations dedicated training;
- Fire-fighting reinforcement course;
- Hazardous work-environment;
- Dedicated training on Transport of Dangerous Goods for the Aviation & Transport Superintendent;
- Dedicated training on safety in electrical and other services for the General Services Officer.

Plan

HSE-PLAN-005 "Waste Management Plan"



HSE-PLAN-005 – Waste Management Plan
rev.05

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Waste Management Plan

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To be consider as uncontrolled copy once downloaded from intranet

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PREPARED BY:	CHECKED BY:	APPROVED BY:
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For information:

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5	28/04/2015	35	Iclude WB/IFC comments and suggestions	M. Bartels-Kodwo	J. Deffis	F. Cavanna
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3	27/01/2012	16	Annual revision	F. Manglaviti	F. Manglaviti	F. Cavanna
2	6/05/2011	12	Annual revision	F. Manglaviti	F. Manglaviti	F. Conticini
1	21/01/2011	12	Annual revision	F. Manglaviti	F. Manglaviti	F. Conticini
0	04/12/2009	9	First Issue	F. Vacas	F. Vacas	G. Moscato

CONTENTS

1 PURPOSE

This document details the overall strategy adopted by Eni Ghana for the management of waste to be generated during the course of conducting offshore and onshore operations (rigs, seismic, charter vessels, onshore support facilities). It covers collection, storage, treatment, transport, disposal, discharge, reporting and data management.

Activities identified as generating waste should have an individual Waste Management Plan (WMP). These WMPs will include site-specific procedures detailing exactly how waste is to be managed, treated and disposed-of. The WMPs should identify the waste stream, point of generation and handling procedures. It should define the approved waste handling contractors, final disposal sites and provide with guidelines for the management of Duty of Care tracking system and site audits and inspections program.

2 SCOPE OF APPLICATION

This document covers the following disciplines:

Health	Safety	Environment
✓	✓	✓

This procedure applies to activities in all eni Ghana locations/sites for the waste management activities.

3 REFERENCES

3.1 External References

[Rif.A1]	*Organization of the Health, Safety, Environment and Public Safety Integrated Management System P n. 1.3.0.1*
[Rif.A2]	*"Standard", eni E&P Document Number 1.3.4.05 - "Waste, wastewater, tenorm and drilling residues management" except wastewater (*)*

3.2 Internal references

[Rif.B1]	*"HSE Manual", eni Ghana Document Number HSE.MAN.001*

3.3 Compliance With Statutory Regulations

General Waste Management in Ghana is the responsibility of the Ministry of Local Government and Rural Development, which supervises the decentralized Metropolitan, Municipal and District Assemblies (MMDAs). However, regulatory authority is vested in the Environmental Protection Agency (EPA) under the auspices of the Ministry of Environment and Science. The Metropolitan, Municipal and District Assemblies are responsible for the collection and final disposal of solid waste through their Waste Management Departments and their Environmental Health and Sanitation Departments.

The legislation guiding the management of hazardous, solid and radioactive waste is scattered amongst a range of Acts and policies, including the Local Government Act (1994), Act 462, the Environmental Protection Agency Act (1994), Act 490, the Pesticides Control and Management Act (1996), Act 528, the Environmental Assessment Regulations 1999, (LI 1652) the Environmental Sanitation Policy of Ghana (1999), the Guidelines for the Development and Management of Landfills in Ghana, and the Guidelines for Bio-medical Waste (2000).

4 ACRONYMS

E&P	Exploration & Production
HSE	Health, Safety, Environment and Public Safety Integrated Management System
BAT	Best Available Techniques
IMS	Integrated Management System
BAT	Best Available Technology
ALARP	As low as Reasonable Practicable
DOT	United States Department of Transportation
IMDG	International Maritime Dangerous Goods Code
MSDS	Material Safety Data Sheets

5 DEFINITIONS

Hazardous Waste	Any material that, because of its quantity, concentration, or physical or chemical characteristics, may pose a real hazard to human health or the environment.
Waste	Any material which is introduced into the work location as a product of the work but which fulfils no further useful purpose, at the location.
Discharge	Any controlled and regulated release of wastewater or liquid waste to surface water bodies
Disposal	Any waste management operation different from reuse, recycling, treatment and discharge, even where the operation has as a secondary consequence, the reclamation of substance or energy.
Treatment	Any operation, including reprocessing, that makes the waste suitable for recycling or disposal by reducing its contaminant load and/or changing its chemical-physical properties
Recycling	Any operation by which waste materials are reprocessed into products,

	materials or substances whether for the original or other purposes
Reuse	Any operation by which by [residual] product or component that are not waste are used again for the original or other purposes without reprocessing

6 WASTE MANAGEMENT GENERAL PRINCIPLES

All waste resulting from Operations and other activities will be managed to ensure protection of the natural environment and the health and safety of personnel and the community – Refer to Decision Making Tree. Waste management activities will be performed in accordance with the following waste management hierarchy principles to:

- Reduce the quantity by better management.
- Re-use materials where possible
- Recycle where feasible.
- Recover as much as possible.
- Responsible disposal

Waste minimization and the application of these principles shall be addressed in the Contracts and Procurement Execution Strategies for the project and taken into consideration when reviewing shipping, storage and disposal method throughout the project life span.

6.1 Duty Of Care

Eni Ghana recognizes that it has a duty to ensure that any waste it generates is handled safely and in accordance with local regulations and Company Policies. Eni Ghana recognizes his responsibility to ensure the safe and proper collection, transportation, treatment and final disposal or recovery of waste that it generates.

6.2 Waste Identification And Classification

For all waste, both hazardous and non-hazardous, a risk assessment will be carried out by the Waste Handling Contractor with the support of the HSE&CI Department as required, to properly identify and classify each waste generated. Once identified, the proper waste handling techniques should be defined to determine on the manifest and provide appropriate handling guidance.

The HSE&CI Department should be consulted in the event that new waste streams are identified by Rig, Contractor, etc ensure that all relevant risks are assessed and appropriate storage and disposal options are provided. The risk classification will be included in any relevant waste documentation. Any unidentified wastes will be quarantined and investigated until an appropriate disposal option is identified.

6.2.1 Hazardous Waste

Waste that exhibit one or more of the characteristics such as ignitability, corrosivity, reactivity, toxicity, which are mutagenic, teratogenic, infectious, irritant, carcinogenic, ecotoxic and non-biodegradable, flammable and highly flammable, explosive, e.g. which can be harmful to health and can cause damage to the environment (land, water contamination, air pollution). The following table lists hazardous waste examples and their sources in the oil industry.

Waste	Activity	Hazardous content
Batteries	Various	Heavy metals, acid, alkali, cadmium
Cement spacers	Cement chemicals	Metals, thinners, viscosifiers, pH salts
Oily contaminated material	Spill, leaks, bunkering errors, rig wash	Hydrocarbons, detergents
Dispersants	Spill clean up	Surfactants
Drilling fluid chemicals / completion fluids	Drilling	Biocides, surfactants, metals, emulsifiers, viscosifiers, organics, salts
Fire fighting agents	Fire fighting	Dry chemical powder, chemical foam and CO_2
Synthetic oil based mud	Vessel tank cleaning / Drilling	Linear Alpha Olefins and mud additives
Incinerator ash	Burn box	Heavy metals, salts, ash
Clinical waste	First aid and	Pathogenic Organisms, Plastic, Glass, Medicines,

	medical support. Sharps and softs.	Needles, Dressings, Cleaning Materials Etc, Blood
Mercury	Instruments, production test	Mercury
Stimulation fluids	Well stimulation	Acids, hydrocarbons, methanol, corrosion inhibitors, oxygen scavengers, formation fluids, gelling agents
Unused chemicals	Drilling	Various mud chemicals
Waste lubricants	Equipment lubrication	Contaminated hydrocarbons
Office waste	Printing material	Cartridges, and toner

Table 1 – Hazardous Waste and Sources

In addition, special hazardous waste categories include:

- **Biohazards** such as medical waste, (sharps e.g. syringes, scalpels & softs e.g. soiled medical dressings). See Appendix 4. Medical Waste Procedure.
- **Radioactive waste** such as Naturally Occurring Radioactive Material (NORM) or Technologically Enhanced Naturally Occurring Radioactive Material (TENORM).

6.2.2 Non-Hazardous Waste

Waste that do not exhibit any of the characteristics of hazardous waste which are biodegradable or inert and do not cause any harm to people and environment. When placed in a landfill it is reasonably expected that non hazardous waste will not undergo any physical, chemical, and/or biological changes to such an extent as to cause pollution or hazard to public health and safety. Categories of non-hazardous waste or inert waste are further classified according to their source. These are:

- **Industrial Waste.** This is defined as any non-hazardous operational waste. It includes: scrap metal, construction waste (concrete, bricks etc.), wooden pallets, plastics and cardboard packaging. It excludes materials contaminated with hazardous substances. It can also include some categories of drilling fluid components and drill cuttings and some waste from offices.

Note: There is often considerable potential for reusing and/or recycling industrial waste. This requires segregation into discrete sub-categories, e.g. scrap metal, plastics, wood, glass, general, etc.

- **Office Waste.** This includes items such as used stationary, plastics, packaging materials, printer cartridges and toner for copying machines.
- **Domestic Waste.** This category includes kitchen waste from the rig galleys, offices, operational and residential accommodation and locations, as well as refuse from general maintenance activities such as cleaning, cooking (except spent cooking oil) and gardening.

6.3 Waste Storage And Segregation

Waste storage areas will be provided for waste containers at each facility. Hazardous and non-hazardous waste will be segregated in designated storage areas. These areas are to be indicated on the facility site plan. Waste must be stored in a manner to prevent:

- Accidental spillage or leakage
- Accidental fire
- Contamination of soils and groundwater
- Corrosion or wear of containers
- Loss of integrity from accidental collisions or weathering
- Theft by people
- Scavenging by animals.

Waste storage containers will be appropriate in terms of volume, composition, shape and access for the material that is being stored. Only containers in good condition will be utilized. Bungs and lids will be securely fastened or other forms of covering shall be provided. Storage of waste will be carried out in accordance with the MSDS sheet, in a designated area, with a suitable surface and a method to contain any leakage or contaminated runoff water. Containers used shall be inert in relation to their content, clearly labelled, indicating the characteristics of the content, date of containerizing or packing, and data on toxicity and/or potential contaminant.

6.4 Container Suitability And Labelling

Prior to allowing the consignment of waste to leave an operational site, the eni Ghana HSE Department through delegation shall ensure that the waste containers are:

- Clearly labelled to describe the waste it contains – using the appropriate waste labels which should be completed in full – old labels should also have been removed to avoid confusion as to the contents of the container. Refer to Section 5.1 for Colour Coding;
- In good condition and are not leaking;
- Acceptable for shipment to avoid the need to change containers prior to shipping (e.g.: in compliance with applicable legislations on transport of dangerous goods such as : IMDG, DOT, etc.);
- Sufficiently sized to prevent overflow;
- Appropriate to the waste they contain;
- Appropriately sealed e.g., with a lid or bung;
- Not emitting any harmful gases or generating heat. This could be a sign that incompatible waste have been stored together resulting in an adverse chemical reaction.

6.4.1 Shipping Offshore Waste Container

As much as reasonably possible, the waste containers should be compliant as per ISO 1496 or EN 1279 standards, in order to ensure that the wastes are stored in fit for purpose containers.

Note: Any unidentified waste should be quarantined. If any of these have not been done or have been done to a poor standard, the waste consignment should not be allowed to leave the facility. The HSE&CI Department or responsible person should be contacted who will take all necessary corrective action(s) to rectify the situation before allowing the waste to leave the facility.

6.5 Waste Transfer Notes (WTN)

Waste Transfer Notes (Waste Transfer and Disposal Waybill) are fundamental to ensuring that waste is transferred from the producer, though transportation chain to the disposer and provide a record of due diligence and 'Duty of Care'.

It is a paper or hard copy waste consignment / transfer system, that tracks the waste stream from the point of origin to the deposit location. Transfer notes will accompany all waste consignments originating from relevant operational sites, and will be duly completed with the details required within the Waste Transfer Notes and the appropriate signatories. An example of the Waste Transfer Notes is included as Annex 1.

6.5.1 Waste coding

For accounting purpose and easily waste identification have been put in place a waste coding system as follows:

Code	Waste category	Code	Waste category
001	WBM (Only if waste)	**032**	Produced water
002	WBM Cuttings	**033**	Oily sludge
003	OBM (Only if waste)	**034**	Production slops / paraffin
004	OBM Cuttings	**035**	Spent production chemicals
005	SBM (specify synthetic base)	**036**	Oily wastes and rags
006	SBM Cuttings (specify Synth. base)	**037**	Plastic
007	Spent Brines	**038**	Wooden pallets
008	Spent non – Hazard. chemicals (list)	**039**	Mixed waste (paper, plastic, wood)
009	Spent Hazardous chemicals/cushions	**040**	Oil polluted soil/concrete
010	Milling waste	**041**	Clinic Waste
011	Cooling water	**042**	Expired medicines
012	Scrap metals: tubings	**043**	Spent Oil
013	Scrap metals: other metals	**044**	Gaskets non containing asbestos
014	Scrap metals: steel	**045**	Dismissed piping/vessels
015	Empty metal drums	**046**	Production scales
016	Empty plastic drums	**047**	Sand blasting residuals
017	Rig mixed waste (paper, plastic, wood)	**048**	Paint residuals
018	Accumulators/Batteries	**049**	Soot
019	Spent Lubricants	**050**	Spent activated carbon
020	Contaminated soil	**051**	Fluorescent lamps
021	Contaminated Concrete	**052**	Glass and bulbs
022	Other masonry waste	**053**	Refrigerating fluids containing CFC
023	Tyres	**054**	Waste containing PCB/PCT
024	Dismantled piping/vessels	**055**	Sewage water
025	Scales	**056**	Septic tanks settlings
026	Wood and Pallets	**057**	Non-food waste (detergents etc.)
027	Plastic Packaging/Wrapping	**058**	Spent cooking oil
028	Waste containing Asbestos	**059**	Food waste (except cooking oil)
029	Waste containing rock- or glass fibre	**060**	Oily water
030	Spent lubricants	**061**	Removed Vegetation
031	Filters	**062**	Unused Soil

Table 2 – Waste coding

6.6 Waste Monitoring, Inspection And Reporting

All waste producers (Operations, Contractors and sub-contractors) are required to keep a waste register and an inspection and reporting plan.

The frequency and type of inspection shall be agreed by all parties with the inspection covering all waste generating activities through segregation, handling, storage and final disposal.

A designated on-site staff member shall maintain the waste register (waste log) and copies of all consignment notes (Waste Transfer Notes) that have been produced from the site. The waste register (waste log) will be available on all eni Ghana workplaces in hard copy. The waste register shall contain a record of all waste arising. It will also serve as an index for all WTN consignments.

The Waste Register (waste log) shall include, as a minimum, the following information:

- Source of waste (eg rig, vessel, Logistics Base, etc)
- Waste description (e.g.: oily rags)
- Classification of waste streams (i.e. hazardous or non-hazardous)
- Quantity (weight (kg) or volume (lt or m3).
- Waste Transfer Note numbers
- Dates of transfer.

All reports shall be passed from the waste contractor to the HSE&CI Department for review and provide feedback to Management.

6.7 Waste Transportation, Disposal Sites – Approved Contractors

All waste shall be handled in a safe and efficient manner taking into consideration associated MSDS information (if any).

Transportation will be via well maintained, legally compliant and 'fit for purpose' vehicles, with appropriate documentation and driven by fully trained operators. Where relevant vehicle shall carry spill containment equipment.

Only approved contractors, which meet the appropriate standards will be used for transportation and disposal of waste. Site visits of disposal sites will be conducted and later inspected / audited by the HSE&CI Department, or independent consultants.

6.8 Spent Oil ,Spare Parts, Paint/ Thinner Tins From All Contractors

Spent oils, spare parts (ex. Filters, batteries, ext) and paint/thinner tins produced by rig maintenance or other 3rd party equipments, will be disposed by the producer himself that shall ensure a correct storage, transfer and disposal being able to provide evidence of this process if requested by eni Ghana.

7 DISPOSAL GUIDELINES

Waste management is an activity whereby the application of the Reduce, Reuse, Recycle principle should always apply. In effect each waste stream must be addressed to determine the optimum disposal option. The sequence for evaluation is as follows:

7.1 Waste Reduction, Disposal and Decision Tree

A key feature of this process is the need to ensure appropriate identification and segregation of waste streams. To facilitate this colour coded containers as described below will be used. The Waste Reduction, Disposal and Decision Tree, shown in Figure 1 details the overall process used for determining the most appropriate method of disposal.

General Waste	
Hazardous Waste	
Scrap Metal	
Wood	
Spill Kit	

Table 3 – Waste Management Color Coding

7.2 Drilling and Logistics Base Waste

This section covers the waste segregation instructions for drilling operations and eni Ghana Logistics Base operations

Listed in table 2 are the waste streams generated and the preferred disposal method;

7.2.1 Non-Hazardous Waste

Category	Type	Source	Transportation method	Sea transport	Storage Logistics base	Final treatment / Destination
Wood	Pallet, crate, beam, general packaging, plywood, doors, furniture	Rig/Ship/ Yard	Open skip / empty return container	Same, but cover with net	same	Reuse/Municipal Landfill
Food	Organic waste, food etc.	Rig/Ship/ Yard				Ground for discharge to sea, at base treated as general waste to landfill
General Waste	domestic waste, paper, tins, cardboard, plastic, glass; textiles (non-contaminated),	Rig/Ship/ Yard	Open skip	Same, but cover with net	same	Municipal Landfill
Metal	steel, gratings, sheet steel, iron beams, 20ubular and casings etc	Rig/Ship/ Yard	Open skip	Same, but cover with net	same	Recycle in Ghana – send to scrap metal merchant
Empty barrels	empty barrels	Rig/Ship/ Yard	Closed container or half height	same	same	Recycle (after puncturing or crushing) – send to scrap metal merchant
Top soil	from ORF excavations and trenching works	Preliminary works, earth moving, excavation	Tipping truck covered with net	no		Reuse at source
Vegetation	ORF area trimmings, felled trees, cleared vegetation, etc.	Site clearance, early works	Tipping truck	no		Reuse at source

Table 4 – Drilling – Non Hazardous Waste Handling

Note: Plastic, drums and other receptacles / containers should not be made available to locals as they could be used as potable water containers.

Because their contents could previously have included degreasers, soap, thinners and other chemicals, it is advisable to make such containers unserviceable and not to allow them to be dumped at uncontrolled landfill sites.

7.2.2 Hazardous Waste

The eni Ghana hazardous waste stream is listed below.

Type	Source Rig/Ship	Rig container	Sea / road transport method	Storage supply base	Final treatment / Destination
Battery (containing heavy metals / acid)	Rig/Ship/ Yard	Barrel	Return container	Barrel	Contractor continuous discussion with EPA to determine approved treatment and disposal
Paint and thinner (liquid)	Rig/Ship/ Yard	Barrel	Return container	Barrel	Contractor continuous discussion with EPA to determine approved treatment and disposal
Spray can/ aerosol	Rig/Ship/ Yard	Barrel	Return container	Barrel	Contractor continuous discussion with EPA to determine approved treatment and disposal
Fluorescent tube/light bulb	Rig/Ship/ Yard	Original packing	Return container	Barrel	Contractor continuous discussion with EPA to determine approved treatment and disposal
Chemical (pure)	Rig/Ship/ Yard	Barrel / tote tank/ or original packaging	Closed container or tote tank	Closed container or tote tank	Contractor continuous discussion with EPA to determine approved treatment and disposal
Chemical mixture	Rig/Ship/ Yard	Barrel / tote tank/ or original packaging	Closed container or tote tank	Closed container or tote tank	Contractor continuous discussion with EPA to determine approved treatment and disposal
Oily solid waste (rags, filter, gloves, etc)	Rig/Ship/ Yard	Clip top drum or lidded skip	Clip top drum or lidded skip	Clip top drum or lidded skip	Contractor continuous discussion with EPA to determine approved treatment and disposal
Used oils	Rig/Ship/ Yard	Mobile tank/barrel or ships hold	Mobile tank/barrel or ships hold	Mobile tank/barrel	Delivered to recycling contractor approved by EPA
Oily water (slop)	Rig/Ship/ Yard	Mobile tank/barrel or ships hold	Mobile tank/barrel or ships hold	Mobile tank/barrel	Delivered to recycling contractor approved by EPA
Low toxicity Oil Based Mud	Rig	Mobile tank/barrel or ships hold	Mobile tank/barrel or ships hold	n/a	Third part recovery
Medical Waste (needles, bandages, blood, etc)	Rig	Bio-hazard bag & box	Bio-hazard bag & box	Bio-hazard bag & box	For Incineration at Takoradi hospital

Medicines			By Air -Escorted Sealed bag		For medical disposal at Takoradi Hospital
Asbestos containing material (If any)	Caf gaskets, building material				To be treated on an ad hoc basis subject to separate risk assessment
Radioactive waste					Separate risk assessment and procedure

Table 5 – Drilling – Hazardous Waste Handling

Note: Hazardous waste, excluding oily waste, will be stored in a suitable disposal as there is no suitable hazardous waste treatment facility in Ghana.

Note: Discharge at sea of OBM cuttings should be avoided, in case of discharge at sea of OBM cutting these shall not exceed 1 % oil content or ALARP using BATs.

7.2.3 Drilling Waste Strategy

The strategy for management and disposal of drilling waste is below described:

- Minimize waste generation.
- Waste shall be segregated and deposited where practicable into clearly coded skips (see colour codes above) for: General waste, Hazardous waste, Recyclable/metal). Maintain sufficient containers or skips for each waste stream. Where it is not practicable alternative containers may be used provided they are fit for purpose and clearly labeled.
- Liquid waste shall be contained in tote tanks, and / or suitable containers and appropriately palletized.
- Offshore monthly waste reports sheets will be transmitted to:

  - Operations Logistics Base Superintendent who shall verify and compare quantities received by Disposer and compare, and to HSE&CI Department for monitoring and reporting purposes.

7.2.4 Logistics Base Strategy

The strategy for management and disposal of logistic base waste is below described:

- Minimize waste generation.
- Waste shall be segregated and deposited into color coded containers.
- Waste to be disposed of via licensed Landfill Waste Management Contractor.
- Disposal of reusable waste, scrap and lubricants will be arranged by the Logistics Base.
- Logistics Base staff will complete the respective Waste Transfer Notes to detail waste leaving the premises.

7.2.5 Waste Contractors Responsibilities

- Submit a Monthly Waste Report to eni Ghana.
- Provide eni Ghana of all waste transfer and disposal waybill duly signed in all his sections.
- Provide documentation confirming receipt of waste and quantities involved using the Waste Transfer Note system.
- Dispose of waste in accordance with contract conditions.
- Provide feedback to eni Ghana HSE&CI Department to inform or advise on areas of difficulties encountered in waste handling with either documentation or packaging and to suggest areas for potential improvements.

7.3 Available Disposal Options

Existing methods of disposal for waste streams arriving in Takoradi, or directly on the rig, are summarized below.

- **Incineration**

  For non-hazardous and hazardous wastes an approved contractor will use incineration site in Takoradi. (Zeal is the EPA approved contractor for Takoradi).

- **Landfill**

  For non-hazardous wastes an approved contractor will use the Takoradi landfill site. (Zeal is the EPA approved contractor for Takoradi).

- **Scrap Metal recycling**

  The plan is to dispose of scrap metal via existing recycling nodes using an approved contractor.

- **Waste Oil treatment and recycling**

  Waste Oil will be disposed of for recycling by an EPA approved contractor to be used by EPA approved operators in the bitumen producing industry, various industrial heating and drying process and the wood treatment industry.

- **Other Hazardous waste**

  Storage at a safe secured site (this is the short term method in place at present – the key objective is to ensure no possibility of hazardous waste entering the non-hazardous waste stream and risk to human and environmental health).

- **Burning Basket**

  The use of a burning basket for non-hazardous galley and cabin waste can be considered offshore if suitable and sufficient risk assessment and procedure is complied with, and provided the provisions of MARPOL Annex V are complied with, and care is taken that no plastic is in this waste stream. In addition, any identified risk issues would preclude the use of this method.

7.4 Discharge At Sea (Off Shore)

- Uncontrolled disposal or discharge of drilling wastes is strictly forbidden.

- Evidences of the assessment to minimize the marine environmental impact adopted all the precautions (for example reduced waste volumes and used environmental friendly products) shall be maintained available for review.
- Drill cuttings discharge shall be in compliance with government and local regulations, and at the same time comply with IFC EHS Guidelines for Offshore Oil and Gas Development.

7.5 Monitoring And Documentation

The HSE&CICI Department shall monitor and record the Monthly Waste Reports submitted by the waste contractor. Waste generated on and off shore shall be recorded.

Reports shall be reviewed:

- to confirm the accuracy of reporting.
- to ensure the Waste Management Plan is being implemented correctly and that standards are being met.
- to monitor waste volumes and streams to identify trends and areas of improvement.,
- to report to the eni Ghana HSE Steering Committee,
- to report to eni E&P Corporate offices.

7.6 Records

Records are required to be kept by relevant parties as follows:

- Waste records will be formally be kept by :
  - the Rigs and vessels – i.e Waste Register including transfer note copies.

- by the HSE&CI Department – Waste register, Monthly Waste Reports for rigs and Logistics Base and disposal contractor Monthly Waste Reports,

- The MSCRO shall submit a Monthly Waste Report (see Annex-3) to HSE&CI Department in Accra.
- The eni Ghana HSE Advisor on the rig shall have access to all records and maintain a record of waste monitoring activities and audits.

7.7 Review and Update

The waste management system needs to adapt to relevant changes such as in the event of:

- Changes to laws and regulations;
- Changes in eni Ghana guidelines, protocols and reporting procedures;
- Changes in eni Ghana program activity;
- Identified deficiencies or improvement opportunities;
- Infrastructure developments.

Audits and inspections are performed according to the HSE Management System audit programme and include both in-house and external auditing.

External audits may be commissioned on an annual basis by the HSE&CI Department.

Key outcomes from review and audit activities are tracked to ensure that waste minimisation opportunities are identified, to help establish goals and objectives, and to improve the Waste Management Strategy.

8 HEALTH AND SAFETY ASPECTS

The potential hazards of materials and unsafe conditions must be determinate for both new waste materials. All applicable Material Safety Data Sheet (MSDS) shall be considered for the material to be handled and all applicable company safety procedures shall be followed. Appropriate personal protective equipment shall be worn.

Some waste materials present physical hazards, such as:

- Fire from a charge of static electricity (e.g., flammable liquids);
- Explosion from compressed gases;
- Spontaneous combustion (e.g., some used gas filters and iron sponge);
- Corrosive damage (e.g., chemical burn or frostbite) to skin upon contact;
- Irradiation, external exposure;
- Contamination, internal exposure (inhalation, ingestion, absorption via dermal contact);

Physical hazards of the job tasks shall be identified and adequate personal protective equipment shall be considered. For example, when moving drums or sampling wastes the following protective practices shall be considered:

- Wear gloves to protect against slivers, cuts, scratches and burns;
- Keep hand clear of pinch points;
- Lift with your legs and avoid twisting your body. Get help if necessary to save your back;
- It take two people to move a heavy drum;
- Use adequate grounding and non-sparking/explosion-proof tools to open a flammable liquids container;
- Bulging drums may be under pressure. Open with extreme

caution;

- Avoid touching or sniffing unknown materials;
- Avoid mixing incompatible materials such as:
  - Acids with caustics (causes heat, bubbling and off-gases);
  - Acids with hydrocarbons (causes fire);

9 UPDATING RESPONSIBILITIES

Responsibilities relevant to the updating of the present procedure are as follows:

9.1 Managing Director (MD)

The Managing Director approves the issue of the present document and oversees the drawing-up and updating of the procedure, with the support of the HSE staff personnel.

9.2 HSE Manager

The HSE Manager co-operates with the Managing Director to ensure the drawing up, updating and distribution of the present procedure and verifies its level of application.

10 RECORDING RESPONSIBILITY

10.1 HSE&CI Manager

The HSE Manager is responsible to maintain, update and archive all the records aforementioned.

The present procedure is distributed to all eni Ghana's departments and archived by the HSE Department, according to the modality illustrated herewith.

10.2 Most Senior Company Representative On-site (MSCRO)

The MSCRO will be responsible to properly manage the records included in this document.

11 ANNEXES

Annex 1 – Waste Transfer And Disposal Waybill

Annex 2 – Waste Register

Annex 3 – Monthly Waste Report

Annex 4 – Medical Waste Procedure

ANNEX – 1 Waste Transfer and Disposal Waybill

Part A – GENERATOR

Source Site Location				**Waste Transfer N.**									
Origin of waste:										**Receiver use only (Part C)**			
Waste description	Waste code	Hazard	Container		N. Units	m3	Kg			Containers type	Quantity received	Units (ton or m3)	Recycle = R Treatment = T Disposal = D
			Serial N.	Type									
Notes:													
Name of Transporter off-shore:													
Intended receiver:													
I declare that the information I have provided in part A Is correct and complete													
Name:			Signature:					Date (dd/mm/yy)					
Telephone:			e-mail:										

Part B – Eni Ghana harbour representative

I declare that I have received the wastes as described in Part A for delivery and agree with Transporter onshore figures certification as stated in part C		
Name:	Signature:	Date (dd/mm/yy)

Part C1 – Transporter on shore

Name of transporter on-shore:		
I declare that I have received the wastes as described in Part A for delivery to the Intended Receiver and that the information in Part B1 and complete.		
Name:	Signature:	Date (dd/mm/yy)
Telephone:	e-mail:	

Part D – Receiver

Receiving Location (site name and address):		
Irregularities/discrepancies:		
Except for the irregularities/discrepancies noted above, I declare that I have received the wastes as described in Part A and that the information in Part C is correct and complete.		
Name:	Signature:	Date (dd/mm/yy)
Telephone:	e-mail:	

Part E – Generator

Name of Authorized Person:	Signature:	Date (dd/mm/yy)

Annex – 2 Waste Register

Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste: code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:

Annex – 3 Monthly Waste Report

	Monthly Waste Report					Month:		Year:			
code	Waste category	hazardous	non hazardous	m3 Estimated	Weigth (ton) Estimated	code	Waste category	hazardous	non hazardous	m3 Estimated	Weigth (ton) Estimated
001	WBM (Only if waste)					044	Gaskets non containing asbestos				
002	WBM Cuttings					045	Dismissed piping/vessels				
003	OBM (Only if waste)					046	Production scales				
004	OBM Cuttings					047	Sand blasting residuals				
005	SBM (specify synthetic base)					048	Paint residuals				
006	SBM Cuttings (specify Synth. base)					049	Soot				
007	Spent Brines					050	Spent activated carbon				
008	Spent non – Hazard. chemicals (list)					051	Fluorescent lamps				
009	Spent Hazardous chemicals/cushions					052	Glass and bulbs				
010	Milling waste					053	Refrigerating fluids containing CFC				
011	Cooling water					054	Waste containing PCB/PCT				
012	Scrap metals: tubings					055	Sewage water				
013	Scrap metals: other metals					056	Septic tanks settlings				
014	Scrap metals: steel					057	Non-food waste (detergents etc.)				
015	Empty metal drums					058	Spent cooking oil				
016	Empty plastic drums					059	Food waste (except cooking oil)				
017	Rig mixed waste (paper, plastic, wood)					060	Oily water				
018	Accumulators/Batteries					061	Removed Vegetation				
019	Spent Lubricants					062	Unused Soil				
020	Contaminated soil					063					
021	Contaminated Concrete					064					
022	Other masonry waste					065					
023	Tyres					066					
024	Dismantled piping/vessels					067					
025	Scales					068					
026	Wood and Pallets					069					
027	Plastic Packaging/Wrapping					070					
028	Waste containing Asbestos					071					
029	Waste containing rock- or glass fibre					072					
030	Spent lubricants					073					
031	Filters					074					
032	Produced water					075					
033	Oily sludge					076					
034	Production slops / paraffins					077					
035	Spent production chemicals					078					
036	Oily wastes and rags					079					
037	Plastic					080					
038	Wooden pallets					081					
039	Mixed waste (paper, plastic, wood)					082					
040	Oil polluted soil/concrete					083					
041	Clinic Waste					084					
042	Expired medicines					085					
043	Spent Oil					086					

ANNEX – 4 Medical Waste Procedure

Medical Wastes produced should be separated and packed according to their category in proper containers correctly identified.

Group A: Includes the following articles: identifiable human tissues, blood, animal carcasses, and tissues from veterinary centres, hospitals or laboratories. Bandages, gauze and other dirty wastes. Other wastes with materials, for instance in cases of contagious diseases, excluding anything from Groups B-E.

Group B: Disposed syringes and needles, packages, broken glasses, and other sharp, contaminated, disposable articles or instruments.

Group C: Microbiological cultures and potentially infected waste from pathology departments (laboratories and autopsy rooms) and other wastes from medical stations and research labs.

Group D: Drugs or other pharmaceutical products.

Group E: Articles used to put urine, faeces and other bodily secretions which do not belong in group A.

Their deposition should take place whenever it is necessary, and in order to do so, one should follow the following procedure:

1. Closing and identification of the containers.
2. Call Medical Provider to set the date and place of delivery of the containers.
3. Deliver the containers on the agreed date and time.

Fill out the Waste Delivery Registration Sheet at Medical Provider, verifying that the clinic's person in charge signs and stamps the respective sheet

Summary of Waste delivered

Type of Waste (group)	Quantity	Delivery Date	Receiver

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WASTE TRANSFER NOTE

Part A – GENERATOR

Source Site Location		**Waste Transfer N.**	

Origin of waste:

Waste description	Waste code	Hazard	Container: Serial N.	Container: Type	N. Units	m3	Kg	Receiver use only (Part C): Containers type	Quantity received	Units (ton or m3)	Recycle = R Treatment = T Disposal = D

Notes:

Name of Transporter off-shore:

Intended receiver:

I declare that the information I have provided in part A is correct and complete

Name:	Signature:	Date (dd/mm/yy)
Telephone:	e-mail:	

Part B – Eni Ghana harbour representative

I declare that I have received the wastes as described in Part A for delivery and agree with Transporter onshore figures certification as stated in part C

Name:	Signature:	Date (dd/mm/yy)

Part C1 – transporter on shore

Name of transporter on-shore:

I declare that I have received the wastes as described in Part A for delivery to the Intended Receiver and that the information in Part B1 and complete.

Name:	Signature:	Date (dd/mm/yy)
Telephone:	e-mail:	

Part D – Receiver

Receiving Location (site name and address):

Irregularities/discrepancies:

Except for the irregularities/discrepancies noted above, I declare that I have received the wastes as described in Part A and that the information in Part C is correct and complete.

Name:	Signature:	Date (dd/mm/yy)
Telephone:	e-mail:	

Part E – Generator

Name of Authorized Person:	Signature:	Date (dd/mm/yy)

eni Ghana Exploration and Production Limited	WASTE REGISTER

Waste registerWaste Transfer Note N. .... Date (dd/mm/yy)	Characteristics of waste: code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:

eni Ghana Exploration and Production Limited	WASTE REGISTER

Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:
Waste Transfer Note N. .... Date (DD/MM/YY)	Characteristics of waste code: .... description: .... hazardous: ☐ Y ☐ N	Quantity m3 .... Kg	Source Site Location: .... Generator: .... Receiver:	Notes:

Monthly Waste Report

Month: **Year:**

code	Waste category	hazardous	non hazardous	m3 Estimated	Weigth (ton) Estimated	code	Waste category	hazardous	non hazardous	m3 Estimated	Weigth (ton) Estimated
001	WBM (Only if waste)					044	Gaskets non containing asbestos				
002	WBM Cuttings					045	Dismissed piping/vessels				
003	OBM (Only if waste)					046	Production scales				
004	OBM Cuttings					047	Sand blasting residuals				
005	SBM (specify synthetic base)					048	Paint residuals				
006	SBM Cuttings (specify Synth. base)					049	Soot				
007	Spent Brines					050	Spent activated carbon				
008	Spent non – Hazard. chemicals (list)					051	Fluorescent lamps				
009	Spent Hazardous chemicals/cushions					052	Glass and bulbs				
010	Milling waste					053	Refrigerating fluids containing CFC				
011	Cooling water					054	Waste containing PCB/PCT				
012	Scrap metals: tubings					055	Sewage water				
013	Scrap metals: other metals					056	Septic tanks settlings				
014	Scrap metals: steel					057	Non-food waste (detergents etc.)				
015	Empty metal drums					058	Spent cooking oil				
016	Empty plastic drums					059	Food waste (except cooking oil)				
017	Rig mixed waste (paper, plastic, wood)					060	Oily water				
018	Accumulators/Batteries					061	Removed Vegetation				
019	Spent Lubricants					062	Unused Soil				
020	Contaminated soil					063					
021	Contaminated Concrete					064					
022	Other masonry waste					065					
023	Tyres					066					
024	Dismantled piping/vessels					067					
025	Scales					068					
026	Wood and Pallets					069					
027	Plastic Packaging/Wrapping					070					
028	Waste containing Asbestos					071					
029	Waste containing rock- or glass fibre					072					
030	Spent lubricants					073					
031	Filters					074					
032	Produced water					075					
033	Oily sludge					076					
034	Production slops / paraffins					077					
035	Spent production chemicals					078					
036	Oily wastes and rags					079					
037	Plastic					080					
038	Wooden pallets					081					
039	Mixed waste (paper, plastic, wood)					082					
040	Oil polluted soil/concrete					083					
041	Clinic Waste					084					
042	Expired medicines					085					
043	Spent Oil					086					

TOTAL Hazardous Waste		m3:	ton:
TOTAL Non-Hazardous Waste		m3:	ton:

Annex G
Impact Assessment

ABSTRACT

This Annex presents the identification and assessment of the Project's environmental, social and health impacts.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

Summary of Revisions

July 2015	05	Issued for disclosure	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
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20-01-2015	00	-	Cristina O.	Henry C.	Daniele S.
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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G ASSESSMENT OF IMPACTS AND MITIGATION

G.1 INTRODUCTION

This Annex provides a detailed assessment of the impacts that may result from the Project and provides details of the mitigation measures and management actions that will be implemented to avoid, reduce, remedy or compensate for significant adverse effects and, where practicable, to maximise potential positive benefits and opportunities from the project. The impact assessment covers all phases of the Project - construction, operations and decommissioning - as well as unplanned events. A summary of the impacts and their assessment is presented in Section 10 of the ESHIA.

Potential impacts from project activities are described for the following receptors or resources.

In the onshore environment:

- air quality;
- GHG emissions;
- noise and vibration;
- surface water;
- groundwater
- terrestrial soils, geology and geomorphology;
- terrestrial flora;
- terrestrial fauna;
- ecosystem services; and
- landscape.

In the offshore environment:

- seawater quality;
- seabed;
- air quality (including GHG);
- underwater noise;
- marine fauna and flora;
- coastal processes.

In the socio-economic environment:

- fisheries;
- economy and employment;
- land, fisheries and livelihood;
- socio-cultural changes;
- cultural heritage resources;

- social infrastructure and public services;
- worker management and rights, and worker health and safety;
- community health, safety and security.

In addition, Project activities have the potential for impacts from:

- unplanned events;
- cumulative effects; and
- transboundary effects.

G.2 ASSESSMENT METHODOLOGY

The impact assessment approach follows Ghana regulations as well as international best practice. Potential impacts are indentified by predicting the effects of Project activities on environmental and social receptors and resources. The significance of each impact (positive or negative) is assessed through the evaluation of the following criteria:

- 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 individuals, households, enterprises, species and habitats) that could be affected by the impact.

Each criterion is scored as defined in the following Table G1 to determine the significance (equal to the sum of the scores).

The significance of an impact heavily relies on

- values of the affected society;
- site-specific human and natural environment;
- nature of the Project; and
- specific conditions of the Area of Influence.

Consequently, in the impact assessment, weights are adjusted in some instances due to the actual possibility of occurrence of the impact. Any change in weighting and the reason for change is described.

Based on the impact significance, appropriate control and management measures are defined (see Table G2).

Table G1 Impact Ranking and Evaluation Criteria

Ranking	Evaluation Criteria				Significance
	Duration	**Extent**	**Importance / Resilience of Receptor/ Resource**	**No. of elements involved**	
1 - Low	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 individuals, households, individual enterprises and/or small no. of species	Ranging from 4 to 16
2 - Medium	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 small number of individuals, communities or administrative and/or higher no. of species and habitats	
3 - High	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 individuals, households and /or medium/large enterprises and/or habitats and ecosystems	
4 - Critical	Over 10 years / Irreversible	International scale: trans-boundary	Extreme value/ sensitivity of receptors or resources, resulting in permanent changes	Affecting huge no. of individuals, households and /or large enterprises and/or habitats structure and ecosystems functions	
Score	*1,2,3 or 4*	*1,2,3 or 4*	*1,2,3 or 4*	*1,2,3 or 4*	

Table G2 Impact Significance, Control and Management Actions

Ranking	Impact Level		Control and Management Action
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 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 Company demonstrates the delivery of continuously improved performance through Research and Development, technology innovation, training of the personnel, strategic partnerships and input and feedback from internal and external stakeholders.

As shown in Table G.1, impacts continuing over 10 years receive a "critical" score which automatically raises impacts significance to "medium". As an outcome, the impacts that are continous across the operations phase of the project are all classified (at least) as medium.

This is a reflection of the methodology's conservative approach, where eni wants to ensure that adequate monitoring and control measures are applied in a timely manner to any possible impacts whose duration would be more than 10 years (see Table G.2 for medium impacts long term control measures).

The specific monitoring and control measures to be applied for these imapcts will be fully developed at the Environmental, Social and health Management Plan, where measures will be tailored to the specific impacts and its main driver (duration, extent, sensitivity, or affected individuals).

G.3 GENERAL MITIGATION MEASURES

An objective of the impact assessment process is to reduce the negative effects and enhance the benefits associated with Project activities. Once potential impacts are identified and evaluated, mitigations are applied to avoid or reduce the effects according to the following hierarchy:

Table G3 Mitigation Hierarchy for Planned Project Activities

Avoid at Source; Reduce at Source Avoiding or reducing at source is essentially 'designing' the project so that a feature causing an impact is designed out (or altered Often called minimisation). Example e.g. re-routing a pipeline, relocating facilities, etc.
Reduction on Site This involves adding design control system to the basic design to abate the impact - pollution controls fall within this category. Often called "*end-of-pipe*". Example wastewater treatment, NOx reduction technology
Reduce off Site If an impact cannot be abated on-site then measures can be implemented off-site. Example soundproof equipment at a nearby residences, visual screening by planting of hedges.
Repair or Remedy Some impacts involve unavoidable damage to a resource, e.g. vegetation disturbance. Repair essentially involves restoration and reinstatement type measures.
Compensate in Kind Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss, damage and general intrusion might be appropriate. Example is a like-for-like biological offset attaining ecological no net loss.
Net Positive Outcomes Make a positive contribution to Biodiversity conservation and/or improvement of Ecosystem Services and communities' development.

G.4 ONSHORE ENVIRONMENTAL IMPACTS

G.4.1 Air Quality

G.4.1.1 Overview

This section assesses the potential impacts on local air quality on the onshore Project area that may arise as a result of the Project activities. Impacts on local air quality are likely to occur during each phase of the Project: construction, operation and decommissioning.

The Project's contribution to ground level pollutant concentrations might produce exceedances of current air quality standards which may affect atmospheric properties, materials, vegetation, human health and, in general, contribute to safety hazards and sense of place.

The key sources of impact, potentially impacted resources and receptors, baseline and Project related influencing factors associated with the Project impacts on local air quality are presented in Table G4.

Table G4 Key sources of impacts and risks, potentially impacted resources and receptors

Sources of Impacts and Risks

- Construction Phase onshore: temporary dust emissions from earth movement, excavation, vehicle movement, stockpiles, unpaved surfaces; temporary emissions of flue gases into the atmosphere from vehicles involved in onshore Project construction; exhaust emission from engine-driven machinery and power generators are expected to be used to supply energy during the Project construction.
- Operation and Maintenance Phase onshore: exhaust emissions from engine-driven machinery, compressors, gas turbines and power generators installed at the ORF; vehicles emissions related to the general pipeline operational maintenance; fugitive emissions from emergency flaring, if any.
- Decommissioning Phase onshore: temporary emissions of dust and exhaust gases produced by earthworks and vehicles activity during the decommissioning of the ORF.

Potentially Impacted Resources and Receptors

- Climate and air quality.
- Residential population living near the construction site, workers and local vegetation/fauna.

Project Influencing Factors

- Amount of machinery in use during the construction phase; emission levels of equipment in the ORF area; traffic management.

The following table presents the key impacts of the project on the air quality component during the key project phases.

Table G5 Key potential impacts – air quality

Installation/Construction Phase	Operations Phase	Decommissioning Phase
• Increased dust emissions from earth movement, excavation works, stockpiles, vehicle movement on unpaved surfaces and increased atmospheric concentrations (CO, NOx, SOx, PM_{10} and VOCs) due to exhaust emissions from vehicles involved in construction activities, engine-driven machinery and power generators and hydrostatic testing.	• Increased atmospheric pollutant concentrations (CO, NOx) due to exhaust emissions from ORF facilities operation and vehicles involved in maintenance.	• Increased dust emissions from earthworks and vehicle movement on unpaved surfaces and increased atmospheric pollutant concentrations (CO, NOx) due to exhaust emissions from vehicles involved in decommissioning.

G.4.1.2 Air Quality Receptor Sensitivity

Two main villages are in the surroundings of the concession area, namely Sanzule and Eikwe, located at a distance of about 700 m and 350 m respectively from the ORF area.

In March 2014 and October 2014 the air quality of the areas potentially affected by the Project facilities was investigated through direct measurements of the air pollutants and comparison of the sampling results with the quality standards, as reported in Chapter 6. The monitored concentrations of NO_2 and PM_{10} were generally low comparing to the Ghana EPA limits and applicable EHS Guidelines. Elevated concentration levels of SO_2 were measured, exceeding in few cases Ghanaian and EHS Guideline standards. Those high values could be attributed to anthropogenic activities such as smoking of fish and burning of refuse at the monitored location.

Considering the current air quality conditions and the presence of villages in the surroundings of the Project area, the sensitivity of receptors, meant in this case as human settlements, is assessed as moderate, according to the methodology applied.

G.4.1.3 Construction Phase

Impacts identification and Assessment

During the construction of the pipeline landing and ORF facilities, the main project activities with the potential to impact the air quality are: site clearance and preparation, building construction, the movement of vehicles, equipment and personnel (including the procurement of goods and services and the use of borrow pits and quarries), trenching and laying of pipes, backfilling and reinstatement of the pipeline trench and land temporarily disturbed by construction, hydrostatic testing for pipeline and equipment.

These activities involve two different types of potential direct negative impacts on air quality:

- An increase in atmospheric concentrations of dust particles due to dust emissions. Temporary dust emissions will arise from earthwork activities (i.e., site clearance, trenching, backfilling); in addition, vehicle movement along the short working strip, pipe laydown area, ORF area and access roads will cause dust re-suspension.

- An increase in atmospheric concentrations of air pollutants such as carbon monoxide (CO), nitrogen oxides (NOx) and sulphur dioxide (SOx) from exhaust emissions from combustion source. Other chemical pollutants expected to be emitted in lower quantities are volatile organic compounds (VOCs). Temporary exhaust gas emissions will be generated by: vehicles and heavy machinery (i.e., excavators, bulldozers, side booms, trucks) used in construction activities such as site preparation and the transport of goods, supplies and personnel); engine-driven machinery and power generators (i.e., diesel engines and diesel generators, engine-driven compressors for hydrostatic testing) used to supply electrical power during the construction and pre-commissioning activities.

The main receptors that could be directly affected by dust emissions are:

- The local population in settlements located less than 1 km from the ORF construction area (i.e., Sanzule and Eikwe villages).
- Flora and fauna, if present in the proximity of the construction area. For example high levels of dust concentration can affect plant photosynthesis processes and animal respiratory systems.

The main receptors that could be directly affected by exhaust emissions are:

- Flora: NOx can be a precursor of acid deposition (as can SOx) and ozone formation, which can damage plants.
- Fauna: exposure to high concentrations of SOx and CO can affect the respiratory and circulatory systems of animals. High concentrations of VOCs can also cause necrosis in fauna.

Dust emissions will be related to the volumes of handled material and duration of activities. It has to be noted that field surveys highlighted the current presence of dust sources, in particular dust raised by road traffic (lifting and dropping of particles by the rolling wheels). This has been monitored particularly for Sanzule.

The volumes and concentrations of exhaust gases emitted into the atmosphere, instead, will be directly related to the amount of fuel consumption. The vehicles and engine-driven machinery involved in the construction phase will generally be fuelled with diesel supplied by tank-trucks. Information on the daily fuel consumption or vehicles fleet required for the entire construction phase is not yet available at this stage of the project. However, exhaust emissions will have an adverse effect on the local population located in the near proximity of the construction sites, as exhaust emissions are likely to disperse within a few hundred of meters of the source.

With regard to the atmospheric emissions produced by engine driven compressors used in the pipeline hydrostatic testing, information on the type of compressors is not yet available at this stage of the project. Moreover it has not been defined yet if the equipment for hydrostatic test will be installed on the FPSO or at the ORF. It has to be noted that if the compressors used for the hydrostatic test will be installed on the FPSO, located at 60 km from the shoreline and the coastal villages, impacts are not expected to affect human settlements. In case of installation of equipment at the ORF, a further analysis of the emissions sources, time and duration of operation and mitigation measures should to be performed, since significant impacts may affect the nearest settlements.

<u>Mitigation Measures</u>

The following mitigation measures will be employed during the ORF construction and pre-commissioning phases and laying of the short pipelines, to reduce impacts on air quality to keep levels of pollutants below applicable and relevant ambient air quality standards, as far as practicable. The following measures will be taken into account:

Increased Dust Emissions

- The covering of materials that can be transported by wind e.g. topsoil stockpiles.
- The use of compacted natural materials (i.e., gypsum sand) in parking areas if available.
- Vehicles will only travel along designated transport corridors.
- Vehicle speed limited to minimise dust generation.
- Dust suppression, using water and/or dust suppression agents, will be undertaken for the control of loose materials if dust generation is observed on any surface and stockpile, the working strip, and/or stored topsoil (according to the availability of water resources).
- Dust arrestment equipment (such as particle traps for vehicle's engine) to be used where practicable.

Several studies have proved that using effective dust control measures can significantly reduce dust emission and help preserve road surfaces. In particular, according to common best practice, dust control can reduce dust production by 30 % to 80 %. For example only cutting average vehicles speed from 40 mph to 35 mph reduces dust emission by 40 %. *(US department of Transportation: Federal Highway Administration, 2010 - Gravel Roads Maintenance and Design Manual (SD LTAP); Wisconsin Transportation Information Center, 1997. Wisconsin Transportation Bulletin No 13).* Therefore the implementation of the abovementioned mitigation measures will considerably reduce the expected potential impacts related to dust emissions.

Increased Vehicle Emissions

A Traffic Management Plan will be implemented which will include the following measures:

- Vehicles and machinery will be turned off when not in use.
- Regular maintenance checks will be carried out and records kept on all vehicles and machinery.
- Speed limits will be implemented along transport corridors.
- A defensive driving training awareness campaign to be carried out and specific training on traffic management to be given to all project drivers.
- A register of trained drivers will be maintained.
- Planning of activities to minimise the use of vehicles and machinery: limitation of deliveries to full capacity loads, scheduling and restricting personnel movements to

minimise journeys, minimisation of supply distances (if and where possible), and limitation of driving on existing tracks as much as possible.

Air emission specifications will be used as criteria for the selection and procurement of equipment and vehicles. EHS Guideline for Air Emissions and Ambient Air Quality shall be applied in the selection of vehicles and mobile sources, such as:

- Fleet owners / operators will implement the manufacturer recommended engine maintenance programs.
- Drivers will be instructed on the benefits of driving practices that reduce both the risk of accidents and fuel consumption, including measured acceleration and driving within safe speed limits.
- Replacing older vehicles with newer, more fuel efficient alternatives.
- Converting high-use vehicles to cleaner fuels, where feasible.
- Installing and maintaining emissions control devices, such as catalytic converters.

An inventory of air emission sources including actual/potential measured or estimated air emissions will be kept.

The following measures are to be considered in the selection of power generators (diesel generators and diesel compressors):

- The use of catalytic reduction to reduce NOx emissions, and catalytic oxidation to reduce CO exhaust emissions.
- Generators to be well maintained (including the maintenance inspections recommended by the manufacturer) and with emission levels meeting IFC/WB Group recommendations for small combustion sources.
- Generators to be located downwind at a minimum distance of 100 m from areas frequented by personnel and air conditioning intakes.
- Application of energy efficiency principles to minimise power requirements.

Emissions from Hydrostatic Testing

- Equipment in compliance with the best available technologies for air pollutant emission reduction will be used.
- Regular and periodic maintenance of the equipment will be undertaken.

Conclusions

The impact on air quality due to both temporary dust emissions and temporary emissions of exhaust gases will be negative, direct, and local in extent, and limited to the period of construction/pre-commissioning activities in each specific location along the pipelines and in the ORF work site.

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential residual impact significance on air quality associated with the construction phase is summarised in Table G6.

Table G6 Ranking of residual impacts and risks on air quality during construction phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Air Quality–Onshore Construction Phase					
Increased dust emissions from earth movement, excavation works, stockpiles, vehicle movement on unpaved surfaces. Increased atmospheric pollutant concentrations (mainly SO2, CO, NOx) due to exhaust emissions from vehicles involved in construction activities, engine-driven machinery and power generators and hydrostatic testing.	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Air Quality–Onshore Precommissioning Phase					
Increased atmospheric pollutant concentrations (mainly SO2, CO, NOx)due to exhaust emissions from hydrostatic testing.	Less than 1 year / Temporary	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	

G.4.1.4 Operational Phase

Impacts Identification and Assessment

During the operation of the onshore pipelines and ORF facilities, potential direct negative impacts on air quality may be generated by an increase in atmospheric concentrations of air pollutants such as CO and NO_x due to exhaust emissions from:

- The power generation unit (with 3 gas turbines), supplying energy to all the onshore facilities;
- The compression station, for compressing the gas at the pressure required by Ghanaian National Network; and
- Vehicles used for the general pipelines operational maintenance and site inspections by personnel along the route.

Further discontinuous air emission sources in the ORF are the diesel generators to supply energy in case of emergency, emergency flaring, cold vent to be used to safely convey into the atmosphere all the relief and blow-down streams outgoing from the onshore process systems, and helicopter movements at the permanent heliport that will be mainly used for MEDEVAC purposes along all the project phases, and finally exhaust emissions released by the vechicles involved in the maintenance activties. These emission sources will be discontinuous and will not generate significant air emissions.

A dedicated Atmospheric Dispersion Modelling Study (ADMS) was performed to estimate the ground level concentrations induced by the continuous emission related to the ORF operation. This ADMS is labelled as ORF ADMS hereinfater. Annex H presents the ORF ADMS, its input, output, model set-up and description.

The ORF ADMS simulated the atmospheric dispersion of continuous emissions released by:

- The compression unit, which consists of two booster compressors with a capacity of 6.9 MW and 9.3 MW.
- The power generation unit: which consists of a gas turbine with an installed power of 3 MW.

The above mentioned facilities will be fuelled with gas and will primarily release gaseous emissions NOx and CO into the atmosphere. The fuel gas is contaminated with H_2S therefore minor SO_2 emissions are also expected, whereas PM emissions are not expected to occur from the combustion of gaseous fuel.

The ORF ADMS highlighted that:

- Atmospheric concentration of airborne pollutants induced by the ORF operation comply with national and international AQS.
- Predicted concentration maxima are localised within a distance of 1.5 km from the ORF and do not affect the closest villages Eikwe and Sanzule.

The outcome of the ORF ADMS supported the assessment of impact on ambient air quality presented in this Section. A detailed description of the modelling study input, assumption and results is provided in Annex H.

Mitigation Measures

The implementation of mitigation measures and design control will keep emissions below the applicable and relevant ambient air quality standards, as far as practicable.

In order to ensure that best practices are followed, it is recommended that the same mitigation measures described in Section G.2 involving equipment and vehicle maintenance and the implementation of a Traffic Management Plan are applied during the operational phase.

Finally, the air quality modelling study will be repeated once the final Project design information is available. This will be made by means of modelling tools (i.e. CALMET-CALPUFF) and results of the modelling will inform the mitigations to be applied.

Conclusions

The impact on air quality due to the operation of the ORF and pipeline maintenance is negative, direct, and local in extent, occurring for the entire Project life.

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impact significance on air quality associated with the operational phase is summarised in Table G7.

Table G7 Ranking of *residual impacts and risks* on air quality during operational phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Air Quality–Onshore Operational Phase					
Increased atmospheric pollutant concentrations (mainly SO2, CO, NOx) mainly due to continuous exhaust emissions released by the ORF facilities	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

The resulting Medium impact significance is mainly a consequence of the score to be assigned to the duration of the operational phase, and not to the actual potential impacts on receptors.

The ORF ADMS, presented in Annex H, highlighted that induced concentration comply with National and International AQS and predicted concentration maxima do not affect the closest villages Eikwe and Sanzule. Therefore no further mitigations are needed.

G.4.1.5 Decommissioning

Impacts Identification and Assessment

At the end of their useful life (foreseen in 20 years), the pipeline and the ORF will be decommissioned safely and in accordance with International Guidelines for abandonment of oil and gas facilities.

The decommissioning activities, to be completed in two years, will be made with equipment similar to the ones foreseen for the construction activities and will include the following activities:

- Disassembling of ORF equipment.
- Demolition of buildings.
- Pigging, purging and filling of the pipelines.

Dust emissions during the decommissioning phase will arise only from the ORF decommissioning, whereas the decommissioning of the pipeline will not produce dust. It has to be noted that impacts arising from the ORF site decommissioning are not comparable with impacts produced during its construction since the decommissioning activities will be carried out on paved surfaces. Therefore, the contribute of dust resuspension due to vehicles transit on unpaved road during the decommissioning phase will be negligible and the main dust emissions will be produced by handled material. Impacts on local air quality produced by dust emissions from handled material during the decommissioning phase are expected to be significantly lower than the impacts assessed for the dust emissions during the construction phase.

The decommissioning operations require also a smaller number of vehicles and equipment compared to the construction phase. Therefore, impacts on local air quality produced by vehicles' emissions during decommissioning are expected to be significantly lower than the impacts assessed for vehicles emissions during construction.

Mitigation Measures

The same mitigation measures anticipated for the construction phase with regards to the dust production and vehicular emissions will be implemented.

Conclusions

The impact on air quality due to the decommissioning of the ORF and onshore pipelines is negative, direct, and local in extent, and limited to the period of decommissioning activities (about 2 years).

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impact significance on air quality associated with the decommissioning phase is summarised in Table G8.

Table G8 ***Ranking of residual impacts and risks on*** **air quality during decommissioning**

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Air Quality–Onshore Decommissioning					
Increased dust emissions from earthworks and vehicle movement on unpaved surfaces and increased atmospheric pollutant concentrations (CO, NOx) due to exhaust emissions from vehicles involved in decommissioning.	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

G.4.2 GHG Emissions

This Section presents an overview of the Greenhouse Gas (GHG) emissions associated with the onshore planned activities, namely ORF installation and pipeline construction. A preliminary quantification of the GHG emissions related to the Project life time is also reported, based on the Project design in terms of equipment and fuel consumption available at this time. A more detailed GHG Emissions inventory will need to be completed once final design has been finalized.

GHG emissions are likely to occur during each phase of the Project: construction, operation and decommissioning (Table G9).

Table G9 GHG emission sources from onshore Project activities

Project Phase	GHG Emissions
Construction	• CO_2 emissions from machinery and vehicles for facilities installations and for personnel and material transport. • CO_2 emissions from power generators to supply energy for construction activities. • CO_2 emissions from compressors used during hydrostatic testing. • CH4 emissions from combustion sources.
Operation	• CO_2 emissions from power generation unit and compression system. • CO_2 and CH_4 emissions from flaring limited to the process upsets. • Fugitive emissions (CH4) from emergency flaring.
Decommissioning	• CO_2 emissions from vehicles for facilities dismantling and for personnel and material transport.

CO2 and CH4 emissions may be released by vehicles, power generators and compressors in use during the different phases (construction and operation). During the normal operation activity, some flaring may be required during facility startup and in the case of process upsets and this will produce GHG emissions. The Project will implement a Zero-Permanent Flaring policy which will limit the GHG emissions from flaring to the process upsets and usually relatively short in duration and pilot flame consumption was considered negligible compared with annual average, based on experience in similar facilities. Based on this, the GHG emissions are not expected to be significant.

A prelimary assessment of the GHG emissions related to the entire Project life time, focused on operations, has been performed according to the IFC's GHG reduction accounting methodology and using IFC's Carbon Emissions Estimator Tool. The estimate reported in Table G10 was based on the current Project design data and refer to the entire Project's emissions during operation, without distinguishing between onshore and offshore activites.

Table G10 Preliminary Estimate of GHG Emissions during Project Operation

Emission Source	t CO2-eq per year
Fuel consumption – Natural gas (gas-fired gas turbines)	367,437
Fuel consumption – Large diesel oil engines	31,899
Gas flaring	185
Fugitive emissions (from gas process and transport)	2,024
Total	*401,545*

Based on the preliminary project data available and considering the degree of confidence in the assessment, the Project is estimated to emit approximately 400,000 tonnes of CO2-eq per year during the entire lifetime. As shown in the Table above, the main contribution to GHG emissions is due to fuel consumption. Flaring contribution is negligible.

If compared with the total amount of national GHG emissions (about 24,000,000 tonnes of CO2-eq in year 2006, based on Ghana's National Inventory reported in Section 6.3.4), the GHG emission of the Project accounts for amount among 1.6% of the projected national emissions. The implementation of the following mitigation measures and design control shall allow to keep Project GHG emissions as low as possible:

- Implementation of best available techniques related to:
  - efficiency of power generation;
  - optimisation of overall energy efficiency;
  - reduction in flaring; and
  - reduction in venting.
- Regular monitoring and recording as part of a continuous improvement programme specifically for GHG.

G.4.3 Noise and Vibration

G.4.3.1 Overview

This section assesses the potential impacts on local ambient acoustic conditions over the onshore Project area that may arise as a result of the Project activities.

There are no significant sources of vibration on the site during both construction and operation; thus, also considering that there are no potential sensitive receptors within 300 m of the site, vibration effects would not be experienced.

Noise impacts are however likely to occur during each phase of the Project: construction, operation and decommissioning. The Project's contribution might produce an increase of the current ambient noise levels at sensitive receptors.

Table G11 shows the key sources of noise impact, potentially impacted resources and receptors, and baseline and project influencing factors associated with the impacts of the Project on the ambient acoustic conditions.

Table G11 Key sources of risks and impact, potentially impacted resources and receptors

Sources of Impacts and Risks
• Construction Phase onshore: temporary noise emissions from preparation of the working strip; road construction; construction of temporary facilities (work sites); ORF installations; movements of vehicles, equipment and personnel; hydrostatic testing.

- Operation and Maintenance Phase onshore: noise emissions from ORF operations; movement of vehicles and personnel for pipelines maintenance.

- Decommissioning Phase onshore: temporary noise emissions from movement of vehicles and personnel for dismantlement of ORF.

Potentially Impacted Resources and Receptors
- Residential population living along the pipeline route and in proximity to the ORF and work sites.
- Fauna.

Project Influencing Factors
- Amount of machinery in use during the construction phase; noise power levels of equipment in the ORF area; machinery operating hours; specific techniques used for hydrostatic testing; traffic management.

The following table presents the key impacts of the project on the ambient acoustic conditions during the key project phases.

Table G12 Key impacts and Risks Noise

Installation/Construction Phase	Operations Phase	Decommissioning Phase
• Increased ambient noise levels due to noise emissions from equipment/vehicles involved in construction activities and hydrostatic testing	• Increased ambient noise levels due to noise emissions from ORF operation and vehicles involved in maintenance.	• Increased ambient noise levels due to noise emissions from equipment/vehicles involved in the dismantlement of the ORF.

G.4.3.2 Noise Receptors Sensitivity

Noise emissions generated during onshore activity, both construction and operation, could affect human receptors present in the proximity of work areas with consequence on behavior and health (i.e., annoyance, sleep disturbance, stress). Noise could also affect local fauna (for a description of the potential disturbances on fauna refer to Section G.4.8).

In March and October 2013 field surveys were performed to identify potential noise sensitive receptors, such as inhabited buildings, along the pipeline and in proximity of the ORF and measure existing ambient noise levels (see Chapter 6). Two main villages are found in the surroundings of the Project site, namely Sanzule and Eikwe, located at a distance of 700 m and 350 m respectively from the ORF area.

Measured ambient noise levels at the villages, both day-time and night-time, were already generally above Ghana EPA guideline (55 dB(A) daytime, 48 dB(A) night time) and EHS Guidelines (55 dB(A) daytime, 45 dB(A) night time) for noise levels in a residential areas. , This was due to significant contribution of noise from routine human activities. Noise originated from non-industrial sources such as domestic activities, fishing activities, beach seine activities and vehicular traffic.

Considering the current ambient noise levels and the presence of villages in the surroundings of the eni concession area, the sensitivity of receptors, meant as human settlements, is assessed as moderate, according to the methodology applied. The sensitivity of fauna is discussed in Section G.4.8.

G.4.3.3 Construction Phase

Impacts Identification and Assessment

During construction activities the main effects on the ambient noise environment are related o noise emissions from construction machinery and hydrostatic testing with the potential to generate an overall increase in the background noise level of the area adjacent to the construction/work sites of the ORF and pipeline. A change in the acoustic environment due to the introduction of additional noise emissions may directly affect:

- Human receptors: residential areas by interfering with sleep, communication, performance and behavior and, in more serious circumstances, causing hearing damage.

- Fauna: disturbance of feeding and other activities and avoidance behavior (for noise impact on fauna, see Section G.4.8).

Noise sources in the construction phase will be intermittent and will depend on the number and types of machinery used for each activity; therefore, the noise impact related to this project phase will vary throughout the day and with the different operations.

During the site preparation, the main equipment used will be soil moving machinery (e.g., excavators, loaders) and trucks. The subsequent phases will involve the operation of equipment to move materials (e.g., cranes, side-boom/pipe layer, pipe bending machine) and stationary machinery (e.g., pumps, generators, compressors).

Each activity entails the use of several types of machinery; therefore the noise impact will be the result of the cumulative noise effect of all the equipment working simultaneously in the same area. The overall noise emission levels can be estimated considering each piece of machinery as a single point source located in the centre of the work site (the ORF work camp or the pipeline centreline). A dedicated Noise Modelling Study was performed to estimate the noise level emissions induced by the constrcution activities related to the ORF and onshore pipeline. Annex I presents the noise modeling study, its input, output, model set-up and description.

The outcome of the noise modeling study supported the assessment of impact on ambient acoustic climate presented in this Section.

Construction activities are expected to happen only during day time, thus the noise levels are compared to the 55 dB(A) limit specified by Ghana EPA and the EHS Guideline. The modelling study simulated the noise emissions from the main construction equipemtn and vehicles in operation. The modeling outcomes highlighted that:

- During pipeline construction, the noise limit of 55 dB(A) for day time is respected at a distance of about 280 m from the pipeline centreline;

- At the village of Sanzule, the maximum predicted noise level generated by the Project is 46.5 dB(A), occurring during the construction of the closest pipeline segment, mainly due to its proximity to the work areas (about 700 m). The cumulative noise levels exceed the Ghana EPA and IFC noise limit, but this is only due to the high values of the monitored background levels. Project contribution, in fact, is well below the daytime limit of 55 dB(A) during all construction activities and will not increase significantly the existing background noise (a maximum increase of 0.8 dB(A) is predicted);

- At the village of Eikwe, the maximum predicted noise level generated by the Project is 53.1 dB(A), occurring during the construction of the closest pipeline segment. The noise level at this village is higher than the level predicted for Sanzule, as a consequence of its proximity to the pipeline route (only 300 m). The cumulative noise levels exceed the Ghana EPA and IFC noise limit, but this is only due to the high values of the monitored background levels. Project contribution, in fact, is well below the daytime limit of 55 dB(A) during all construction activities and will not increase the existing background noise (a maximum increase of 0.7 dB(A) is predicted).

During pre-commissioning phase, once the pipeline has been cleaned and gauged and ORF equipment installed, they will be subjected to a hydrostatic test operation. The hydrostatic test is expected to last about one month; in this phase the most critical aspect regarding noise emissions is represented by the continuous activity (24 hours per day) of flooding pumps, air driven pumps and generators needed for raising the pressure in the pipeline to the specified test pressure and for cleaning operations. The effects of this will be temporary, since this activity is expected to last only few days (generally 48 hours). .

A dedicated Noise Modelling Study (reported in Annex I) has been performed to assess the potential noise impact due to the hydrostatic testing phase. At this stage of the Project, it is not confirmed if the equipment for hydrostatic test will be installed on the FPSO or at the ORF. It has to be noted that if the compressors used for the hydrostatic test will be installed on the FPSO, located at 60 km from the shoreline and the coastal villages, thus impacts of noise on onshore receptors are not expected to occur although crew on FPSO would be affected by increased noise levels. Workers will be equipped with hearing protection devices (earplugs, earmuffs) and occupational noise exposure requirements will be strictly observed.

In case of installation of equipment at the ORF, further analysis of noise emissions sources, including at least description of the layout, time and duration of operation, will be performed, since significant noise impacts may affect the nearest sensitive receptors. Conservatevely, considering the presence of residential receptors locetd onshore in the proximity of the ORF site, the Noise Modelling Study reported in Annex I assumed that hydrostatic testing will occur onshore.

Hydrostatic Testing is planned to be undertaken only few days but continuously throughout the entire day (24/day), so the noise limits in force to identify impacts at noise sensitive receptors are: 55 dB(A) during day time, both for Ghana EPA and IFC standards; 45 dB(A) during night time for IFC standard; 48 dB(A) night time for Ghana EPA regulation.

Comparing the estimated project sound pressure levels with the noise limits it is observed that:

- The Project contribution respects the IFC and Ghana EPA noise limits both during day time and night time. Noise levels at receptors are, in fact, very low as below 20 dB(A). Thus, the noise produced during hydrostatic testing is unlikely to be perceived by the human settlements in the area.

- Cumulative noise levels, calculated as the logarithmic sum of monitored background noise and Project contribution, are well above the noise limits both for day and night time. The exceedances are only due to the high levels of the current background noise monitored during the field surveys; the project contribution, in fact, is well below the noise limits and it is so low to not cause any increase of the background noise level at receptors.

Mitigation Measures

In addition to general mitigation measures, the noise impact on receptors during the construction phase will be specifically reduced to keep it below the applicable and relevant noise standards, as far as practicable. The following measures will be taken into account:

On noise sources/equipment:

- switch off equipment when not in use;
- selection of equipment according to the best technologies available in terms of noise reduction;
- regular maintenance of noisy equipment and vehicles in accordance with manufacturers specifications to prevent increases in noise emissions;
- keep the noise level of audible warning devices to the minimum necessary for health and safety.

On construction activities:

- limit noisy construction activities to the least noise-sensitive times of day;
- perform noisy construction work during daylight hours, avoiding night activities;
- if construction work outside daylight hours is unavoidable, notify the scheduled activity to the residents of nearby in advance;
- apply strict speed limits to all vehicles moving around the construction area and on roads approaching the construction works, and repair road surfaces damaged by construction traffic to avoid increases in noise from vehicles travelling over uneven ground

On propagation path:

- locate stationary equipment (i.e., compressors) as far as practicable from nearby receptors;
- orient plant to direct noise emissions away from sensitive locations as far as possible;
- use on-site structures and terrain to screen sensitive locations wherever practicable.

Conclusions

The impact on the ambient acoustic conditions due to construction noise emissions is negative, direct, and local in extent, and intermittant and limited to the period of construction/pre-commissioning activities in each specific location along the pipelines and in the ORF work site.

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts significance on the ambient acoustic conditions associated with the construction phase is summarised in Table G13.

Table G13 Ranking of residual impacts and risks on ambient noise levels during construction phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Ambient Acoustic Conditions –Onshore Construction Phase					
Increased noise emissions from equipment involved in the construction of the ORF, pipeline installation	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Ambient Acoustic Conditions –Onshore Pre-commissioning Phase (Hydrostatic testing)					
Increased noise emissions from hydrostatic testing	Less than 1 year	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	

G.4.3.4 Operational Phase

<u>Impacts Identification and Assessment</u>

During the operation of the onshore pipeline and ORF facilities, potential direct negative impacts on the ambient acoustic levels may be generated by an increase in ambient noise levels due to noise emissions from:

- The power generation unit (specially gas turbines and diesel generators), supplying energy to all the onshore facilities.
- The compression station, for compressing the gas at the pressure required by Ghanaian National Network. The total treatment capacity is 190 MMSCFD (confirmed "base case" operating conditions).
- ORF ancillary facilties (e.g., air cooler, water pumps) and vehicles (i.e., 4WD cars) used for the general pipeline operational maintenance and site inspections by personnel along the route.

Further noise emission sources in the ORF are the cold vent and the permanent heliport. These emission sources will be discontinuous and will not generate significant noise emissions.

Power generation and compression units will run 24 hours a day, 7 days a week, thus the noise emissions will be continuous over the entire operational life of the facility.

Noise impacts on fauna expected to occur during operation are assessed in Section G.4.8.

Maintenance activities will involve a very low number of vehicles on an infrequent basis, thus adverse impacts on the acoustic environment and sensitive receptors are unlikely to occur in this phase.

A dedicated Noise Modelling Study has been performed in order to estimate the noise emissions generated during the ORF operation. Annex I presents the noise modeling study, its input, output, model set-up and description.

The outcome of the noise modeling study supported the assessment of impact on ambient acoustic climate presented in this Section..

ORF operation is planned to be undertaken continuously 24 hours per day, so the noise limits in force to identify impacts at noise sensitive receptors are: 55 dB(A) during day time, both for Ghana EPA and IFC standards; 45 dB(A) during night time for IFC standard; 48 dB(A) night time for Ghana EPA regulation.

Comparing the Project sound pressure levels with the day time noise limit it is observed that:

- The Project contribution respects the IFC and Ghana EPA noise limits both during day time and night time. During day time, noise levels at receptors are about 20 dB(A) below the limit (IFC and Ghana EPA) at Sanzule and about 15 dB(A) below at Eikwe. During night time, predicted noise level at Sanzule is 10 dB(A) below IFC limit and 13 dB(A) below Ghana EPA noise limit; at Eikwe, 5 dB(A) below IFC limit and 8 dB(A) below Ghana EPA noise limit.
- Cumulative noise levels, calculated as the logarithmic sum of monitored background noise and Project contribution, are above the noise limits both for day and night time. The exceedance is due to the high levels of the current background noise monitored during the field surveys; the project contribution, in fact, is below the noise limits. Considering the high existing background noise levels, the noise produced during ORF operation is unlikely to be perceived by the human settlements in the area.

Mitigation Measures

Best practice and good operational management of equipment and vehicles are standard requirements and can help in further reducing the potential noise impact and keep it below the applicable and relevant noise standards, as far as practicable. In particular:

- Regular maintenance of noisy equipment and vehicles in accordance with manufacturer specifications to prevent increases in noise emissions.
- Considering noise performance in the selection of equipment and vehicles in accordance with the best available technique (selection of lower noise equipment).
- Optimization of the ORF layout, locating the emission sources as far as possible from the sensitive receptors.
- If feasible, planning the installation of noise barriers, equipment enclosures and silencers to reduce noise emissions.

- Operating strict speed limits for all vehicles moving around the Project area for maintenance activities, and maintain road surfaces to avoid increases in noise from vehicles travelling over uneven ground.
- Keep the noise level of audible warning devices to the minimum necessary for health and safety.
- The noise modelling study will be repeated once final Project design is available by means of modelling tools (i.e., SoundPLAN). Results of the modelling will inform the mitigations to be applied.

Conclusions

The impact on the ambient acoustic conditions due to the operation of the ORF and pipeline maintenance is negative, direct, and local in extent, occurring for the entire Project life.

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts significance on the ambient acoustic conditions associated with the operational phase is summarised in Table G14

Table G14 Ranking of residual impacts and risks on ambient noise levels during operational phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Ambient Acoustic Conditions –Onshore Operational Phase					
Increased noise emissions from power generators and compressors of the ORF and vehicles for maintenance operations	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

The resulting Medium impact significance is mainly a consequence of the score to be assigned to the duration of the operational phase, and not to the actual potential impacts on receptors.

The Noise Modeling Study, presented in Annex I, highlighted that noise emission levels generated during ORF operation (Project contribution) at receptors comply with IFC and Ghana EPA noise standards.

G.4.3.5 *Decommissioning*

Impacts Identification and Assessment

At the end of its useful life (foreseen in 20 years), the pipeline and the ORF will be decommissioned safely and in accordance with International Guidelines for abandonment of oil and gas facilities.

The decommissioning activities, to be completed in two years, will be made with equipment similar to the ones foreseen for the construction activities and will include the following activities:

- Disassembling of ORF equipment;
- Demolition of buildings;
- Pigging, purging and filling of the pipeline.

The decommissioning operations require a smaller number of vehicles and equipment compared to construction. Therefore, lower noise emissions are expected to be generated.

Mitigation Measures

The same mitigation measures anticipated for the construction phase with regards to the vehicular emissions will be implemented.

Conclusions

The impact on ambient acoustic conditions due to decommissioning of the ORF and onshore pipeline is negative, direct, and local in extent, and limited to the period of decommissioning activities (about 2 years).

Considering the mitigation measures described in the previous section and the evaluation criteria defined in Section G.2, the residual impacts significance on the ambient acoustic conditions associated with the decommissioning is summarised in Table G15.

Table G15 Ranking of residual impacts and risks on ambient noise levels during decommissioning

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Ambient Acoustic Conditions –Onshore Decommissioning					
Increased noise emissions from equipment involved in pipeline and ORF decommissioning	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

G.4.4 Surface water

G.4.4.1. Overview

This section identifies and assesses the main impacts on onshore environment, proposes mitigation and management measures and then discusses the conclusion and impact ranking applying eni Standard requirements for project construction and operation activities relating to surface water resources.

The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on surface water resources.

Box G1 Key Sources of Impacts and Risks, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Construction Phase: site clearance, preparation, infilling and elevation (up to 3 m); construction of roads and other facilities; ORF construction; construction of temporary facilities (work site); movements of vehicles; equipment and personnel; water consumption; hydrocarbon spills; waste and wastewater management; water use.
- Operations and maintenance phase: water consumption, hydrocarbon spills, movement of vehicles, waste and wastewater management and effluent discharge.
- Decommissioning phase: ORF decommissioning, movements of vehicles, equipment and personnel, water consumption; waste and wastewater management.

Potentially Impacted Resources and Receptors

- Surface water bodies (including seasonal wetlands inundated by water during the wet season, ephemeral and permanent ponds and the Amansuri River to the east of the onshore concession area (hereafter referred to as the project site).
- Surface water ecology (i.e. fauna and flora) (refer to Sections G.4.7-G.4.8).
- Fishing activities in rivers and along the coast (refer to Section G.6).

Baseline Influencing Factors

- Due to the high annual rainfall in the area, the AoI is characterised by the presence of many brackish and freshwater ponds. These ephemeral and permanent ponds are found in and around the Project site and onshore pipeline sections.
- The Project site is characterised by a coastal belt with higher elevation than the low lands located to the north. Given the topography, surface runoff is expected to flow towards the Amansuri River in a northerly, northeasterly and easterly direction from the concession area and work sites related to the pipeline spur to the north of the site. The Amansuri River flows eastward from about 1.4 km north and east of the Project site (including the ORF and short sections of onshore pipeline). The Amansuri River mouth is located 7 km to the east of the Project site. The Amansuri River floodplains extend up to 300-400 m from the eastern boundary of the Project site.
- The low lying lands to the north of the project site are part of the Amansuri wetland system. The low lying wetland areas are reportedly seasonally flooded up to a depth of approximately 1 m.

Project Influencing Factors

- Specific techniques used for hydrotesting, water management and waste management.
- Infilling of Concession Area to up to 3 m above the current elevation.

The following table presents the key impacts of the project on the surface water component during the key project phases.

Table G16 Key potential impacts and risks – surface water resources

Construction Phase	Operations Phase	Decommissioning Phase
• Removal of seasonally inundated areas small ephemeral surface water bodies within the Project site. • Degradation of surface water quality due to potential increased sediment load (resulting from increased erosion and dust generation). • Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste. • Degradation of groundwater quality due to accidental spillages of the fuels and chemicals used during construction. • Changes in hydrology and/or the hydrological regime caused by reduced flows and/or changes in flow direction caused by project related work (i.e. site clearance, earthworks and constructions).	• Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste. • Degradation of surface water quality due to accidental spillages of the fuels and chemicals used during operation.	• Degradation of surface water quality due to potential increased sediment load (resulting from increased erosion and dust generation). • Degradation of surface water quality due to potential water contamination from wastewater discharges and hazardous and non-hazardous wastes. • Degradation of water quality due to potential water contamination from mobilisation of contaminant present in the soil/ sediment/ hard surfaces by rainfall, run-off and seepage. • Changes in hydrology and/or the hydrological regime caused by changed flows and/or changes in flow direction caused by project related work (i.e. ORF decommissioning).

The *sensitivity* of the surface water component is reported in the following Sections. Then potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project. Conclusions are presented taking into account the application of the identified mitigation measures.

G.4.4.2. Surface Water Sensitivity

In order to be able to evaluate the significance of each impact on surface water resources, it is necessary to describe the sensitivity of nearby surface water receptors within the AoI.

Salient features related to potentially affected surface water receptors within the AoI are as follows:

- There are no permanent water courses on the Project site (including the short section of pipeline leading to the existing national gas pipeline). The nearest major permanent surface water body is the Amansuri River located 1.4 km from the Project site. The Amansuri River floodplains extend up to 300 m from the eastern border of the Project site.

- The Project site is characterised by a coastal belt with higher elevation than the low lands located to the north (i.e., away from the sea). Surface drainage across the ORF site is expected to flow both towards the sea to the south and towards the Amansuri River in a northeasterly and easterly direction.

- The baseline survey results indicate that the Amansuri River water is polluted as a result of domestic waste (i.e. fertilizers and soap) and also potentially influenced by ocean tides.

- A number of ephemeral and permanent ponds are found within the 5 km AoI particularly to the west of the site (approximately 1.5 km) in the seasonally inundated plains between Sanzule and Atuabo and further to the northwest of the ORF site. It is likely that these water bodies are linked through upper aquifer groundwater flow to the Amansuri system to the north, but it is not expected that these seasonal areas of inundation on the Project site are connected to this system via direct and continuous surface water flows (given that the Amansuri River is located approximately 1.4 km north from the Project).

- The sensitivity of the Amansuri wetland system can be considered **High**. It is however expected that impacts to surface water, if any, would be primarily be on the Amansuri River. In line with a precautionary approach, the surface water sensitivity of the Amansuri River can be considered **Moderate**.

G.4.4.3. Construction Phase

Regarding the construction phase of the Project, the following sources of impact have been identified. Without mitigation, the sources listed below have the potential to cause impacts on surface water resources.

Table G17 Key sources of potential surface water impacts and risks - construction and pre-commissioning phase

Source of Potential Impact	Potential Impact
Movement of vehicles, equipment and personnel	Temporary effects of sediment on surface water, spills leading to potential contamination from fuels, lubricant oils and chemicals.
Development (including site clearance and preparation) of temporary facilities (work site, construction site, stockyard)	Temporary effects of sediment on surface water. Removal of any ephemeral or permanent surface water bodies within the construction site.
Hardening of surfaces, removal of natural vegetation and construction or roads and other facilities.	Will result in less rainwater being able to infiltrate the soil, which could lead to increased runoff and degradation to nearby surface water bodies through increased sediment load.
Storage and handling of fuels and chemicals	Potential temporary contamination of water resources due to accidental spillages of the fuels and chemicals used during construction.
Preparation of the Project site (topsoil removal, infilling and construction)	Increased sedimentation and temporary effects of sediment on surface water, and the potential effects on hydrological and hydraulic regime.
Pipelines and equipment hydrotesting	Temporary consumption of water resources, potential temporary contamination of water resources from leakage

The impact assessment on surface water resources described in the following sections is based on the analysis of the sources of potential impact reported in Table G16.

<u>Impacts Identification and Assessment</u>

The aim of this Section is to identify the possible impacts on water quality and hydrologic aspects during the construction and pre-commissioning phase, including onshore hydrotesting. The potential impacts on surface water resources are likely to be confined to the Project site, the area surrounding the onshore pipeline sections and access roads associated with the ORF site.

Key potential impacts on surface water resources are the following:

- Removal of ephemeral ponds within the Project site (or onshore concession area).
- Degradation of surface water quality in the extended AoI due to increased sediment load resulting from increased erosion, surface runoff (from hardstanding) and dust generation.
- Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste.
- Degradation of surface water quality due to accidental spillages of the fuels and chemicals used during construction.
- Changes in hydrology and/or the hydrological regime caused by reduced flows and/or changes in flow direction caused by projected related work (i.e. site clearance, earthworks and constructions).

Removal of Ephemeral Surfacewater Water Bodies

Site clearance and preparation activities will potentially result in the loss of ephemeral ponds in the vicinity of the ORF and onshore pipeline sections. Ponds that fall within the onshore concession footprint area will be infilled as part of the site preparation and levelling works prior to construction. The loss of ephemeral ponds is an on-site impact that could result in the loss of ecological functions provided by such ponds, and specifically the loss of habitat for resident species.

Degradation of Surface Water Quality due to Increased Sediment Load (Resulting from Increased Erosion and Dust)

Activities such as the removal of vegetation, site levelling, grading, infilling of the wetlands, trench excavation and backfilling, pipeline laying, rehabilitation and the use of existing dirt roads are likely to cause erosion and generate dust. This could result in a relatively rapid increase in sediment load in the surrounding seasonal wetland system and nearby surface water bodies if not controlled. In this regard, the temporary exposure of surface materials to rainfall, erosion and scour may deliver coarse and fine sediment via surface runoff to watercourses and water bodies, with related potential changes in the magnitude and timing of natural suspended sediment transport in surface water. Although increased sedimentation may affect surface water bodies directly adjacent and downslope of the site, it is unlikely to result in significant sedimentation effects on the Amansuri River.

A change in sedimentation patterns in a system can negatively impact the physical and chemical variables such as temperature, oxygen, turbidity and salinity levels. Specific impacts associated with such biophysical changes can include:

- Increased sedimentation can lead to barriers, causing the loss of connectivity within the fresh-water wetlands and between the fresh-water wetlands and the estuaries.
- Increased sedimentation can cause changes in streambed conditions (ie the porosity and composition of the aquatic streambeds).
- Turbidity determines the degree of penetration of light, and hence impacts the photosynthesis of plants.
- A change in the suitability of the substrate composition can affect some benthic taxa, and increased drift (i.e. the rate at which organisms move by floating downstream) affects respiration and feeding activities.

- High turbidity and suspended sediment concentrations cause physiological effects in fish (i.e. impairment of gill function or reduced resistance to diseases), a reduction in suitable spawning habitat and hindering of development (eggs, larvae and juveniles), and changes in migration patterns.

Degradation of Surfacewater Quality due to Potential Contamination from Improper Handling of Hazardous and Non-hazardous Waste

Various waste streams will be generated during the construction phase, including:

- Non-Hazardous Solid Waste will be generated including, but not limited to, plastic packaging, glass, kitchen waste, paper and cardboard, wood and domestic waste.

- Hazardous waste will be generated including, but not limited to, used oils and lubricants, batteries, tank sludge, rubber, chemicals, paints, fluorescent lighting tubes, glue, fuel and oil filters, metal or plastic containers that previously contained hazardous material and medical waste.

Water that has come into contact with waste products which are improperly stored, discarded or disposed on- or off-site entering surface water bodies has the potential to negatively impact on local surface water quality. The magnitude of the change in water quality would depend on the nature of the waste materials being stored, discarded or disposed to the environment. There is potential for contaminated surface run-off to result in groundwater concentrations above national or international standards or guidelines.

Degradation of Surface Water Quality due to Accidental Spillages of the Fuels and Chemicals

Surface water is vulnerable to contamination which may arise as a consequence of mobilisation of any contaminant (e.g. fuel, oil or lubricant) present in the soil by rainfall and run-off. This type of contamination could arise from fuel spills, release of oily water, testing of equipment and other sources. During working strip, access roads and project facilities construction, potential contamination of the ground may arise from the transport, storage and handling of fuels, lubricants and chemicals. Potential contamination may also occur at the ORF main camp, as it will also be the main stockyard for the onshore pipeline and accommodation for workers.

Accidental minor spills and leaks could affect surface water quality and the biotic environment within these ecosystems. These can have acute as well as chronic effects on flora and fauna within the systems, resulting in the potential loss of sensitive biota. Changes to water quality could also result in:

- relocation of a community of aquatic organisms;
- introduction or loss of species;
- reduction in diversity as a result of increases in the concentration of toxins such as trace metals; and
- reduced ecosystem functioning.

Changes in Hydrology by Reduced Flows and/or Changes in Flow Direction

The development of the Project will require infill and levelling. In some locations fill will be used to raise the ground elevation to up to 3 m. The result will be a change in topography and thus a change in surface water drainage patterns within portions of the Project site as well as areas directly adjacent to the Project site. Similarly, excavation for topsoil removal in the working strip can affect the hydrological and hydraulic regime of the area. Especially in areas with high slope rates, the terrain mobilisation can result in landslip phenomena and in a loss of resistance against soil erosion by runoff and runout or other external agents, influencing the drainage network. Therefore, excavation works may cause the collapse of such structures resulting in hydrological and hydraulic effects on the adjacent areas.

During periods of high rainfall, the seasonal wetland that surrounds the Project site may have a weak hydraulic connection to the larger wetland system to the north and west of the Project site. During these periods there may be impacts on the hydrology and water quality of the neighbouring seasonal wetlands due to the change in flow patterns created by development of the Project site. Impacts could include an increase in water flow due to runoff from the Project site drainage systems, or damming effects disrupting surface water flows caused by raised areas of the Project site. Despite this, as the surface water systems are predominantly seasonal in nature (i.e. empemeral) and located at the bottom of a catchment, the downstream impacts are expected to be minimised.

Mitigation Measures

Removal of Ephemeral and Permanent Surfacewater Bodies

The following management measures will be implemented in the project's environmental management plans:

- The footprint of the site will be minimised. Storage and laydown areas, vehicle parking areas and workers' facilities such as accommodation, eating halls and toilet facilities need to be clearly specified, and activities will be restricted to these areas. Construction staff and contractors will be informed of the importance of minimising footprint and restricting activities to designated areas.

- The outer limits of wetland buffers in the vicinity of planned developments will be surveyed (during pre-construction), clearly defined on the ground and marked as no-go areas prior to the onset of construction activities.
- The deposition of material onshore will be restricted to the areas to be infilled.

- Disturbed areas will be re-vegetated with a diversity of naturally occurring tree species, including locally endemic species.

Degradation of Surface Water Quality due to Increased Sediment Load (Resulting from Increased Erosion and Dust)

The following management measures will be implemented in the project's environmental management plans:

- Topsoil will be stripped and stored away from watercourses in designated topsoil stockpile areas.

- The runoff from bare areas, such as access roads, would need to be collected and conveyed by adequate side drains. This water, which would be high in total suspended solids (TSS) content, will be attenuated and retained sufficiently to allow sediment to settle prior to the discharge of the sufficiently clean supernatant.

- The quality of runoff in watercourses will be monitored on a regular basis depending on flow and corrective actions taken as appropriate.

- Intercepting channels will be provided to prevent stormwater run-off from washing across exposed soil surfaces.

- Surface water management structures within the construction areas must include stream diversion channels, internal run-off capture and diversion channels, to control sedimentation wherever necessary.

- Where required, drainage channels will be provided on-site to direct stormwater to sand/silt traps for the removal of soil particles.

- All exposed areas will be stabilised once the covering vegetation has been removed.

- Monitor stockpiles for erosion and implement erosion control measures if required.

- Adequate dust control strategies will be applied to minimise dust deposition and reduce sedimentation in the wetland systems, for example:
  - periodic spraying of roads with water or dust inhibitor; and
  - covering transport trucks/spraying hauling materials that have the potential to become airborne, to prevent dust emission during transport.
  - maximum permitted vehicle speed will be reduced in the proximity of water courses, in order to reduce the amount of dust that potentially could sediment in the water course.

- After being removed, excavated topsoil and subsoil stockpiled in the proximity of the trenching will be irrigated periodically, in order to reduce its dispersion towards surface water by the action of the wind.

- Monitor the turbidity and suspended solids on an ongoing basis as part of a surface water monitoring programme, to ensure that levels do not increase or decrease by more than 10 to 15 percent of recorded baseline levels.

Degradation of Surfacewater Quality due to Potential Contamination from Improper Handling of Hazardous and Non-hazardous Waste

- A waste inventory of potential wastes will be generated prior to construction. A plan for waste management (including disposal) will be developed based on the waste inventory, as a minimum, in line with national and international requirements. As part of this plan:
  - It will be verified that all transport of waste meets Ghana regulations as well as internationally recognised standards;
  - Where appropriate, government-approved disposal sites, methods and contractors will be used when disposing of waste;
  - Disposal sites that meet internationally recognised standards will be used; when disposing of hazardous waste;
  - Hazardous waste will be segregated from other waste;
  - Waste tracking records will be retained for periods defined by local legal requirements. Sufficient and adequate facilities will be available to store solid wastes to the extent required;

  - All solid wastes will be sorted by type, compacted where practicable, and stored before handover to a qualified waste contractor for disposal to an appropriate facility;
  - All aspects of waste management will be fully described in the monitoring documentation;
  - Complete records of waste produced, segregated, and stored during the construction phase will be kept; and
  - Management measures will be identified and implemented to reduce seepage to the groundwater system.

Degradation of Surface Water Quality due to Accidental Spillages of the Fuels and Chemicals

- Handling, storage and disposal or containers of potentially hazardous materials will be in accordance with the requirements of the relevant legislation.

- Fuels and other hazardous chemicals will be stored according to industry best practice including bunds that can accommodate 150 % of the total storage volume and covered to prevent rainfall entering the bund.

- Refuelling of equipment and vehicles will be carried out in designated areas on hard standing ground to prevent seepage of any spillages to ground. Collection systems will be installed in these areas to manage any spills, fuels will be collected and either reused, treated or removed by an approved local contractor.

- Vehicles, vessels and equipment working onshore near the estuaries or in the near shore will be serviced regularly.

- Project staff will not be permitted to utilise any natural water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing or for any other construction or related activities.

- An Emergency Response and/or spill contingency plan will be in place for any accidental spillage. Spill containment and clean-up kits will be available on-site, and clean-up from any spill must be carried out at the time of a spillage, with appropriate disposal as necessary.

- Temporary fuel stored along the pipeline working strip and access roads will be correctly bunded during construction.

- Spills to ground (soil) will be remediated immediately by an appropriately qualified person and the remediation verified.

Changes in Hydrology by Reduced Flows and/or Changes in Flow Direction

- No effluent will be discharged into the fresh-water or seasonal wetlands.

- No water will be pumped from wetlands (for Project need).

- No impoundments or ponds will be constructed within any of the wetlands or within the 150 m buffer zone around streams and wetlands.

- Wherever possible, existing roads will be upgraded rather than building new ones.

- Considering that the topsoil removed during construction activities will be restored, vegetation will be reinstated in the project area and the drainage from the working areas will be granted, potential erosion/flood events due to rainfall runoff will be minimized.

- If structures (e.g. overpasses) are required to cross streams, construction will, wherever possible, minimise in-stream supporting structures to ensure minimal impact on the in-stream habitat.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined by eni Standard requirements (*Environmental, Social and Health Impact Assessment Standard - Doc n° 1.3.1.47*), the residual impacts on surface water resources associated with the construction phase are summarised in Table G18.

Table G18 Ranking of Impacts on Surface Water Resources during Construction Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Surface Water Resources – Construction Phase					
Removal of ephemeral water bodies within the Project site	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	
Score	4	*1*	*3*	*1*	**9 - Medium**
Degradation of surface water quality due to increased sediment load	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Degradation of surface water quality due to spillages of the fuels and chemicals used during construction	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium**
Score	*2*	*2*	*3*	*1*	

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Surface Water Resources – Construction Phase					
Changes in hydrology and/or the hydrological regime caused by reduced flows and/or changes in flow direction caused by projected related work (ie site clearance, earthworks and constructions)	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium**
Score	*4*	*1*	*2*	*1*	

Given the assessment reported in the previous table, the residual impacts on the surface water component, due to Project construction activities is considered **Medium** to **Low**.

G.4.4.4. Operations and Maintenance Phase

During the operation phase, water consumption and waste production will be related to ORF operation and maintenance. The sources listed below could potentially cause impacts on water resources.

Table G19 Key sources of potential surface water impacts and risks - operation and maintenance phase

Source of Potential Impacts and Risks	**Potential Impact**
Generation and disposal of solid and liquid wastes	Potential temporary contamination of surface water resources from improper handling of hazardous and non-hazardous waste.
Movement of vehicles, equipment and personnel	Effects of sediment plumes on surface water, potential contamination from fuels, lubricant oils and chemicals.
Storage, transport and handling of fuels and chemicals	Potential contamination of water resources by hazardous and non-hazardous liquid effluents, and contamination of water resources by hazardous and non-hazardous wastes.
Pipelines and equipment	Consumption of water resources, potential contamination of water resources from leakage.

For the assessment of the potential impact on surface water resources due to operation, all the sources identified in the table above have been considered together, providing an overall assessment on the component.

<u>Impacts Identification and Assessment</u>

The potential impacts on surface water are likely to be confined to the ORF site during the operational and maintenance phase. Key potential impacts on surface water resources be the following:

- Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste.
- Degradation of surface water quality due to accidental spillages of the fuels and chemicals used during operation.

Degradation of Surfacewater Quality due to Potential Contamination from Improper Handling of Hazardous and Non-hazardous Waste

Various waste streams will be generated (predominantly from maintenance activities) during the operation phase, including:

- Non-Hazardous Solid Waste will be generated including, but not limited to, plastic packaging, glass, kitchen waste, paper and cardboard, wood and domestic waste.

- Hazardous waste will be generated including, but not limited to, used oils and lubricants, batteries, tank sludge, rubber, chemicals, paints, fluorescent lighting tubes, glue, fuel and oil filters, metal or plastic containers that previously contained hazardous material and medical waste.

Water entering surface water bodies that has come into contact with waste products stored, discarded or disposed on- or off-site has the potential to negatively impact on local surface water quality. There is potential for contaminated surface run-off to result in groundwater concentrations above national or international standards or guidelines.

Degradation of Surface Water Quality due to Accidental Spillages of the Fuels and Chemicals used

Minor accidental spills and leaks have the potential to affect the water quality of nearby surface water bodies and the biotic environment within these ecosystems. These impacts typically arise from poor maintenance of machinery, resulting in petroleum fuel, oil or hydraulic leaks. These substances and their constituents can have acute as well as chronic effects on flora and fauna within the systems, resulting in the potential loss of sensitive biota. Furthermore, a loss of biodiversity resulting from spills/leaks could lead to changes in the community structure, such as the loss of sensitive species and the dominance of tolerant organisms.

The potential effects to fish and macro-invertebrate species are a function of the type of pollutant, concentration and the duration of exposure. Impacts associated with a small spill will have no significant impact on aquatic species, as the fuel/oil will quickly disperse and will not cause a detectable effect. However, impacts may result from a larger spill.

Mitigation Measures

Degradation of Surfacewater Quality due to Potential Contamination from Improper Handling of Hazardous and Non-hazardous Waste

- A waste inventory of potential wastes will be generated prior to construction. A Waste Management Plan (including disposal procedure) will be developed based on the waste inventory, as a minimum, in line with national and international requirements. As part of this plan:

- Transport of waste will meet internationally recognised standards;
- Where appropriate, government-approved disposal sites, methods and contractors will be used when disposing of waste;
- Disposal sites that meet internationally recognised standards will be used; when disposing of hazardous waste;
- Hazardous was will be segregated from other waste;
- Waste tracking records will be retained for periods defined by local legal requirements. Sufficient and adequate facilities will be available to store solid wastes to the extent required;
- All solid wastes will be sorted by type, compacted where practicable, and stored before handover to a qualified waste contractor for disposal to an appropriate facility;
- All aspects of waste management will be fully described in the monitoring documentation;
- Complete records of waste produced, segregated, and stored during the construction phase will be kept.
- Management measures will be identified and implemented to reduce seepage to the groundwater system.

Degradation of Surface Water Quality due to Accidental Spillages of the Fuels and Chemicals used

- Procedures for vehicle/equipment refuelling will be implemented to prevent spillage and will prohibit construction vehicles and equipment to be refuelled near water courses. Appropriate spill containment equipment will be available at refuelling sites. All drivers will be trained in emergency spill response procedures.

- Any storage facilities containing hazardous substances will be lined, bunded or otherwise designed to prevent seepage and impact to surface water or groundwater.
- Project staff will not be permitted to utilise any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing or for any other construction or related activities.

- Vehicles, vessels and equipment working onshore or in the near shore will be serviced regularly.

- Oil spill prevention and response plans will be put in place. Temporary fuel stored along the pipeline and access roads for maintenance purposes will be correctly bunded during construction.

- An Emergency Response and/or spill contingency plan will be in place for any accidental spillage. Spill containment and clean-up kits will be available on-site, and clean-up from any spill must be in place and executed at the time of a spillage, with appropriate disposal as necessary.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined by eni Standard requirements, the potential impacts on freshwater resources associated with the operation phase are summarized in Table G20.

Table G20 Ranking of Impacts on Surface Water Resources during Operation Phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Freshwater Resources – Operation Phase					
Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**6 - Low**
Score	2	1	2	1	
Degradation of surface water quality due to spillages of the fuels and chemicals used during operation	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	2	1	2	1	

The residual impacts on the surface water resources due to Project operation activities is **Low.**

G.4.4.5. Decommissioning Phase

For ORF facilities decommissioning, apart from the impact associated with the removal of ephemeral and permanent ponds within the Project site, the potential impacts and the mitigation measures will be the same as the construction phase for the ORF area (foreseen as **Medium** to **Low**).

For pipeline decommissioning, considering that the pipes will remain underground and related impacts on freshwater resources will be **Not significant**.

G.4.5 Groundwater

G.4.5.1 Overview

This section identifies and assesses the main impacts on onshore environment, proposes mitigation and management measures and then discusses the conclusion and impact ranking applying methodology described in section G.2for project construction and operation activities relating to groundwater resources.

The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on groundwater resources.

The impact assessment in this Section is based on the current Project design. Eni Ghana is undertaking a further Water Risk Assessment Study (expected to be completed March 2015) to evaluate options for water supply and with an objective to minimise the environmental, social and health impacts and improve water management.

Box G2 Key Sources of impact, potentially impacted resources and receptors

Sources of Impact

- Construction Phase: site clearance and preparation; surface sealing, compaction and infilling; construction of roads and other facilities; ORF construction; construction of temporary facilities (work site); movements of vehicles; equipment and personnel; water consumption; unplanned events (hydrocarbon spills); improper waste and wastewater management.
- Operations and maintenance phase: water consumption, unplanned events (hydrocarbon spills), movement of vehicles, waste and wastewater management and effluent discharge.
- Decommissioning phase: ORF decommissioning, movements of vehicles, equipment and personnel, water consumption; improper waste and wastewater management.

Potentially Impacted Resources and Receptors

- Groundwater and indirectly marine water.
- Flora and Fauna.

Baseline Influencing Factors

- The Project area is situated within an area dominated by Cenozoic and Mesozoic sediments with three main aquifers, namely a shallow unconfined freshwater aquifer, a saltwater aquifer in the sandy layer and a deep freshwater aquifer.
- The shallow aquifer is a sandy unconfined aquifer and occurs in the recent sand close to the coast. It is between 2 m and 4 m deep and contains fresh meteoric water.
- The intermediate aquifer is either semi-confined or confined and occurs mainly in the Red Continental deposits of sandy clay and gravels. The depth of this aquifer varies from 6 m to 120 m, and it contains mostly saline water.
- The third aquifer is a deep limestone aquifer, which varies in depth between 120 m and 300 m. The groundwater in this aquifer occurs under artesian condition and is fresh.
- Recharge of the aquifer systems is mainly by direct infiltration of precipitation through fracture and fault zones along the highland fronts and also through the sandy portions of the weathered zone. Some amount of recharge also occurs through seepage from ephemeral stream channels during the rainy seasons.

Project Influencing Factors

- Specific techniques used for waste management and storing, handling and transport of fuels and chemicals.

The following table presents the key impacts of the project on the groundwater component during the key project phases as presented in Table G21.

Table G21 Key impacts – groundwater

Construction Phase	Operations Phase	Decommissioning Phase
• Reduction in groundwater resources through consumption of water for both domestic and industrial use by the Project. • Surface sealing and infilling leading to lowering of groundwater levels by restricting recharge. • Degradation of groundwater quality due to seepage from discharge of wastewater and temporarily improper handling and stored waste. • Degradation of groundwater quality due to spillages of the fuels and chemicals used on Project site (unplanned events).	• Reduction in groundwater resources through consumption of water for both domestic and industrial use. • Degradation of groundwater quality due to seepage from discharge of wastewater and temporarily improper handling and stored waste.. • Degradation of groundwater quality due to spillages of the fuels and chemicals used on Project site (an unplanned event).	• Reduction in groundwater resources through consumption of water for both domestic and industrial use. • Degradation of groundwater quality due to seepage from discharge of wastewater and temporarily improper handling and stored waste. • Degradation of groundwater quality due to spillages of the fuels and chemicals used on Project site (an unplanned event).

Please note that the impacts on community health are addressed in Section G7.7.

The *sensitivity* of the groundwater component is reported in the following Sections. Then potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project. Conclusions are presented taking into account the application of the identified mitigation measures.

G.4.5.2 Groundwater Sensitivity

Measurement of groundwater samples taken from nearby communities boreholes indicate near neutral pH and low salinity but high electrical conductivity levels and high levels of BOD and nutrients (ie Phosphate, Nitrate and Silicates) and Lead (Pb), Iron (Fe) and Mecury (Hg) concentrations above WHO and Ghana EPA standards for drinking water. There were also high levels of total coliforms and faecal coliforms in water samples taken, as well as E.coli and total heterotrophic bacteria.

The aquifers in the Project site are considered to be of a moderate level of vulnerability and susceptibility as the area has sandy soils which allow good infiltration and there are shallow unconfined aquifers that exist near to the surface. This aquifer is vulnerable to contamination as a result of unplanned events such as spills.

Taking this into account the groundwater sensitivity of the local area is considered **Moderate**.

G.4.5.3 Construction Phase

Regarding the construction phase of the Project, the following sources of impact have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on groundwater resources.

Table G22 Groundwater impacts and risks = construction and pre-commissioning phase

Source of Potential Impact	Potential Impact
Movement of vehicles, equipment and personnel	Potential contamination from accidental release of fuels, lubricant oils and chemicals.
Water consumption	Reduction in groundwater resources through consumption of water by the Project for both domestic and industrial uses
Generation and disposal of solid and liquid wastes	Potential temporary contamination of surface water resources from wastewater discharges and from improper handling of hazardous and non-hazardous waste (unplanned event).
Storage and handling of fuels and chemicals	Potential temporary contamination of groundwater resources by spilled fuels and chemicals (unplanned event).
Hardening of surfaces, removal of natural vegetation and construction or roads and other facilities.	Reduction in groundwater resources through consumption of water for both domestic and industrial uses (resulting from less rainwater being able to infiltrate the soil, which will lead to localised lowering of groundwater levels and recharge (drawdown)). Surface sealing and infilling leading to lowering recharge (drawdown).
Pipelines and equipment hydrotesting	Potential temporary contamination of water resources from leakages or fuel or chemical spills.

The impact assessment on groundwater resources described in the following sections is based on the analysis of the sources of potential impact reported in Table G22.

Impacts Identification and Assessment

The potential impacts on groundwater are likely to be confined to the ORF site and the area surrounding the onshore pipeline corridor and associated access roads. Effects from contamination of groundwater are unlikely to extend beyond these areas.Key potential impacts on groundwater resources are the following:

- Reduction in groundwater resources through consumption of water by the Project for both domestic and industrial uses.
- Surface sealing and infilling leading to lowering of groundwater levels and recharge (drawdown).
- Degradation of groundwater quality due to seepage from discharge of wastewater and temporarily stored waste on the Project site.
- Degradation of groundwater quality due to spillages of the fuels and chemicals used during construction.

Reduction in Groundwater Resources due to Water Consumption
The water consumption envisaged during the construction phase is related primarily to the watering of construction sites to reduce dust emissions during earth moving activities and for domestic uses.

During pre-commissioning, seawater will be used for hydrotesting of both onshore and offshore pipeline, therefore this activitiy will not have an effect on groundwater.

The estimated water consumption foreseen during construction is listed in Table G23 below.

Table G23 Water consumption estimated during the construction phase

Typology	Quantity	Comments
Onshore		
Water for consumption	Approximately 60-70 m^3/day during construction	100 l/person per day
Industrial water	20 m^3/day	Working strip dust control
Seawater	500-600 m^3	For hydrotesting

Source: eni, 2014

Water for onsite consumption and working strip dust control will be sourced via deep groundwater abstraction wells on-site. Based on the desktop information on the hydrogeology of the area, the likely drawdown and change in water quality has not been quantified; however, there is unlikely to be an impact on the upper sandy aquifer as a result of abstraction from the deep limestone aquifer as these two systems are understood to be separate. Furthermore, it will be confined to the local area and persist in the short term (during the construction phase).
These conclusions will be confirmed through additional pump testing to confirm effects of abstraction on the aquifer .

Surface Sealing and Infilling Leading to Lowering of Groundwater Levels
Construction at the Project site could lead to increased erosion by concentrating water flows and removing the natural erosion protection (vegetation cover), as well as increasing run-off from the Project site, thus reducing infiltration and groundwater recharge.

In addition, sealing of a surface with concrete or tarred surfaced will result in some increases in stormwater run-off, reduced direct groundwater recharge and localised lowering of the groundwater water table. This could have further effects of seawater intrusion and changes to groundwater quality (i.e. increased salinity).

Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling
The various waste streams generated during the construction phase are described in Section G.4.4.3 above. The seepage of rainwater that has come into contact with waste products that have been improperly stored, discarded (unplanned event) or disposed on- or off-site has the potential to impact on local groundwater water quality. The magnitude of the change in water quality from this seepage would depend on the nature of the waste materials being stored, discarded or disposed to the environment. There is potential for seepage from these waste materials to result in groundwater concentrations above national or international standards or guidelines.
Sewage and any other discharged process effluents from the construction camp, Project site and/or temporary drainage system could result in undesirable water quality constituents

entering the groundwater through infilitation and unplanned events such as spills and leaks. This has the potential to negatively impact on local groundwater quality.

Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals
Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from construction vehicles or storage tanks. Hydrocarbons are toxic to the ecosystem, with spills and leaks of hydrocarbon product having potential negative impacts on the surface and groundwater ecosystems.

These impacts are dependent on the size of the spill and the speed with which it is remediated, as well as the vulnerability and susceptibility of the aquifer. Given the moderate level of vulnerability and susceptibility of the aquifer (refer to Section G.4.5.2) the potential impacts due to spills are likely to be of a moderate significance. However, the Project site is located less than 500 m from the marine environment so the extent of any groundwater contamination would be limited to the local area.

Mitigation Measures

Reduction in Groundwater Resources due to Water Consumption

- The use of water on-site will be optimised by minimisation of water use, and recycling to reduce the demand for groundwater extraction, All wells used for water supply will be installed at sufficient depths to access the deep freshwater aquifer in line with outcomes of the current pump testing results which will help to quantify effects of abstraction on the aquifer.
- Within the water management plan and on the basis of further investigations, thresholds for the amount of groundwater that can be extracted by the Project will be established.

Surface Sealing and Infilling Leading to Lowering of Groundwater Levels and Drawdown

- Groundwater level change (drawdown) cannot be mitigated. It is therefore recommended that groundwater levels in the vicinity of the eni concession area are monitored on a regular basis throughout the construction phase.

Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling

- A waste inventory of potential wastes will be generated prior to construction. A plan for waste management (including disposal) will be developed based on the waste inventory, as a minimum, in line with national and international requirements. As part of this plan:
    - It will be verified that all other transport of waste meets internationally recognised standards;
    - Where appropriate, government-approved disposal sites, methods and contractors will be used when disposing of waste;
    - Disposal sites that meet internationally recognised standards will be used; when disposing of hazardous waste;
    - Hazardous waste will be segregated from other waste;

- Area storing hazardous and non-hazardous liquid will be protected from direct contact with the soil and in case of liquid waste, provided with secondary containment
- Waste tracking records will be retained for periods defined by local legal requirements. Sufficient and adequate facilities will be available to store solid wastes to the extent required;
- All solid wastes will be sorted by type, compacted where practicable, and stored before handover to a qualified waste contractor for disposal to an appropriate facility;
- All aspects of waste management will be fully described in the monitoring documentation;
- Complete records of waste produced, segregated, and stored during the construction phase will be kept.
- Management measures will be identified and implemented to reduce seepage to the groundwater system.

- Waste water discharge to the environment is foreseen from the onshore activities during construction phase.
- Project staff will not be permitted to utilise any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing or for any other construction or related activities.
- All wastewater generated during construction will be collected in a saver pit and treated and disposed of in conformity with legal requirements. There will be no direct discharge of wastewater to onshore water receptors.
- Within the Water Management Plan, and on the basis of further investigations, thresholds for quality of groundwater that cannot be exceeded as a result of seepage will be established.

Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals (Unplanned Event)

- Vehicles, vessels and equipment working onshore near the estuaries or in the near shore will be serviced regularly.
- Temporary fuel stored along the pipeline working strip and access roads will be correctly bunded during construction.
- Handling, storage and disposal of excess or containers of potentially hazardous materials will be in accordance with the requirements of the relevant legislation.
- Fuels and other hazardous chemicals will be stored according to industry best practice including bunds that can accommodate 150 % of the total storage volume and covered to prevent rainfall entering the bund.
- Refuelling of equipment and vehicles will be carried out in designated areas on hard standing ground to prevent seepage of any spillages to ground. Collection systems will be installed in these areas to manage any spills, fuels will be collected and either reused, treated by incineration or removed by an approved local contractor.
- Spills to ground (soil) will be remediated immediately by an appropriately qualified person and the remediation verified.

- Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site.
- An Emergency Response and/or Spill Contingency Plan will be in place for any accidental spillage. Spill containment and clean-up kits will be available on-site, and clean-up from any spill must be in place and executed at the time of a spillage, with appropriate disposal as necessary.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on groundwater resources associated with the construction phase are summarised in Table G24.

Table G24 Ranking of impacts and risks on groundwater during construction phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Freshwater Resources – Construction Phase					
Reduction in Groundwater Resources due to Water Consumption	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7 - Medium**
Score	*2*	*1*	*2*	*2*	
Surface Sealing and Infilling Leading to Lowering of Groundwater Levels and Drawdown	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Freshwater Resources – Construction Phase					
Score	*2*	*1*	*2*	*1*	
Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

Given the assessment reported in the previous table, the impacts on the groundwater component due to Project construction activities are considered **Medium** to **Low**.

G.4.5.4 Operations and Maintenance Phase

During the operation phase for the onshore component of the project, water consumption and waste production will be related to ORF operation and maintenance. The sources listed below could potentially cause impacts on water resources.

Table G25 Groundwater impacts - operational and maintenance phase

Source of Potential Impact	**Potential Impact**
Movement of vehicles, equipment and personnel	Potential contamination from fuels, lubricant oils and chemicals.
Water consumption	Consumption of water from groundwater wells on-site will create a reduction in groundwater quantity at the source.
Generation and disposal of solid and liquid wastes	Potential temporary contamination of groundwater resources by hazardous and non-hazardous liquid effluent discharge and contamination of water resources by improper handling hazardous and non-hazardous wastes.
Storage and handling of fuels and chemicals	Potential temporary contamination of groundwater resources by spilled fuels and chemicals (this represents an unplanned event).

For the assessement of the potential impact on groundwater resources due to operation, all the sources identified in the table above have been considered together, providing an overall assessement on the component.

<u>Impacts Identification and Assessment</u>

The potential impacts on groundwater are likely to be confined to the ORF site and onshore pipeline corridor; however effects could potentially extend off-site (i.e., locally). Key potential impacts on groundwater will be the following:

- Reduction in groundwater resources through consumption of water for both domestic and industrial use.
- Degradation of groundwater quality due to seepage from discharge of wastewater and temporarily stored waste on the Project site.
- Degradation of groundwater quality due to spillages of the fuels and chemicals used during operations (this would be considered an unplanned event).

Reduction in Groundwater Resources due to Water Consumption

During the operation phase water consumption will be related to ORF operation. This consumption will be low and associated with domestic use and facility maintenance. In particular, water consumption will be intended to:

- Provide potable water to the ORF buildings (such as control building) to satisfy personnel needs.
- Supply service water to the various plant areas of the ORF for general purposes and to satisfy the equipment washout needs.
- Supply service water to the fire extinguishing water cistern (stored in a tank).

Table G26 Water consumption estimated during the operational phase

Typology	**Quantity**	**Comments**
Onshore		
Water for consumption	7 – 10 m^3/day	100 l/person per day

Source: eni, 2014

Water will be sourced via deep groundwater abstraction wells on-site. This extraction is likely to lower the groundwater table in the local area. The likely drawdown and change in water quality has not been quantified; however, the impact on the upper aquiferis likely to be of low intensity given as the water will be sourced from the deep freshwater aquifer. The impact is likely to be confined to the local area and persist in the long term (during the life of the project with recovery in post closure).

Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling

The various waste streams generated during the operation phase are described in Section G.4.4.4 above.

The seepage of rainwater that has come into contact with waste products improperly stored, discarded or disposed on- or off-site has the potential to impact on local groundwater water quality. The magnitude of the change in water quality from this seepage would depend on the nature of the waste materials being stored, discarded or disposed to the environment. There is potential for seepage from these waste materials to result in groundwater concentrations above national or international standards or guidelines.

Sewage and any other discharged process effluents from the wastewater treatment plant could result in undesirable water quality constituents entering the groundwater through infilitation. This also has the potential to negatively impact on local groundwater water quality.

Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals (Unplanned Event)

Groundwater may be impacted as a result of infiltration of contaminants associated with spills or leaks of fuels, oils and lubricants from operation and maintenance activities. Hydrocarbons are toxic to the ecosystem, with spills and leaks of hydrocarbon product having potential negative impacts on the surface and groundwater ecosystems.

Depending on the type of chemical/fuel spilled, its relative mobility through the soil layer and depth to groundwater there is potential for the concentration of contaminants to be elevated above national or international guideline levels (for example WHO drinking water guidelines). Given the moderate level of vulnerability and susceptibility of the aquifer (refer to Section G.4.5.2) the potential impacts due to spills are likely to be of a moderate significance. However, the Project site is located less than 500 m from the marine environment so the extent of any groundwater contamination would be limited to the local area.

<u>Mitigation Measures</u>

Reduction in Groundwater Resources due to Water Consumption

- The use of water on-site will be optimised by minimisation of water use, re-use and recycling to reduce the demand for groundwater extraction.
- All wells installed for water supply will be installed at sufficient depths to access the deep freshwater aquifer to avoid impacts on groundwater resources used by local communities.

Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling

- A waste inventory of potential wastes will be generated prior to construction. A plan for waste management (including disposal) will be developed based on the waste inventory, as a minimum, in line with national and international requirements. As part of this plan:
    - It will be verify that all other transport of waste meets internationally recognised standards;
    - Where appropriate, government-approved disposal sites, methods and contractors will be used when disposing of waste;
    - Area storing hazardous and non-hazardous liquid will be protected from direct contact with the soil and in case of liquid waste, provided with secondary containment. Disposal sites that meet internationally recognised standards will be used; when disposing of hazardous waste;
    - Hazardous was will be segregated from other waste;
    - Waste tracking records will be retained for periods defined by local legal requirements. sufficient and adequate facilities will be available to store solid wastes to the extent required;
    - All solid wastes will be sorted by type, compacted where practicable, and stored before handover to a qualified waste contractor for disposal to an appropriate facility;
    - All aspects of waste management will be fully described in the monitoring documentation;

- Complete records of waste produced, segregated, and stored during the construction phase will be kept.
- Management measures will be identified and implemented to reduce seepage to the groundwater system.

- Should a landfill be constructed in the future, this will be designed to industry best standards for wastes generated at the Project site. This will include the installation of natural or synthetic liners and management of surface water to prevent overflow of the system. Additional permits would be obtained prior to construction through separate applications as required by Ghanaian requirements.
- The permanent facilities will be equipped with a sewage treatment system to treat civil water from toilets, showers, lavatories, kitchen and laundry. An Imhoff tank will be installed. Compared to other treatment solutions, the use of an Imhoff tank shall imply the management of lower and limited volumes of wastewater, which could be likely reflected in a reduction of environmental impacts. Treated water will be discharged through an underground infiltration network, while sewage sludge will be disposed as waste offsite.
- Project staff will not be permitted to utilise any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing or for any other construction or related activities.
- All wastewater generated during construction will be collected in a saver pit and treated and disposed of in conformity with legal requirements. There will be no direct discharge of wastewater to water receptors.
- Particular care will be taken to ensure that land drainage infrastructure, access roads, other networks and facilities disturbed/moved during construction will be reinstated to their former state.

Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals (Unplanned Event)

- An Emergency Response and/or spill contingency plan will be in place for any accidental spillage. Spill containment and clean-up kits will be available on-site, and clean-up from any spill must be in place and executed at the time of a spillage, with appropriate disposal as necessary.
- Fuels and other hazardous chemicals will be stored according to industry best practice including bunds that can accommodate 150% of the total storage volume and covered to prevent rainfall entering the bund.
- Refuelling of equipment and vehicles will be carried out in designated areas on hard standing ground to prevent seepage of any spillages to ground. Collection systems will be installed in these areas to manage any spills, fuels will be collected and either reused, treated by incineration or removed by an approved local contractor.
- Spills to ground (soil) will be remediated immediately by an appropriately qualified person and the remediation verified.
- Handling, storage and disposal of excess or containers of potentially hazardous materials will be in accordance with the requirements of the relevant legislation.
- Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a registered landfill site.

- Vehicles, vessels and equipment working onshore near the estuaries or in the near shore will be serviced regularly.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on groundwater resources associated with the operation phase are summarised in Table G27.

Table G27 Ranking of impacts and risks on groundwater during operation and maintenance phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Groundwater Resources – Operation Phase					
Reduction in Groundwater Resources due to Water Consumption	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	
Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals (Unplanned Event)	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	

The impacts on the groundwater resources due to operational and maintenance activities are considered of **Medium** significance. This is mainly due to the duration criteria (Project lifetime is about 20 years).

G.4.5.5 Decommissioning Phase

For ORF facilites decommisioning the potential impacts and the mitigation measures will be the same as for the construction phase for the ORF area (foreseen as **Medium** to **Low**).

For pipeline decommissioning, considering that the pipes will remain underground and they will be only filled with a suitable material, the related impacts on groundwater resources will be **Not significant**.

G.4.6 Terrestrial Soils, Geology and Geomorphology

G.4.6.1 Overview

Potential impacts to soils, geology and geomorphology in all phases of the Project including construction, operation and decommissioning are assessed in this chapter.

Box G3shows the key sources of impact, potentially impacted resources and receptors, baseline and Project-influencing baseline factors associated with the impacts of the Project on geology and soils.

Box G3 Key Sources of risks and impact, potentially impacted resources and receptors

Sources of impact

- Construction phase: preparation of the working strip; construction of roads; ORF; construction of temporary facilities; vehicle movements, equipment and personnel; improper waste management, accidental spills of hazardous materials.
- Operations and Maintenance Phase: improper waste management; movements of vehicles, equipment and personnel; land take; accidental spills of hazardous materials.
- Decommissioning Phase: ORF decommissioning; movements of vehicles, equipment and personnel; improper waste management; accidental spills of hazardous materials; land take.

Potentially impacted resources and receptors

- People
- Soils
- Groundwater
- Flora and fauna
- Habitats
- Ecosystem Services Agricultural activity
- Landform

Baseline-influencing factors

- Sandy soils susceptible to erosion
- High rainfall

Project influencing factors

- Specific techniques used for topsoil removal, open cut, construction and operational ORF site management and effluent and waste management approach and activities.

Table G28 presents the key impacts of the project on the soil component during the key project phases.

Table G28 Key impacts and risks: soils

Construction Phase	Operations Phase	Decommissioning Phase
• Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste). • Potential disturbance and degradation of soil during the construction, including loss of productivity (erosion, soil compaction, soil removal modification of morphology, collapse and sinkhole formation). • Removal of soils (landtake) during earthworks and land clearance.	• Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste).	• Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste). • Potential disturbance and degradation of soil during the decommissioning activities (erosion, soil compaction, soil removal modification of morphology, collapse and sinkhole formation)

The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted. Conclusions are presented taking into account the application of the identified mitigation measures

G.4.6.2 Construction Phase

Regarding the construction phase of the Project, the following impact sources have been identified (Table G29). Without mitigation, the sources listed have the potential to cause impacts on soils.

Table G29 Soil impacts and risks - construction and pre-commissioning phase

Source of Potential Impact	***Potential Impact and Risks***
Movement of vehicles, equipment and personnel	Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste, compaction of the soil surface and potential degradation, collapse and sinkhole formation.
Clearance of vegetation cover	Potential disturbance and erosion of exposed soil, soil compaction.
Production, handling and disposal of solid and liquid wastes	Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste.
Set-up (including site preparation) of temporary facilities (work site, construction site, stockyard, block valve)	Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste. Potential disturbance and degradation of soil during the construction, including loss of productivity (erosion, soil compaction, soil removal modification of morphology, collapse and sinkhole formation).
Storage and handling of fuels and chemicals	Potential soil contamination (unplanned event, by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste.
Preparation of the working strip (topsoil removal)	Potential disturbance and degradation during construction, soil exposure, Potential soil contamination (by accidental spills of hazardous and non-hazardous materials and by improper handling of hazardous and non-hazardous waste, collapse and sinkhole formation, soil compaction
Horizontal drilling	Potential contamination from fuels, lubricant oils and chemicals, collapse and sinkhole formation
Displacement of areas of soil cover by Project infrastructure	Potential occupation of soil by infrastructures with limitation of soil functionalities (habitat, human activities, landscape), soil tamping, increase in impermeable surfaces, sealing of surfaces.

The impact assessment on soil reported in the following sections is based on the analysis of the sources of potential impact reported in Table G29.

Impacts Identification and Assessment

The Section describes the potential impacts on soil during the construction and pre-commissioning phase. The potential impacts on soil are likely to be largely confined to the concession area, pipeline ROW and associated access roads.

The sources of potential impacts on soil are the following:

- Potential contamination of soils;
- Potential disturbance and degradation of soil during construction; and
- Soil removal.

A total of area of approximately 190,000 m^2 will be required for the installation of the ORF and associated facilities. Additionally the area required for the construction of the pipeline, from landfall to the ORF, will be approximately 51,000 m^2 and 27,200 m^2 connecting the ORF and the existing pipeline. The area of the temporary construction camp will be approximately

30,000 m^2. The working strip for the pipeline extends 34 m each side of the pipeline during construction. The areas not used beyond construction phase will be rehabilitated, in total this area is expected to be in the order of 103,000 m^2.

Potential Contamination of Soil

Soil may potentially be polluted by accidental spills from vehicles, storage tanks and chemical stores, metalworking and welding residues, process waste and effluent. Soils could also be contaminated from improperly managed waste.

Contaminated or polluted soil can directly affect human health through direct contact with soil or via the infiltration of soil contamination into groundwater used for human consumption.

Contaminated soil can have harmful consequences for ecosystems. The changes in soil chemistry can arise from the presence hazardous chemicals even at low concentration in the contaminant species.

Soil contamination can have a negative impact on soil and will directly impact the soil where the contamination occurs. The duration of contamination once it has taken place is long term, depending on the nature and properties of the specific pollutant.

Potential Disturbance and Degradation

During the onshore construction works, soil movements will result from excavation and earthworks related to:

- Trenching;
- ORF construction;
- Temporary worksite preparation;
- Pipeline landfall open cut excavation.

As a consequence, during this phase the potential effects related to physical disturbance are:

- Loss of soil by removing or burying entire soil profiles, excavating bedrock, and covering areas under soil/rock stockpiles;
- Change in soil characteristics by compaction or erosion by construction vehicles around the hard standing pads, pipelines, access roads, bridges and land drains;
- Soil erosion and non-recoverable soil compaction that leads to soil degradation;
- Alteration of existing slopes and morphologies; and
- Degradation, alteration or compaction of topsoil stored in stockpiles.

Soil Erosion

During the construction phase, all soil forms will be susceptible to erosion to some extent because the natural vegetation will be cleared. Soils at the Project site have have a large sand fraction which means they are susceptible to erosion. The main potential consequences of soil erosion are the reduction in soil quality and the reduced water-holding capacity of eroded soils, but indirect consequences include disruption of riparian ecosystems and sedimentation leading to reduced surface water quality, changes in existing flooding regime, sediment runoff and reduction of crops areas. The significance of these impacts is assessed within the impacts on Surface Water and impacts on livelihoods.

Soil erosion causes an impact when the resource has been lost from the landscape, until it is suitably reclaimed and rehabilitated. Although there are off-site indirect impacts associated with this, the impact is mainly considered to be local.

Soil Compaction

Soil compaction can take place due to heavy load and increased traffic due to heavy construction vehicles in the area thus changing the soil structure. During the construction phase, soil is susceptible to compaction from heavy construction vehicles when soil is stripped and stockpiled. Soil compaction generally reduces the amount of water that plants can take up. This is because compaction crushes the macropores into micropores, increasing bulk density. The impacts of soil compaction are mainly direct and although the impact only has local extent, it is considered to be permanent as soil compaction is very difficult to remediate and will still continue after decommissioning.

During the construction phase, topsoil wherever found will be stripped and stockpiled for proposed activities including construction of the ORF, roads and accommodation areas. The reason for stripping topsoil is to have soil material available for rehabilitation following construction. The most critical and important part of the soil is the uppermost 20 cm as this is the repository for seeds, tubers, bulbs etc. Under natural conditions most grass seed remains viable for only about one (1) year (reproductive seedbank life), with only very few species having seed that can survive for up to 2 - 3 years. Under stockpile conditions it is probable that the seedbank life will be shorter as compared to natural conditions. The stockpiles are likely remain for more than six (6) months during which time the organic carbon content of the soil will decompose in the absence of new carbon sources from dead plant roots and leaf litter. The impact on topsoil through stripping and stockpiling is direct but of local extent as it is restricted to the site area. It is considered a long-term impact though it may be restored to a certain extent after decommissioning.

Removal of Soil

Soil is a non-renewable resource that performs many vital functions: food and other biomass production, storage, filtration and transformation of many substances including water, carbon, and nitrogen. Soil has a role as habitat, serves as a platform for human activities, landscape and heritage and acts as a provider of raw materials. For this reason the permanent covering of soils by buildings or other hardstanding areas is considered a potential impact.

During the construction phase, land will be needed, and as a consequence soil will be removed and lost. Soil removal/ land take is associated with the Project components:

- Access roads and site access;
- Construction sites including storage and parking;
- Temporary infrastructure (eg, pipeline yard, administration buildings); and
- Permanent infrastructure (eg, ORF, roads, accommodation)

Table G30 summarises the land use required for construction activities.

Table G30 Land Use during Construction and Operations

Component	Construction Phase	Operation Phase
Onshore Section of Gas Export Pipeline	Working strip: max width 34 m; length 800 m Area: 27,200 m^2	Width 50 m (no construction activities allowed) Length 800 m Area 40,000 m^2
Onshore Receiving Facilities (ORF) and construction yard and facilities	190,000 m^2	90,000 m^2
Accommodation camp and associated facilities	30,000 m^2	27,200 m^2

Mitigation Measures

Potential Contamination of Soil

- The Project will develop and implement a Waste Management Plan to address waste handling, storage and disposal. Waste will be managed in accordance with Ghana laws and regulations and in line with best practice principles. Waste will be collected, stored and transported in appropriate and approved bins and containers.

- The Project will develop and implement a Hazardous Materials Management Plan to address hazardous material handling and storage. Hazardous materials will be managed in accordance with Ghana laws and regulations and in line with best practice principles as reflected within WB/IFC PS 3 PS 4 guidance on "Hazardous Materials Management".

- Facilities will be built with systems to contain hazardous materials in case of an accidental release (e.g., interceptor drain downslope of storage area). Control systems will be properly maintained proper operation.

The Project will develop and implement an Emergency Response Plan to address accidental spills or release of hazardous materials. Spills of hazardous materials will be cleaned up in accordance with Ghana laws and regulations, in a manner that is safe for human health and the environment .

- *Potential Disturbance and Degradation* Before starting any construction work, topographic and photographic records will be made of the existing condition of the pipeline route and access roads. These records will be used as the standards against which the quality of site restoration will be evaluated.

- Topsoil will be removed from the working strip and stockpiled in the form of a continuous ridge along the edge of the RoW. The topsoil stockpile should be formed as is suitable for the soil specific types in the area of excavation and be protected to reduce the possibility of physical damage and compaction. Topsoil will be deposited on one side of the working corridor where it will be stored in such a way that it is not mixed with other trenched materials or driven over by vehicles.

- The removed topsoil will be finally placed back on the working corridor. The original contours of the land will be restored as closely as possible.

- Soil stockpiles must be sampled, ameliorated (if necessary) and re-vegetated with indigenous species as soon after construction as possible to reduce exposure to rainfall and wind, as well as to slow and trap runoff to reduce soil erosion. Once stockpiles have been established they will not be moved around to other areas but directly used for rehabilitation to avoid creating more compacted areas.

- Topsoil will be used after stripping to fill nursery bags that will be used to re-establish indigenous vegetation in a proposed nursery at the mine. This will ensure that beneficial micro-organisms associated with the indigenous plants remain active in the soil and will re-establish populations in the landscape once it is transplanted during rehabilitation. At the end of this phase, a shallow tillage of the soil will be realised through mechanical agitation with the aim of aerating the top layer of soil compacted by machinery.

- No machinery will be allowed to leave the working strip or access roadways.

- Following the pipeline backfilling operation, prior to the completion of the above-mentioned restoration works, a preliminary phase involving general tidying up of the line will be carried out to level the area affected by the works, restoring pre-existing slopes and the original morphology of the ground and well as of pre-existing flow lines. During ground levelling, particular care will be taken in order not to leave holes or depressions that could create problems for subsequent farming activities.

- An erosion monitoring programme be carried out periodically during construction biannually to determine seasonal variations and thereafter, annual monitoring will be implemented which includes physical observation and reporting of the following:
    - evidence of erosion or land degradation;
    - condition of access roads;
    - condition of cleared areas;
    - condition of perimeter drains (if installed) and associated settlement ponds (if installed); and
    - compliance with applicable regulatory and corporate requirements.

Soil Removal

As above, during construction activities, as mitigation measures, no machinery will be allowed to leave the access roadways or the working strip. Land clearance must be kept to a minimum and must only be cleared for areas that will be developed.

<u>Conclusions</u>

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2the residual impacts on soils associated with the construction phase are summarised in Table G31.

Table G31 Residual Impacts on Soil during Construction Phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Geology, Geomorphology and Soil – Construction Phase					
Potential contamination of the Soil	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential Disturbance and Degradation During Construction	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Soil Removal/ Land Take	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*2*	*1*	*2*	*1*	

The residual impact on the soils due to Project construction activities is considered to be **Low** besides the soil removal/ land take which is **Medium,** mainly due to the duration criteria (Project lifetime of about 20 years).

G.4.6.3 Operations and Maintenance Phase

During the operation phase, land take (as discussed previously) and waste production will be related to ORF operation and maintenance. The sources listed in Table G32 could cause potential impacts on soil.

Table G32 Soil impacts and risks - operation and maintenance phase

Source of Potential Impact	Potential Impact
Improper handling and disposal of solid and liquid waste, vehicle and equipment use	Potential contamination of soil (unplanned event) by hazardous and non-hazardous spill, and contamination of soil by hazardous and non-hazardous wastes
Soil compaction and erosion	Potential for compaction of soils in heavily used areas and erosion along roads and around other hardstanding areas.

For the assessment of the potential impact on soil due to operations, all the sources identified in the table above have been considered together, providing an overall assessment on the component.

Impacts Identification and Assessment

The potential impacts on soil will largely be confined to the ORF areas and access roads. Key potential impacts on soil and landform along the pipeline route from all phases of the Project are the following:

- Potential soil contamination; and
- Soil compaction and erosion.

Potential Soil Contamination

During the operation phase only limited amounts of waste are expected, mainly generated during maintenance activities. The waste water effluents discharged to the environment will from the ORF operation will be to the treated discharge through infiltration of trated sewage from the Imhoff tank.

During the operational phase, accidental spillages can result in contaminants entering groundwater resources and soil ecosystems. Spillages from fuel storage units and leakages from vehicles can also result in chemical pollution. During operation, small quantities of waste will be produced from the ORF, due to equipment maintenance and operation. Domestic waste will also be generated. Both waste types will be handled accordingly with existing regulations and the Waste Management Plan (Annex E).

Soil Compaction and Erosion

During the operational phase, soil compaction will continue to increase due to long term stockpiling of soils for rehabilitation as well as continued use of access roads resulting in further compactuion of these areas. The presence of the facilities, roads and hardstanding will also result in increased runoff resulting in an increased potential for erosion.

Mitigation Measures

Potential Soil Contamination

All the effluents will be treated as liquid waste, and the mitigation measures will be, where applicable, the same as those used during the construction phase. In particular waste water will be collected in sewage tanks and treated as waste.

Any spills must immediately be collected using booms, pads and absorbent mops and correctly disposed on site before being removed for final disposal at a licensed hazardous waste site (to be identified).

Any solid waste generated on site will be stored and removed in accordance with the Waste Management Plan (Annex E).

Soil Compaction and Erosion

Topography will be restored and soil stockpiles will be revegetated and any rehabilitated areas must be regularly maintained and monitored in order to maintain a high basal cover. Such maintenance will limit soil erosion due to both water (runoff) and wind (dust) erosion..

Where possible, rehabilitation will be undertaken during operations, in order to reduce the potential for further compaction and erosion..

<u>Conclusions</u>

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2the residual impacts on soil component associated with the operation phase are summarised in Table G33.

Table G33 Residual Impacts and Impacts on Soil during Operation Phase

Impacts	*Duration*	*Extent*	*Importance/ Resilience of Receptor/ Resource*	*No. of Elements Involved*	*Impact Rank*
Geology, Geomorphology and Soil – Operation Phase					
Potential contamination of the Soil	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Soil compaction and erosion	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

The impact on the soil component due to Project operation activities is **Medium;** this is mainly due to the duration criteria (Project lifetime is about 20 years).

G.4.6.4 Decommissioning Phase

The sources listed in Table G34 could cause potential impacts on soil.

Table G34 Soil impacts and risks - decommissioning phase

Source of Potential Impact	**Potential Impact**
Production and disposal of solid and liquid waste	Potential contamination of soil by hazardous and non-hazardous spill, and contamination of soil by improper handling of hazardous and non-hazardous wastes
Soil compaction and erosion	Potential for compaction of soils in heavily used areas and erosion along roads and around other hardstanding areas

For the assessment of the potential impact on soil due to decommissioning, all the sources identified in the table above have been considered together, providing an overall assessment on the component.

Impacts Identification and Assessment

Potential Soil Contamination

With the decommissioning phase, soil surfaces are exposed to chemical soil pollution when stored fuel is transported off-site and by leakages from vehicles.

Soil Compaction and Erosion

During the decommissioning phase, soil is again compacted as construction vehicles move up and down to remove infrastructure and move topsoil to areas for rehabilitation purposes. The impacts of soil compaction are mainly direct and although the impact only has local extent, it is considered to be permanent as soil compaction is very difficult to remediate and will still continue after decommissioning.

Mitigation Measures

Potential Contamination of Soil

- Waste management will be kept closely in line with the legal framework and best practice principles. All waste will be collected, stored and transported separately in appropriate and approved bins and containers. The waste management plan will address handling, storage and disposal of waste.

- Any spills that do occur must immediately be cleaned up in accordance with the approved Waste Management Plan and appropriately stored and disposed of at a licenced waste facility (to be identified).

- An intercept drain should possibly be constructed downslope of polluted areas, in order to drain potentially polluted water into a pollution control dam.

- Drains and intercept drains will be maintained to ensure that they continue to redirect clean water away from the dirty areas.

- Conduct proper chemical waste management to avoid spillage of chemicals during all the phases of the project cycle.

Soil Compaction and Erosion

The following mitigation measure will be undertaken:

- Before starting any decommissioning work, topographic and photographic records will have been taken of the existing condition of the pipeline route and access roads. These records will be used as the standards against which the quality of the restoration work will be judged when construction work is completed.

- Any topsoil, which supports plant life and contains seed stock, will be removed from the working area by suitable earth moving equipment and stockpiled in the form of a continuous ridge along the edge of the strip. The topsoil stockpile will be typically no higher than 2 m and a minimum of 10 m from the ditch to prevent degradation of the soil and will not be disturbed to reduce the possibility of physical damage and compaction.

- Topsoil will be deposited on one side of the working corridor where it will be stored in such a way that it is not mixed with other trenched materials or driven over by vehicles. If topsoil requires long-term storage, then aeration and raking will be carried out regularly to avoid compaction.

- Once stockpiles have been established they will not be moved around to other areas but directly used for rehabilitation again to avoid creating more compacted areas.

- The removed topsoil will be finally placed back on the working corridor. The original contours of the land will be restored as closely as possible.

- No machinery will be allowed to leave the working strip or access roadways.

- At the end of this phase, a shallow tillage of the soil will be realized through mechanical agitation with the aim of aerating the top layer of soil compacted by machinery.

- Pipeline will be left in situ.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2the residual impacts on soil component associated with the operation phase are summarized in Table G35.

Table G35 Residual Impacts on Soil during Decommissioning Phase

Impacts	***Duration***	***Extent***	***Importance/ Resilience of Receptor/ Resource***	***No. of Elements Involved***	***Impact Rank***
Geology, Geomorphology and Soil – Decommissioning Phase					
Potential contamination of the Soil	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Soil Compaction and Erosion	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**

Impacts	***Duration***	***Extent***	***Importance/ Resilience of Receptor/ Resource***	***No. of Elements Involved***	***Impact Rank***
Geology, Geomorphology and Soil – Decommissioning Phase					
Score	*2*	*1*	*2*	*1*	

The impacts on the soil component due to Project decommissioning activities is considered to be **Low** provided that mitigation measures are implemented.

G.4.7 Terrestrial Flora

G.4.7.1 Overview

This Section identifies and assesses the main impacts on onshore environment, proposes mitigation and management measures and then discusses the conclusion and impact ranking described in Section G.2 for project construction, operation and decommissioning activities relating to terrestrial flora.

The following Box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on terrestrial flora within the AoI.

Box G4 Key sources of impacts and risks, potentially impacted resources and receptors

Sources of Impacts and Risk

- Construction phase: preparation of the working strip & site clearance; construction of roads & ORF; construction of temporary facilities and the associated dust generation; movements of vehicles, equipment and personnel, improper waste management; accidental spills of hazardous materials.
- Operations and Maintenance phase: improper waste management; movements of vehicles, equipment and personnel; land take; accidental spills of hazardous materials, emissions of nitrogen oxides (NO_x).
- Decommissioning: ORF decommissioning; movements of vehicles, equipment and personnel; improper waste management; accidental spills of hazardous materials; land take.

Potentially Impacted Resources and Receptors

- Native plant species
- Native plant communities
- Abiotic factors in ecosystems including soil, air and water quality

Baseline Influencing Factors

- Presence of species with high conservation value
- Occurrence of natural vegetation, especially near the coastline
- Presence of pioneer species in the AoI

Project Influencing Factors

- Location of RoW, ORF and other work sites; construction techniques, machinery in use during the construction phase; water management; work site management, waste management and traffic management. Soil management and restoration of construction areas and following final decommissioning.

Table G36 presents the key impacts of the project on the terrestrial flora component during the key project phases.

Table G36 Key impacts and risks– flora

Construction Phase	Operations Phase	Decommissioning Phase
• Loss of natural vegetation (and secondary plant species) and deforestation • Loss of Habitat/Habitat Fragmentation • Degradation of abiotic components in ecosystems (water, soil and air) • Introduction of alien species	• Impacts on flora due to degradation of abiotic components in ecosystems (water, soil and air)	• Degradation of abiotic components in ecosystems (water, soil and air)

The potential impacts relating to each of the three main Project phases are described prior to presenting the mitigation measures that will be adopted. Conclusions are presented taking into account the application of the identified mitigation measures

G.4.7.2 Flora Sensitivity

The habitats are understood to be largely modified within the concession area, with some areas of natural habitat identified to the east of the concession area (more than 500 m away from the concession), and areas where there is habitat that could potentially be classified as Critical as per the IFC Performance Standards along the beaches (i.e. specifically at turtle nesting sites, as discussed in the marine impacts). A description (and supporting maps) of the habitat within the AoI is provided in the description of the environmental baseline (Section 6.5.2).

Flora species were identified during the dry and wet season field surveys performed in April and October 2014 and two IUCN listed Vulnerable species encountered within the AoI during the wet season (*Albizia ferruginea (Scarlet Star)* and *Hallea stipulosa (Red Star))* and two Vulnerable species in the dry season *(Albizia ferruginea* and *Coffea macrochlamys (Gold star)).* The majority of the species identified on the site (87.21%) have not yet been assessed by the IUCN. The Vulnerable species, *Albizia ferruginea* are widespread in the secondary thickets, and does not fall directly within the project footprint. There was only one Blue Star species encountered in the study, *Syzygium guineense*.

The studies also showed that there are a large number of pioneer species on the site indicating that the area is largly disturbed and thus consistent with the classification of the site as modified habitat. Some of the pioneer species encountered in the study include *Alchorneacordifolia, Cleistopholis patens, Flagellaria guineensis, Macaranga barteri, Rauvolfia vomitoria, Sterculia tragacantha* and *Voacanga africana.* .

Based on the findings of the field survey, flora sensitivity can be classified as **Moderate**.

Construction and Precommissioning phase.

The following sources of impact have been identified (Table G37) as potential impacts within the construction and pre-commissioning phase. Without the implementationof mitigation, the sources listed below have the potential to cause impacts on existing terrestrial flora.

Table G37 Flora impacts and risks - construction and pre-commissioning phase

Source of Potential Impact	Potential Impact
Preparation of the working strip & ORF site clearance (topsoil removal)	Loss of natural vegetation and deforestation; Loss of habitat/ habitat fragmentation
Set-up (including site preparation) of temporary facilities (work site, construction site, stockyard and access roads)	Loss of habitat/ habitat fragmentation; introduction of alien species
Movement of vehicles, equipment and personnel	Impacts on Flora due to degradation of abiotic components in ecosystems (water, soil and air); Loss of habitat/ habitat fragmentation
Production and disposal of solid and liquid wastes	Degradation of abiotic components in ecosystems (water, soil and air)

The terrestrial flora impact assessment is based on the analysis of potential impacts caused by the various sources detailed in Table G37.

The aim of this Section is to identify the potential impacts on flora during the construction phase. These potential impacts will largely be confined to the area of the pipeline corridor, associated access roads and the ORF site.

During construction, the Project will directly impact on the vegetation and the habitats upon which they rely. Possible impacts on their environment include:

- loss of natural vegetation and deforestation;
- loss of habitat/habitat fragmentation;
- degradation of abiotic components in ecosystems (water, soil and air); and
- introduction of alien species.

Temporary impacts will arise from the land takes (working strip and work sites), which will be reinstated to pre-construction conditions once construction is completed. Permanent impacts will arise from the pipeline RoW, which will need to be cleared of vegetation, and from above ground structures at the ORF site.

Loss of Natural Vegetation

Most direct impacts on the flora are likely to take place during the site clearance and construction period. The construction of the ORF and facilities as well as laying of the pipeline ROWs will result in the complete removal of vegetation. It is foreseen that there will be a permanent land take of maximum 110,000 m^2 of land for the ORF site and the accommodation camp. Construction will require approximately 240,000 m^2 to be cleared resulting in a potential loss of natural vegetation in those areas.

Vegetation clearing may allow for opportunistic grass species (and any other species) to grow in place of the original flora and thus change the regional overall pattern of vegetation. In addition, the faster growth of alien species allows that naturally occurring species are out-competed by the aggressive alien invasives, which threatens their survival of the indigenous species.

Loss of Habitat/Habitat Fragmentation

The clearing of vegetation for the construction of new infrastructure at the concession area, for new roads as well as for the pipeline ROW could result in the fragmentation of existing habitats. Habitat fragmentation of the habitats reduces the viability of that area or habitat to support its resident species and is associated with declining populations. However, the habitats within the areas to be cleared and directly disturbed are classified as Modified, with small portions of Natural possible surrounding these areas. The impacts are therefore considered to be low.

Impacts on Flora due to Degradation of Abiotic Components in Ecosystems

Three abiotic components in ecosystems may potentially affect flora, which is also a mechanism for effects on flora and habitats:

- degradation of soil;
- alteration of water quality; and
- modification of air quality.

Modification of topsoil characteristics (fertility, texture, etc.) greatly affects plant growth, especially in natural habitats. However, Project earthworks are largely limited to the working strips and small areas whe re natural or semi-natural habitats are very limited.

Sediment plumes from the working strip and access roads due to rainwater runoff may reach the water systems, as well as unintentional discharge of oil and chemicals from machinery. Thus, the water quality of these systems may potentially be affected by the Project, thus having an indirect effect on flora.

The dust generated from the movement of earth during construction, excavation, vehicle movement, stockpiles and unpaved surfaces along the working strip and access roads, and in work sites, could be deposited on plants, reducing the photosynthetic capacity of leaves. If dust deposition occurs during the growing season, the impact can be higher although concentrated in a short time period. Due to the typical climatic conditions, however, precipitation is expected to wash dust from leaves, thus significantly reducing the loss of photosynthetic capacity.

Atmospheric emissions from machinery and vehicles (i.e. generators, excavators, bulldozers, side booms, trucks, cars, hydrotesting compressors, etc.) will be another source of potential effects on air quality for plants but would be limited to during the construction period and within a the near vicinity of the current work areas .

Introduction of Alien Species

Linear infrastructures (such as pipelines and roads), possibly near uncultivated lands, are one of the sources of the spread of alien plants. Road improvements may facilitate the accessibility and subsequent deliberate introduction (i.e. planting alien trees for landscaping or forestry purpose) or accidental spread (e.g. seeds in the soil attached to vehicle tyres) of exotic plants.

Mitigation Measures

Loss of Natural Vegetation and Loss of Habitat/Habitat Fragmentation

- Collection and/ or selling of plant specimens by employees of the Company is forbidden.
- Vehicles will use only demarcated areas and not drive off the roads which can have significant impacts on the natural habitats and vegetation.
- If a population of priority important species is directly affected by works in the Project, the plants will be transplanted to a new area at the end of the growing season. If this is not possible (e.g. the transplant is technically impractical), a conservation plan on the species will be required to grow a nearly equivalent number of plants, by methods such as reproduction ex situ (i.e. out of the natural habitat) for subsequent transplanting in situ (within the natural habitat).
- To avoid the loss of vegetation especially for species of importance as endemic species (*Albizia ferruginea, Hallea stipulosa* and *Coffea macrochlamys*), a monitoring plan will be prepared for work along the pipeline route and all other planned work sites. The floral pre-construction surveys will be planned during the flowering season. The monitoring plan will include activities to ensure the control of alien & pioneer species.
- The removed vegetation and biomass will be set aside as to not disturb the preliminary site preparation activities and will be made available to the community for use through traditional leaders

Impacts on Flora due to Degradation of Abiotic Components in Ecosystems

In addition to those mitigation measures presented within the impacts on Surface Water, Air Quality and Soils, the following mitigation measures are identified:

- Vehicles will be restricted to specific areas when driving outside the ORF and only use demarcated areas and not drive off the roads.
- Where required roads and working areas will be wet (or similar) to prevent dust generation.
- Hazardous substances will be stored within sealed containers and bunded to prevent unplanned spills.
- According to international best practice, standard onshore pipeline construction has the following main elements:
    - Top soil will be stripped and temporarily stored on one side of the working strip;
    - Non-fertile "subsoil" obtained from the pipeline trench excavation will be stored on the opposite side of the working strip; and
    - Fertile top soil must be promptly re-deposited on top of the non-fertile soil to ensure adequate crop or vegetation growth.

These practices appear adequate to minimise soil degradation and therefore plant and vegetation recovery. In addition, revegetation (i.e. the sowing of native herbaceous species on top soils and/or the planting of native shrubs/trees) will be more suitable for reducing soil degradation in or close to natural habitats.

Introduction of Alien Species

- No planting of alien species will occur in the camps or any areas within the AoI, including landscaping of re-vegetated areas.
- A monitoring plan will be carried out for the most rigorous invasive species, to record their populations in the AoI. These results can then be used to define an Alien Species Eradication plan aimed at removing new populations and preventing them from spreading throughout the AoI. In addition, prompt revegetation (i.e. sowing of native herbaceous species and/or planting native shrubs/trees) on bare soil with natural or semi-natural vegetation will reduce the spread of alien species.
- Revegetation (i.e. the sowing of native herbaceous species on top soils and/or the planting of native shrubs/trees) will be undertaken as soon as possible after clearance and construction.

Conclusions

Considering the mitigation measures described and the evaluation criteria defined in section G.2, the potential impacts on the terrestrial flora associated with the construction phase are summarised in Table G38.

Table G38 Ranking of residual impacts and risks on flora during construction and pre-commissioning phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Flora– Construction Phase					
Loss of natural vegetation	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	
Loss of habitat/ habitat fragmentation	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**9 - Medium**
Score	*4*	*1*	*2*	*1*	
Impacts on flora due to degradation of abiotic components of ecosystems	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Introduction of alien species	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

The impacts on the flora component due to Project construction activities is considered to be **Medium** (**Low** for what concern the introduction of alien species) provided that mitigation measures are implemented and the correct monitoring is carried out to prevent any vulnerable species being impacted on. Impact classification is guided primarily by the long duration of the impacts, especially for what is concerned the loss of vegetation and habitats. Impacts will be directly confined to the Project footprint.

G.4.7.3 Operational Phase

During Project operations, impacts will be mainly related to vehicle, equipment and people movement, emissions and waste management during operational activities. (impacts related to loss of natural vegetation and loss of habitats/fragmentation have been evaluated as part of the construction phase impact, as detailed in the previous section). These potential impacts are listed in Table G39.

Table G39 Operational phase impacts and risks on flora

Source of Potential Impact	Potential Impact
Movement of vehicles, equipment and personnel	Degradation of abiotic components in ecosystems (water, soil and air)
Production and disposal of solid and liquid wastes	Degradation of abiotic components in ecosystems (water, soil and air)
Emission of atmospheric pollutants (mainly NO_x)from power generation unit	Degradation of abiotic components in ecosystems (air)

Impacts Identification and Assessment

During project operations, there is a potential for impacts to flora caused by the movement of vehicles, equipment and people as well as from improper waste handling resulting in destruction and disturbance of flora on and around the ORF site. There is also the potential for the degradation of soil and water quality offsite due to spills and various other activities taking place on the site which could have an impact on the vegetation within the AoI.

During operations there will be an increase of concentrations of air pollutants such as CO and NOx due to exhaust emissions from a power generation unit (with 3 gas turbines), supplying energy to all the onshore facilities, a compression station and vehicles used for the general pipelines operational maintenance and site inspections by personnel along the route, cold vent for relief and blow-down streams from the onshore process systems and infrequent helicopter operations.

These effects will result in negative effects on the abiotic components of the environment which could have an indirect negative impacts on terrestrial and aquatic flora in the immediate vicinity of the concession area.

Mitigation Measures

In addition to those mitigation measures presented within the impacts on Surface Water, Air Quality and Soils, the following mitigation measures are identified:

- Vehicles will be restricted to specific areas when driving outside the ORF and only use demarcated areas and not drive off the roads.
- Hazardous substances will be stored within sealed containers and bunded to prevent unplanned spills.

- According to international best practice, a survey with a regular frequency will be performed in order to verify the status and the implementation of the vegetation recovery process in the AoI.
- The power generation unit will include abatement technologies as per the best available techniques to minimize NO_x emissions.

Conclusions

Considering the evaluation criteria defined in section G.2, the potential impacts on the flora associated with the operational phase are summarised in Table G40.

Table G40 Ranking of residual impacts and risks on flora during operational phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Flora – Operation Phase					
Impacts on flora due to degradation of Abiotic Components of Ecosystems	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

The impacts on the flora due to Project operation activities is considered to be **Medium**, mainly due to the long duration of the effects.

G.4.7.4 Decommissioning

Impacts Identification and Assessment

The expected lifetime of the Project is about 20 years. The potential environmental impacts likely to be associated with the decommissioning phase will be related to the ORF facility only as the pipes will remain underground and be filled with a suitable material (i.e. sand). Potential impacts will be, therefore, be similar to those described for the construction phase, but to a lesser degree.

During the decommissioning phase, the demolition operations will be temporary and are unlikely to produce any significant emissions. Potential impacts are summarised in Table G41.

Table G41 Flora Impacts and Risks - Decommissioning Phase

Source of Potential Impact	**Potential Impact**

Source of Potential Impact	Potential Impact
Demolition and decommissioning of ORF and other facilities	Degradation of abiotic components in ecosystems (water, soil and air)
Movement of vehicles, equipment and personnel	Degradation of abiotic components in ecosystems (water, soil and air); Introduction of Alien species.
Production and disposal of solid and liquid wastes	Degradation of abiotic components in ecosystems (water, soil and air)

The aim of this Section is to identify the possible impacts on flora during the decommissioning phase. The potential impacts will largely be confined to the area of the ORF site, access roads and pipeline corridor.

During decommissioning, the Project will directly impact on the vegetation and the habitats upon which they rely, within the AoI. Possible impacts on their environment include:

- Impacts on flora due to degradation of abiotic components in ecosystems (water, soil and air); and
- introduction of alien species.

Degradation of abiotic components in ecosystems

The dust generated from decommissioning activities and vehicle movement could be deposited on plants, reducing the photosynthetic capacity of leaves. If dust deposition occurs during the growing season, the impact can be particularly significant, although concentrated in a short time period. However, due to the typical climatic conditions, precipitation is expected to wash dust from leaves, thus significantly reducing the loss of photosynthetic capacity.

Atmospheric emissions from machinery and vehicles (i.e. generators, excavators, bulldozers, side booms, trucks and cars) will be another source of potential effects on air quality for plants.

Introduction of Alien Species

As described for the construction phase, the demolition of the infrastructure and buildings will allow for the regrowth of vegetation, including alien species.

<u>Mitigation Measures</u>

Degradation of Abiotic Components of Ecosystems

See mitigation measures proposed during construction and operational phase.

Introduction of Alien Species

Once the site has been decommissioned, the ORF and associated areas will be planted with native vegetation in order to rehabilitate the site. The site must be monitored for a number of years post decommissioning to ensure that the vegetation takes as well as to remove any alien pioneer species which may be growing there.

Conclusions

Considering the mitigation measures described and the evaluation criteria defined in section G.2, the potential impacts on the flora associated with the construction phase are summarised in Table G42

Table G42 Ranking of residual impacts and risks on flora during decommissioning phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Flora– Decommissioning Phase					
Impacts due to emissions	Between 1 and 5 years	Local scale: the proposed site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Introduction of alien species	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6- Low**
Score	*2*	*1*	*2*	*1*	

The impacts on the flora component due to Project decommissioning activities is considered to be **Low**, provided that mitigation measures are implemented and the correct monitoring is carried out to prevent any vulnerable species being impacted on.

G.4.8 Terrestrial Fauna

G.4.8.1 Overview

This Section identifies and assesses the main impacts on onshore environment, proposes mitigation and management measures and then discusses the conclusion and impact ranking described in section 10.2 relating to terrestrial fauna.

Box G5 shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on terrestrial fauna within the AoI.

Box G5 Key sources of impact and risks, potentially impacted resources and receptors

Sources of Impacts and Risks:

- Construction phase: preparation of the working strip; construction of roads; ORF; construction of temporary facilities; improper waste management; accidental spills of hazardous materials.
- Operations and Maintenance phase: permanent land-take for ORF; improper waste management; movements of vehicles, equipment and personnel; land take; accidental spills of hazardous materials; noise generation due to operation of compressors and gas turbines.
- Decommissioning: ORF decommissioning; movements of vehicles, equipment and personnel; improper waste management; accidental spills of hazardous materials; land take.

Potentially Impacted Resources and Receptors:

- Wildlife species
- Wildlife communities
- Abiotic factors in ecosystems including surface water ecology

Baseline Influencing Factors

- Occurrence of natural vegetation, especially near the coastline, as habitat for several species

Project Influencing Factors

- Location of RoW, ORF and other work sites; construction techniques, machinery in use during the construction phase; water management; work site management, waste management and traffic management. Soil management and restoration of construction areas and following final decommissioning.

Table G43 presents the key potential impacts of the Project on fauna during the different project phases.

Table G43 Key impacts and risks – fauna

Construction Phase	*Operations Phase*	*Decommissioning Phase*
• Habitat reduction/ habitat fragmentation, and isolation (presence of fences, artificial surfaces and increased traffic). • Potential temporary disturbance and/or displacement of fauna due to noise, water, air and light pollution. • Increased mortality of wildlife, caused by accidents (collisions with vehicles) and hunting.	• Increased mortality of wildlife, caused by accidents (collisions with vehicles) and hunting • Potential ongoing disturbance and/or displacement of fauna due to noise, water, air and light pollution.	• Potential temporary disturbance and/or displacement of fauna due to noise, water, air and light pollution, (e.g. reduction of usable habitat). • Increased mortality of wildlife, caused by accidents (collisions with vehicles) and hunting.

The impacts related to each of the three main project phases (firstly construction, subsequently operation and maintenance, finally decommissioning) are described below.

G.4.8.2 Fauna Sensitivity

Information on fauna in the Study Area are based on field observations and information obtained from interviews with communities.

Although there are a number of species documented to exist in the greater area around the AoI only a few faunal species were recorded on site during the field observations (wet and dry). The species recorded are listed as Least Concern with one species, the hooded vulture (*Necrosyrtes monachus),* listed as Endangered. The avian species *Thalasseus maximus* and *Calidris alba* (trigger species for the listing of the area as an IBA) were not observed but are known to occur within the AoI.

Thus as a conservative approach, the sensitivity of local fauna has been considered as **Moderate**, as there is the potential for sensitive species to be found in the AoI.

G.4.8.3 Construction Phase

A summary of the impacts on fauna during the construction phase are listed in Table G44.

Table G44 Fauna impacts and risks - construction and pre-commissioning Phase

Source of Potential Impact	Potential Impact
Preparation of the working strip & ORF site clearance (topsoil removal)	Disturbance and/or displacement of fauna due to Pollution, Habitat reduction, habitat fragmentation, and isolation
Set-up (including site preparation) of temporary facilities (work site, construction site, stockyard; access roads)	Habitat reduction, habitat fragmentation, and isolation
Movement of vehicles, equipment and personnel	Disturbance and/or displacement of fauna due to Pollution, Increased mortality of wildlife.
Accommodation of employees and increased movement of people into the area in search of employment	Increased mortality of wildlife, mainly as a result of potential poaching and bushmeat hunting by personnel.
Production and disposal of solid and liquid wastes	Disturbance and/or displacement of fauna due to Pollution

<u>Impacts Identification and Assessment</u>

The dust, light, noise and vibration from construction activities such as truck movements, vegetation clearance, earth moving and other construction activities as well as the presence of larger numbers of people in the area will result in direct disturbance to local fauna. It could also affect breeding and nesting patterns. Bird species in particular are sensitive to noise, vibration, and light, which would disturb natural behavioural patterns.

More specifically, the proposed Project activities during construction are anticipated to have both direct (primary) and indirect (secondary) impacts on wildlife within the AoI. Potential impacts on wildlife species include:

- Habitat reduction, habitat fragmentation, and isolation (presence of fences, artificial surfaces and increased traffic);

- Potential temporary disturbance and/or displacement of fauna due to noise, water, air and light pollution; and
- Increased mortality of wildlife, caused by accidents (collisions with vehicles) and hunting.

Habitat Reduction/ Fragmentation and Isolation

Impacts on the ecological network and natural habitats will occur in the areas permanently occupied by the ORF and the new roads due to potential loss of habitats; this area is approximately 110,000 m^2.

Wildlife species have been known to respond to disturbance and changes in their environment (habitat destruction or conversion, pollution and hunting pressure) by either migrating or adapting. Species are able to adapt if the disturbance is gradual and minimal. But in cases where the change is rapid and spontaneous, the species do not have time to adapt and will either migrate or face mortality. The species that migrate to other areas may be forced to live under unsuitable conditions and face threats which they may not have faced if they were in the previous natural habitats.

Landscape fragmentation due to linear infrastructure may also promote a process of progressive isolation caused by the lack of ecological permeability to movement and also intra-and interspecific interactions, leading to a high reduction in favourable habitats for many species, particularly in terrestrial vertebrates. Overall, landscape fragmentation may lead to:

- isolation and fragmentation of populations, especially if associated with specific habitats;
- increase of ubiquitous and synanthropic species, and depletion or even extinction of the most-demanding species;
- increase of edge effect, which reduces the availability of habitats with suitable features for habitat specialists ("interior species");
- higher reproductive costs and higher risks of death (e.g. nest predation);
- higher sensitivity of ecosystems to future alterations; and
- loss of genetic diversity because of genetic drift and inbreeding, which may cause loss of fitness in fragmented populations.

Disturbance and/or Displacement of Fauna due to Pollution

Air Emissions

The digging and handling of top soil, and particularly the increase in vehicular traffic, will cause an increase in the generation of dust and gas pollutants. Tese effects will occur at and around the ORF, around the work strip associated with the pipeline laying as well as along the access roads.

Noise

The noise produced by both machinery and vehicles will be a source of impact during construction, operations and decommissioning.

Wildlife responds to noise by altering activity patterns, such as an increase in heart rate and increased production of stress hormones (Algers et al., 1978). In laboratory animals subjected to severe noises, these effects appear at values between 85 and 89 dB. These levels will not be reached outside the work areas, although they may be exceeded where there is intense traffic or during hydrotesting activities. In addition to harmful effects on health, communication problems may occur occasionally. Sometimes animals get used to the increased levels of noise and then apparently return to normal activities, but birds and other wildlife species that communicate using sound signals may be affected by the proximity of noise sources. Excessive noise levels may also affect the reproductive behaviour of several species. Although the effects of noise disturbance are more difficult to measure than other types of pollution, such as air pollution, acoustic disturbance is considered one of the main causes of environmental pollution in Europe (Vangent & Rietveld, 1993; Lines et al., 1994).

Studies have been performed to identify the species most strongly affected by noise pollution, as well as critical thresholds of disturbance in relation to specific noise sources. The species characterised by the following characteristics will be considered the most vulnerable to disturbance (Hill et al., 1992): large size, long lifespan, with relatively low reproductive rates; especially specialists to particular habitats, such as exposed (e.g. wetlands) or covered habitats (e.g. forests); rare, with populations concentrated in a few key regions.

The Project will potentially affect wildlife species (especially birds and small mammals) in that they will be displaced from the immediate work areas and through the clearing of the ORF site and pipeline ROW. This may result in a very small scalealteration of the wildlife communities, in which opportunistic and ubiquitous species are less affected. The extent of these effects is expected to be very limited and directly surrounding the Project activities.

During the construction phase vehicles and machinery will be the dominant noise source and, therefore, potentially a nuisance to wildlife. The noise impact during the construction phase is expected to be temporary and will be performed largely only during the day minimising the impact on some of the species which perform breeding calls at night (ie amphibians and some birds) or around dawn (ie many birds). During the hydrotesting phase, a higher noise impact may be generated.

The heliport is intended only for use for medical emergencies and impacts will be of a temporary nature.

<u>Light Pollution</u>

Light pollution is defined as "any alteration in the amount of natural light present at night and in outdoor environments due to light from anthropic sources". Alteration in day/night equilibrium, caused by direct artificial light could cause substantial harm, especially to animals (i.e. disorientation of nocturnal birds and mammals and death of moths or butterflies caused by the heat produced from the light sources).

Butterflies, and more generally the order Lepidoptera, suffer from disorientation under artificial light conditions. It is well known that moths set their migration route on the moon or very bright stars and as a consequence, the migration swarm is dispersed, moths may be not able to reach suitable habitats. The impact on butterflies and moths due to light emissions is, however, expected to affect a limited number of individuals, if any, given that the area is not considered a relevant habitat for these species, in contrast to the Ankasa Reserve, located more than 25 km away, where up to 600 butterfly species have been recorded.

The presence of artificial light sources may affect bird species which use astronomical orientation in their nocturnal migrations and birds which use morning song to attract potential mates.The impact is, however, expected to be limited to a few individuals with no consequences at a population level, as these species will tend to avoid the area once construction activities begin and the current habitat diminishes its suitability for these species and concentrate in nearby, more suitable habitats.

The Project is not expected to produce significant light pollution in the Area of Influence. However, the artificial illumination at the ORF may produce limited impacts on nocturnal fauna.

Water

There is the potential for water to be contaminated due to unplanned/ accidental spills from machinery or storage areas. This could have an impact on fauna, including aquatic fauna who are dependent on these water bodies for drinking, habitats and habitat of prey and which would be negatively affected by contamination of these resources.

Increased Mortality of Wildlife

The mortality rates due to vehicle collisions is a negative impact caused by increased vehicular traffic, which has been greatly increased in the recent decades and is now the top source of wildlife mortality directly caused by humans. The main reasons causing wild animals to cross roads include voluntary crossing, unintentional incursion on the road, feeding on the remains of animals killed by traffic, and seeking micro thermal conditions, nesting sites or shelter.

All wildlife species may be victims of traffic, although reptiles and some mammals are at higher risk than other species. The highest risk situations occur when biological corridors, along which the animals move, cross roads (e.g. roads that interrupt the annual migration of amphibians between feeding, wintering and reproduction areas).

There is also the possibility of avifauna being impacted by the use of helicopters due to direct collisions and the potential to be caught in the rotors.

The killing of wildlife is against the law of most countries including Ghana, but most projects are unable to avoid it completely. Even those projects that have carried out large rescue missions have more often than not concentrated on the large mammals due to the difficulty involved in tracking the smaller animals. It is anticipated that there will be some losses especially in the early stages, of some wildlife species in the AoI. However, considering the limited number of large mammals currently reported having been seen in the area during the study, this number is not expected to be high.

Mitigation Measures

Habitat Reduction/ Fragmentation and Isolation

In addition to those mitigation measures presented within the impacts on Flora, the following mitigation measures are identified:

- The project will consider undertaking the clearing of vegetation during construction in phases. In this way, the change will be gradual which will give fauna the chance to identify new suitable areas and migrate.

Disturbance and/or Displacement of Fauna due to Pollution

In addition to those mitigation measures presented within the impacts on Surface Water, Groundwater, Soils and Air Quality, Noise the following mitigation are identified:

- Facilities will be built with systems to contain hazardous materials in case of an accidental release (eg, interceptor drain downslope of storage area). Control systems will be properly maintained proper operation.
- Lighting will, where possible, be aimed directly at the areas where it is required, minimising light pollution outside of the ORF and other working areas.
- Construction activities, will as far as possible, be limited to daytime hours.
- A pre-construction survey will be undertaken to identify sensitive avian species that may be present during times outside of those surveyed previously (April and November) and particularly during the boreal winter.
- Machinery and vehicles will be in good working order and regularly maintained to prevent unnecessary noise.
- The Project will develop and implement a Waste Management Plan to address waste handling, storage and disposal. Waste will be managed in accordance with Ghana laws and regulations and in line with best practice principles. Waste will be collected, stored and transported in appropriate and approved bins and containers.
- The Project will develop and implement a Hazardous Materials Management Plan to address hazardous material handling and storage. Hazardous materials will be managed in accordance with Ghana laws and regulations and in line with best practice principles.
- The Project will develop and implement an Emergency Response Plan to address accidental spills or release of hazardous materials. Spills of hazardous materials will be cleaned up in accordance with Ghana laws and regulations.

Increased Mortality of Wildlife

- The hunting for bush meat needs to be strictly controlled. Design and implementation of embedded bush meat action plans to prevent all activities of staff and contractors related to the trade in animal protein and live specimens.
- Since Ankasa Conservation Area is the closest protected area mandated by the Government of Ghana to protect wildlife and their habitats, and despite the absence of impacts expected in this protected area, eni could collaborate with the park to undertake this conservation program. This is important because lessons learnt from past conservation programs have shown that such programs are most successful when they work with local institutions which have the legal backing of the government and the support of the local people. A similar collaboration with relevant authorities or Birdlife international should take place with regards to the Amansuri Wetlands IBA, with special attention to its trigger species, *Thalasseus maximus* and *Calidris alba*, both present in the area during the boreal winter months (preferably in the beach and more coastal margin of the IBA).

<u>Conclusions</u>

Considering the mitigation measures described and the evaluation criteria defined in section G.2, the potential impacts on fauna associated with the construction phase are summarised in Table G45.

Table G45 Ranking of residual impacts and risks on fauna during construction phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Fauna – Construction Phase					
Habitat Reduction/ Fragmentation and Isolation	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Disturbance and/or Displacement of Fauna due to Pollution	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Increased Mortality of Wildlife	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

The impacts on fauna due to Project construction activities is in general considered to be Low besides the impact of habitat reduction/ fragmentation and isolation which is considered to be **Medium**, largely due to the fact that this will continue for the lifetime of the Project.

G.4.8.4 Operational Phase

A summary of the impacts on fauna identified during the operational phase are listed in Table G46.

Table G46 Fauna impacts and risks - operations phase

Source of Potential Impact	Potential Impact
ORF land take and presence	Disturbance and/or displacement of fauna due to pollution
Movement of vehicles, equipment and personnel	Disturbance and/or displacement of fauna due to pollution ; increased mortality of wildlife
Accommodation of employees and increased movement of people into the area in search of employment	Increased mortality of wildlife

Impacts Identification and Assessment

There will be ongoing impacts on fauna within the AoI due to operations at the ORF and associated activities such as vehicular movements.

Disturbance and/or Displacement of Fauna due to Pollution

During operations there will be an increase of concentrations of air pollutants such as CO and NOx due to exhaust emissions from a power generation unit (with 3 gas turbines), supplying energy to all the onshore facilities, a compression station and vehicles used for the general pipelines operational maintenance and site inspections by personnel along the route, cold vent for relief and blow-down streams from the onshore process systems and infrequent helicopter operations. Although these emissions contribute to the degradation of environmental quality of the AoI, it is not expected that these will have a direct impact on fauna. To support this statement, a dedicated Atmospheric Dispersion Modelling Study have been performed to evaluate the atmospheric pollutant concentrations generated by the ORF operation; the results are reported in details in Annex H. The study highlighted that the extent of the emissions will be limited to the area in the proximity of the ORF (e.g., NO_2 concentration maxima fall within a distance of 1.5 km from the ORF). Moreover, the contribution of the ORF operation is not expected to alter or worsen the current situation in terms of air quality conditions. Thus, the indirect impact of potential effects of dust emissions on fauna is considered negligible.

Similarly, the noise emissions from the operation of the ORF could lead to disturbance of fauna leading to a displacement and avoidance of the area affected by higher noise levels. The extent of the affected araea in the vicinity of the ORF site will be confirmed through a screening model to be performed prior to the operational phase.

In addition, potential changes to the water and soil quality as a result of unplanned spill events will result in decreased habitat quality for faunal species and may result in their disturbance or mortality (in serious cases). The effect of this impact is however expected to occur at a local scale.

Light pollution is likely to be produced from the ORF as operations will continue for 24 hours a day. The radiation from artificial light is however limited and will not change the day/night balance of the most vulnerable wildlife species (e.g. disorientation of birds and nocturnal mammals); thus the significance of the impacts caused by artificial lighting is considered to be low.

Increased Mortality of Wildlife

As discussed under the construction phase, the influx of people in search of employment can result in increased hunting of bush meat to feed the growing local population. This hunting can put local fauna populations under severe pressure.

The traffic generated during the operation phase will be reduced compared to the construction phase and will essentially related to the movement of workers, by minivans or cars, for the ORF operation, planned maintenance and inspection of the pipelines. Vehicular movements for maintenance and operational purposes will increase the traffic risks to local fauna and could result in injury and mortality along the access roads to the site. As such, provided road rules are complied with, the impacts on wildlife are not considered significant.

<u>Mitigation Measures</u>

Although impacts during the operations phase may be lower than the construction phase, the long term over which these impacts can occur increases the significance. It is thus crucial that mitigation measures are implemented in order to minimise the impacts. The proposed mitigation measures are listed below:

Disturbance and/or Displacement of Fauna due to Pollution

- Please see mitigation within the Air Quality, Noise and Landscape and Visual impact assessment Sections.

Increased Mortality of Wildlife

- Monitoring programs on target wildlife species (i.e. amphibians, reptiles, small mammals and birds) will be implemented.
- Maintenance of the areas planted with native species during the construction phase will be undertaken on a regular basis.
- The hunting for bush meat needs to be strictly controlled. Design and implementation of embedded bush meat action plans to prevent all activities of staff and contractors related to the trade in animal protein and live specimens.
- Roads must be clearly marked with speed limits and all staff and contractors must obey these regulations.

<u>Conclusions</u>

Considering the mitigation measures described and the evaluation criteria defined in section G.2, the potential impacts on fauna associated with the operation phase are summarised in Table G47.

Table G47 Residual Impacts on Fauna during Operations Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Fauna – Operations Phase					
Disturbance and/or Displacement of Fauna due to Pollution	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Increased Mortality of Wildlife	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9 - Medium**
Score	*4*	*1*	*2*	*2*	

The impacts on the fauna due to Project operations are considered to be of **Medium** significance which is mostly due to the long term over which the impact is occurring (ie for the life of the project).

G.4.8.5 Decommissioning Phase

A summary of the impacts on fauna identified during the decommissioning phase are listed in Table G48.

Table G48 Fauna Impacts and Risks - Decommissioning Phase

Source of Potential Impact	**Potential Impact**
Demolition of ORF and other infrastructure	Disturbance and/or Displacement of Fauna due to Pollution
Movement of vehicles, equipment and personnel	Disturbance and/or Displacement of Fauna due to Pollution ; Increased Mortality of Wildlife
Production and disposal of solid and liquid wastes	Disturbance and/or Displacement of Fauna due to Pollution

Impacts Identification and Assessment

The decommissioning phase will result in further temporary impacts on fauna in the area.

Disturbance and/or Displacement of Fauna due to Pollution

During the decommissioning phase, it is assumed that the demolition of the ORF will produce significant dust and noise pollution which could impact fauna within the AoI. Light pollution is also likely to be produced if these activities continue for 24 hours a day. There will also be large amounts of waste produced, which if improperly managed could cause an impact on local fauna within the AoI. Impacts will be similar to those described within the construction phase.

Increased Mortality of Wildlife

There will be large numbers of vehicles bringing in employees and machinery for the site decommissioning/ demolition which could lead to further mortalities of fauna along the roads within the AoI. Impacts will be similar to those described within the construction phase.

Mitigation Measures

Although temporary in nature, the impacts caused during the decommissioning phase could impact local fauna. It is thus crucial that mitigation measures are implemented in order to minimise these impacts.

Disturbance and/or Displacement of Fauna due to Pollution

In addition to those mitigation measures presented within the impacts on Surface Water, Air Quality, Landscape and Soils, the following mitigation measures are identified:

- Lighting will, where possible, be aimed directly at the areas where it is required, minimising light pollution outside of the ORF and other working areas.
- Decommissioning activities, will as far as possible, be limited to daytime hours.
- Machinery and vehicles will be in good working order and regularly maintained to prevent unnecessary noise.
- Waste Management Plan must be implemented to address waste handling, storage and disposal. Waste will be managed in accordance with Ghana laws and regulations and in line with best practice principles. Waste will be collected, stored and transported in appropriate and approved bins and containers.
- An Emergency Response Plan must be adhered to in the case of accidental spills or release of hazardous materials. Spills of hazardous materials will be cleaned up in accordance with Ghana laws and regulations.
- All waste generated during the decommissioning phase must be disposed of in accordance with Ghana laws and regulations and in line with best practice principles.

Increased Mortality of Wildlife

- The hunting for bush meat needs to be strictly controlled. Design and implementation of embedded bushmeat action plans to prevent all activities of staff and contractors related to the trade in animal protein and live specimens.
- Roads must be clearly marked with speed limits and staff and contractors must obey these regulations.

Conclusions

Considering the mitigation measures described and the evaluation criteria defined in section G.2, the potential impacts on fauna associated with the operation phase are summarised in Table G49.

Table G49 Residual Impacts on Fauna during Decommissioning Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Fauna – Decommissioning Phase					
Disturbance and/or Displacement of Fauna due to Pollution	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Increased Mortality of Wildlife	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7 - Medium**
Score	*2*	*1*	*2*	*2*	

The impacts on the fauna due to Project decommissioning are considered to be of **Low to Medium** significance. Wildlife mortality is still assumed to be medium due to the difficulty in controlling this and the larger area that is affected.

G.4.9 Landscape

G.4.9.1 Overview

This section identifies and assesses the main impacts on onshore landscape, proposes mitigation and management measures and then discusses the conclusion and impact ranking defined in Section G.2.

The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on landscape.

Box G6 Key sources of impacts and risks, potentially impacted resources and receptors

Sources of Impact

- Construction Phase: Clearing and levelling of the ORF site (3 m above surrounding area), presence of construction/work sites, machinery, vehicles and storage of materials and excavated subsoil, lighting impact, vessels movements.
- Operations and Maintenance Phase: presence of onshore facilities (ORF) including lighting.
- Decommissioning Phase: similar sources of impact as for the construction phase are expected (presence of machinery, vessels).

Potentially Impacted Resources and Receptors

- Panoramic views.
- Current landscape.
- Landscape elements which have symbolic value for the local community.
- Inhabitants.

Baseline Influencing Factors

- Settlements potentially near the onshore facilities.
- Offshore facilities located at approximately 60 km from the coastline.

Project Influencing Factors

- Volumes and elements position.

The following table presents the key impacts of the project on landscape and visual amenity during the key project phases.

Table G50 Key impacts and risks – landscape and visual amenity

Construction Phase	***Operations Phase***	***Decommissioning Phase***
• Landscape changes and visual impacts due to installation of the pipeline; • Landscape changes and visual impacts due to construction of ORF and associated infrastructure; and	• Visual impacts due to presence of the ORF and associated infrastructure	• Not significant

In the following Sections, each potential impact has been expanded giving information on how each source is likely to have an impact on receptors and the mitigation measures built into the Project.

G.4.9.2 Landscape Sensitivity

The onshore Project area is a flat area of low altitude (0-10 m) with very few headlands or rocky outcrops. The ground elevation increases from the sea for several meters within the beach up to around 4 m high when it decreases again below 2 m high resulting on the generation of flat and low-lying area that occupies the central section of the ORF site. The higher grounds are located at the north-western most corner of the ORF site with 8.9 m elevation, while the site generally varies between 3.9 and 4.6 m. The current land use and activities on the site are farming and aquaculture. The ORF will be constructed in the north east of the concession area which is at elevated portion of the site. Therefore, the levelling of the site will not require major excavation (in terms of levelling). The base camp and helipad are located on the slightly more elevated section of the concession area and therefore require increased levelling (although to the general low lying nature of the site this will not require major excavation. The construction of the ORF and associated infrastructure will alter the landscape permanently.

The ROW for the pipeline from the ocean along the beach does not have any significant rocky outcrops. Therefore, the excavation required for the pipeline will be temporary and the trench will be backfilled such that this laying activites will not change the landscape permanently.

Figure G1 Actual landscape conditions at ORF site

From clockwise: the view from the existing pipeline ROW to the north of the eni concession area; view of the concession area and pipeline ROW; two views of the beach towards the pipeline landing site (ie the ocean is to the right and the concession area to the left of the photograph)

Considering all factors, the sensitivity of the landscape near the ORF site and along the pipeline is **Moderate**.

G.4.9.3 Construction phase

Regarding the construction phase of the Project, the following sources of impact have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on landscape.

Table G51 Landscape and visual impacts and risks. Construction and pre-commissioning phase

Source of Potential Impact	Potential Impact
Pipeline installation (onshore and nearshore) including removal of vegetation and sand, presence of workers, and machinery.	Landscape changes and visual impacts due to installation of the pipeline.
ORF construction, earth moving activities and associated infrastructure and access road. Including the removal of vegetation, and the presence of workers and machinery.	Landscape changes and visual impacts due to construction of ORF and associated infrastructure.

The impact assessment on visual and landscape described in the following sections is based on the analysis of the sources of potential impact reported above.

Impacts identification and Assessment

This Section describes the potential visual and landscape impacts during the construction and pre-commissioning phase. The visual and landscape impacts are largely confined to the concession area and ORF. It is important to note that although the construction activities will bring about permanent changes both visually and to the landscape it is likely that this will be diminished over time as the area experiences re growth of the vegetation surrounding the concession area and the pipeline ROW.

The potential visual and landscape impacts are as follows:

- Landscape changes and visual impacts due to installation of the pipeline; and
- Landscape changes and visual impacts due to construction of ORF and associated infrastructure.

A total of approximately 90,000 m^2 will be required for the installation of the ORF. The areas not used beyond construction phase will be rehabilitated. In the AoI the presence of the pipeline determines a safety zone of 25 m per side where no construction will be allowed.

Landscape Changes and Visual Impacts due to Installation of the Pipeline

The onshore laying of the pipeline refers to laying the pipeline along the beach and onshore to the ORF and from the ORF to the Ghana gas pipeline to the north of the ORF. There will be temporary visual impacts due the presence of worksites, including the trenching along the beach and change in the landscape as a result of the construction, which is likely to alter the sense of place. Although the pipeline will be reburied, there will be landscape impacts due to clearing of vegetation and maintence of a cleared ROW.

In addition, the construction areas will be lit during the night for security purposes which will result in light spill and visual impacts both along the shore and along the pipeline ROW in the north of the concession area. Although the majority of the offshore activities during installation/ construction are considered too distant from the shore to result in significant visual impacts, there could be potential temporary lightspill effects during the laying of the offshore sections of the pipeline.

The laying of the pipeline in the north of the concession area will alter the area permanently both from a landscape and visual perspective due to clearing of vegetation and maintence of the cleared ROW.

Landscape Changes and Visual Impacts due to Construction of the ORF and Associated Facilities

During onshore construction activities, the presence of machinery, construction vehicles and temporary facilities will generate a temporary and permanent visual impact; Temporary visual and landscape impacts would arise from the changes in the receiving landscape resulting from the introduction of temporary structures and facilities to enable the construction works to take place (including pipeline yard, and and adminstration buildings) which would alter the current rural nature of the area surrounding the concession area. In addition, there will also be temporary light spill impacts from the lighting at the construction site and laydown areas.

In addition, the site will need to be cleared and levelled in order for the construction to take place resulting in a permanent loss in vegetation. The construction of the ORF and associated infrastructure within the concession area will result in a permanent impact on the landscape. This impact on the landscape will also impact the concession area permanently and would result in a changed in the sense of place as the currently the area is rural in nature with no industrial facilities.

Mitigation Measures

It is important to note that when considering the impacts during the construction phase:

- Worksite facilities will be constructed a at minimal height to avoid unnecessary impacts on the landscape
- Worksites will only be temporary as machinery and construction equipment will be dismantled and removed. In addition, there will be a reduction in workers on site as construction is completed and restoration activities will be undertaken.

Some mitigation measures already specified in other sections of the Impact assessment are also effective for reduction of landscape related impacts. For example:

- the removed topsoil will be finally placed back on the working corridor. The original contours of the land will be restored as closely as possible; and
- soil stockpiles must be sampled, ameliorated (if necessary) and re-vegetated with indigenous species as soon after construction as possible to reduce exposure to rainfall and wind, as well as to slow and trap runoff to reduce soil erosion.

Measures will be applied to reduce the light pollution, as the follow:

- Using directed downward lighting which will be sufficient to enhance the night time visibility required for safety and security but minimise impacts;
- use specifically designed lighting equipment that minimises the upward spread of light near to and above the horizontal.

Conclusions

Considering the mitigation measures and the evaluation criteria defined in section G.2, the potential impacts on landscape associated with the construction phase are summarized in Table G52.

Table G52 Ranking of residual impacts and risks on landscape during the construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Landscape and Visual – Construction Phase					
Landscape changes and visual impacts due to installation of the pipeline	Less than 1 year / Temporary	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	
Landscape changes and visual impacts due to construction of ORF and associated infrastructure	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	*4*	*1*	*2*	*1*	

The residual impacts on the landscape due to Project construction activities is considered to be **Low** and **Medium.**

G.4.9.4 Operation and Maintenance Phase

Regarding the operational phase of the Project, the following sources of impact have been identified in Table G53. Without mitigation, the sources listed below have the potentiality to cause visual impacts and imapcts on landscape.

Table G53 Landscape and visual impacts and risks – operational and maintenance phase

Source of Potential Impact	**Potential Impact**
Presence of ORF and associated infrastructure	Visual impacts from the presence of the ORF and associated infrastructure

The impact assessment on landscape described in the following sections is based on the analysis of the sources of potential impacts in the table above. During operations, the lighting related to the FPSO will have affects on fishing activities, which are assessed within Section G.6.

Impacts Identification and Assessment

The sources of potential visual and landscape impacts are as follows:

Visual and light impacts from the presence of the ORF and associated infrastructure

Visual Impacts Due to Presence of the ORF and Associated Infrastructure

During operations the visible infrastructure will include the ORF, the helipad and the base camp. All facilities will include security lighting at night with possible light spill to the surroundings. The ORF will operate 24hrs a day, and will be lit during the night time. . Although only operated for medical emergencies, the helipad facilities will include security lighting.

Visually, the ORF is located in the norh western section of the concession area which is furtherest away from existing communities and sensitive receptors. The presence of the ORF will constitute a visual obstruction only at specific viewpoints and is largely expected to be concealed by vegetation including tall trees and surrounding palm plantations.

The assessment of impacts on landscape and visual amenity has been performed based on an approach derived from ERM experience and internal guidance (in compliance with IFC Standards), structured according to the following steps:

- Definition of the ZVI: visual impact assessment is informed by an understanding of the existing visual qualities within the region that can be visually affected by a development. For the purpose of the Visual Impact Assessment the Study Area is referred to as Zone of Visual Interference "ZVI", as described below;
- Viewshed analysis and calculation of the potential range of visibility;
- Identification of Potential Visual Sensitive Receptors located within the ZVI.

The result of the viewshed analysis revealing that the most sensitive areas are located nearby the ORF and about 1.4 km far from the sea. Moreover, the presence of dense and high vegetation characterizing the coastline is acting as a natural barrier that reduces the visibility of the proposed development, as confirmed by the outcomes of the field surveys performed in March 2015. However, moving east and west along the coasts there are also areas where the vegetation is sparser allowing for an increasing of the visibility.

For more details refer to the Annex J Visual Impact assessment. .

Mitigation Measures

Vegetation will be planted for restoration and this action will partially mitigate visual and light spill from the ORF and screen viewers from potential negative effects. Some appropriate measures will be applied to reduce the light pollution, as the follow:

- use a lower level of lighting; it will be sufficient to enhance the night time visibility required for safety and security; and
- use specifically designed lighting equipment that minimises the upward spread of light near to and above the horizontal.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential visual and landscape impacts associated with the operation phase are summarised in Table G54

Table G54 Residual visual and landscape impacts during operational phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Landscape and Visual Impacts – Operation Phase					
Visual impacts due to presence of the ORF and associated infrastructure	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium**
Score	*4*	*1*	*2*	*1*	

The visual and landscape impacts due to Project operation is **Medium;** this is mainly due to the duration criteria (Project lifetime is about 20 years).

G.4.9.5 Decommissioning Phase

Potential impacts during Project decommissioning are likely to be similar to impacts during the construction phase for onshore and offshore facilities (**Low** impact).

For the pipeline decommissioning, considering that the pipeline will remain underground ant they will be only filled with a suitable material, the related impacts on landscape are considered **not significant**.

G.5 OFFSHORE ENVIRONMENTAL IMPACTS

With regards to the offshore impacts, it must be noted that there is a general commitment by eni to comply with all measures specified in the OSCP (Annex F) and well control strategy, during the different phases of the project, that is, construction and comissioning, operation and decomissioning.

G.5.1 Seawater Quality

G.5.1.1 Overview

This Section identifies and assesses the main impacts on seawater quality, proposes mitigation and management measures and then discusses the conclusion and impact ranking defined in section G.2.

The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on seawater resources.

Box G7 Key sources of risks and impact, potentially impacted resources and receptors

Sources of Impact

- Installation/ Construction Phase: FPSO installation, wells drilling, re-entry and testing; pipe-laying activities; pipeline's flooding, testing, dewatering, drying; anchor handling; seabed facilities (flowlines, umbilicals, etc.) installation, resulting in re-suspension and spreading of sediments; vessels operations resulting in contamination from wastewater and waste disposal systems.
- Operations and maintenance phase: wells and FPSO operation; external inspections and routine maintenance works resulting in sediment suspension in the vicinity of the pipeline and other subsea facilities; waste and waste water discharge management.
- Decommissioning phase: FPSO wells decommissioning; pipes remain on the seabed and are filled with a suitable material; movements of vessels for equipment and personnel transport, consumption of water; waste management.

Potentially Impacted Resources and Receptors

- Sea Water.
- Aquatic biota (see marine flora and fauna impact assessment, Section G.5.6 for secondary impacts).
- Fishing activities (see fisheries impact assessment section G.6).

Baseline Influencing Factors

- The oceanographic parameters.
- Seawater quality can be classified as good with low levels of organic, hydrocarbon or heavy metal pollution.

Project Influencing Factors

- Specific techniques used for trench excavations, direct seabed positioning, hydrotesting; water management and waste management.

The following table presents the key impacts of the project on the sea water component during the key project phases.

Table G55 Key impacts and risks – sea water quality

Installation/Construction Phase	Operations Phase	Decommissioning Phase
• Contamination of marine water due to drilling fluid and mud, drill cuttings, cement, fuel spillage, routine and occasional discharges (grey and black water, drainage and bilge water) from drillship, pipelaying vessel, support vessels and FPSO to the marine environment. • Increased turbidity of water column due to well completion, pipeline-laying activities and flowlines and other subsea facilities installation works and pipe-laying activities. • Water and sediment contamination due to use of drilling/cement and other chemicals • Release of nutrients (food wastes)	• Release of pollutants and degradation of sediment and water quality (produced water, sewage, sanitary and kitchen wastes, spillage and leakage).	• Contamination of marine water due to vessels movement

The *sensitivity* of the seawater component is reported in the following Sections. Then potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project. Conclusions are presented taking into account the application of the identified mitigation measures.

G.5.1.2 Seawater Sensitivity

The oceanographic parameters such as salinity and temperature and the variations given due to the seasonal upweilling processes are known to be key in the support of marine productivity and associated species of fish, marine mammals, turtles and even birds.

No criticalities have been identified in terms of water physical parameters; therefore the sensitivity of these parameters to changes in case of potential water pollution is expected to be low.

Based on the analytical results and the comparison with the quality standards, as reported in Section 6 (Environmental Baseline), seawater quality can be classified as good and the sensitivity can be considered **Moderate**.

G.5.1.3 Installation/Construction Phase

The following sources of installation/construction impacts have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on seawater quality.

Table G56 Seawater impacts and risks. Installation/Construction and pre-commissioning phase

Source of Potential Impact	Potential Impact
Pipe-laying	Temporary limited disturbance of sediment with resulting increase of turbidity
FPSO anchor handling	Temporary limited disturbance of sediment with resulting increase of turbidity
Well drilling and completion	Temporary limited disturbance of sediment with resulting increase of turbidity and contamination of sea water due to drilling waste and cement discharges
Seabed facilities (flowlines, umbilicals, etc.) installation works	Temporary limited disturbance of sediment with resulting increase of turbidity
Routine and occasional discharges from support and installation vessels to the marine environment	Potential temporary decreasing of seawater quality as a result of the discharge of liquid effluents.
Hydrotesting	Potential temporary decreasing of seawater quality as a result of the discharge of liquid effluents.

The impact assessment on seawater resources described in the following sections is based on the analysis of the sources of potential impact reported above.

Impacts identification and Assessment

The aim of this Section is to identify the possible impacts on seawater quality and oceanographic aspects during the installation/construction and pre-commissioning phase, including onshore hydrotesting that will use seawater.

The potential impacts on seawater will largely be confined to the area of the offshore pipeline corridor, drilling wells and FSPO location.

As a result of pipe-laying, anchor handling, drilling wells and subsea facilities installation works, key potential impacts upon the water column during the installation/construction phase are correlated to:

- increase in water turbidity as result of the re-suspension and spreading of sediments;
- release of contaminants (heavy metals and organic pollutants) and nutrients as result of the re-suspension and spreading of sediments;
- potential contamination from vessels fuels and from wastewater and waste disposal systems from vessel operations;
- contamination of sea water due to the release of drilling waste (mud and cuttings) and cement discharges;
- potential contamination from the release of hydrotest water.

Increase in Turbidity

Works on the seabed will result in the disturbance and subsequent re-suspension of sediments together with the associated compounds such as nutrients and contaminants that they may contain.

This would result in an increase of local turbidity levels as well as an increase of potential pollutants concentration in the water column, leading to a reduction of water quality. In the photic zone (usually up to 50-75 m depth on non-turbid waters) this may result in reductions of phytoplankton production due to metal pollution (nickel and chromium from sediments at stations 5 and 6 and arsenic along the pipeline route) or an increase of certain plankton species due to nutrient pollution. In deeper areas, the increased turbidity and compound concentration may affect the existing benthic communities (see section G.5.6). The intervention works to bury the offshore pipeline close to the shore are expected to generate the most re-suspended sediment. Pipeline-laying , sub-sea facilities installation and anchor handling are expected to contribute very little.

The amount of sediment disrupted is highly dependent on the methods and equipment used during the pipeline' installation phase as well as the extent of the disturbance area of the installataion works. Certain types of sediment are generally prone to suspension due to their fine textures. According to *Pennekamp & Quaak 1990*, the degree of resuspension of sediments and turbidity from seabed intervention works and disposal depends on three main variables:

- sediments type (size, density and quality of the material);
- method of excavation (and disposal);
- hydrodynamic regime in the area (current direction and speed, mixing rate, tidal state);
- existing water quality and characteristics (background suspended sediment and turbidity levels).

Turbidity levels observed in the Project area are low and therefore any re-suspension would affect water quality. However, sediments are mainly composed of sands of medium size which are difficult to re-suspension and enhances sedimentation when compared to fine sediments. The latter dominate, however, in the deeper areas, where the wells are planned.

During excavation works, sediments are re-suspended for a period of time before being deposited (sedimentation). In most cases, sediment resuspension is only likely to present a potential problem if it is moved out of the immediate work location by tidal processes (*Bray, Bates & Land 1997*). Therefore when trenching in limited areas, there is little likelihood that material will be transported to the wider environment and affect the marine features. In general, the effects of suspended sediments and turbidity are generally short term (less than 1 week after activity) and take place over a reduced area (less than 1 km from site).

Project excavation works are planned to be performed only for a limited section of the offshore pipeline, when approaching the shore. The pipeline will be buried in order to protect the pipeline and ensure its stability by a pre-excavated trench method for a section of approximately 0.55 km and by post-trenching tecniques for an additional 1.5 km. Given that in the Project area the proportion of finer sediments decrease in shallower areas where sandy sediments dominate, it is expected that despite the mobilization of sediments due to excavation works, most of them (those of bigger sizes) will re-deposit again in a brief period of time.

In the deeper areas, where the pipeline will not be buried but laid on the seabed, the works can result in the re-suspension and further spreading of sediments due to the existing currents as well as from the pressure transfer when the pipelines hit the seabed. Pipeline-laying activities will extend along the entire length of the pipeline (around 63 km) using anchor handling to move forward. This methodology implies the placement and retrieval of anchor and chain on the seabed along the pipeline route, which results in an additional increase in the mobilization of sediments.

The presence of materials suspended in the water column directly reduces transparency (and thus light penetration) and this can interfere with the variation in euphotic zones and, in turn, photosynthesis of the plant organisms present, both in the water column and on the sea bed. Generally, fine materials are a direct result of the increase in particulate substances present in the sea. However, reduced transparency is often the result of increased numbers of phytoplanktonic organisms or organic substances present as a result of the increased availability of nutrients.

Several studies on sediment suspension due to seabed intervention works highlight that during both anchor placement and retrieval, and assuming a sediment density of 1500 kg/m^3, approximately 0.1 m^3 of sediment will be placed in suspension during each activity per anchor on average.

No seagrasses or corals are present in the vicinity of the pipeline route, or on the wells area. However, the presence of isolated patches of coral individuals cannot be discarded as they have been observed in the wider area. As a result a specific seabed survey will be carried out before installation/construction activities to avoid disturbance of areas with sensitive benthic organisms.

In summary, the expected increase in turbidity will be higher in the shallower section of the pipeline route due to the excavation works, though the impact in that area will be temporary due to the dispersion of the turbidity plume and the nature of the sediments that would enhance a quick re-deposition of most of it, and will not last once the works have finalised. The area affected will also be limited mainly to the vicinity of the working area, affecting therefore a limited number of individuals, mainly from benthic communities usually adapted to a certain degree of turbidity.

Potential Seawater Contamination due to Release of Contaminants and Nutrients as a Result of Sediment Mobilisation

As indicated by the results of the offshore surveys performed in February and April 2013, the presence of pollutants (identified as trace metals and hydrocarbons) are present in the seawater of the AoI at low background levels. These levels are slightly higher in the sedments, specially in the deeper stations close to the wells where background levels of nickel and chromium were recorded at levels above the Dutch quality standards for dredged material. Similarly, the sediments close to the proposed well Gye Nyame1 present signs of hydrocarbons.

Contaminants have the ability to be mobilised into the water column but would generally be diluted, eventually to non-toxic levels. Moreover, release of contaminants due to seabed intervention works will have limited extent and duration. No resulting slurry dispersion is expected, while dispersion from trenching or pre-dredging activities will be similar to natural movements of water due to the low or background concentrations.

The release of nutrients such as nitrogen and phosphorus as a result of the re-suspension of sediment could lead to a stimulation of phytoplankton production in shallow waters, including the available biomass and potentially contribute to oxygen depeletion of the seawater due to additional oxygen consumption by degradation of organic matter. A release of oxygen-consuming compounds during trenching may aggravate local oxygen deficiencies at the sea bottom. These are however not expected to increase significantly beyond background levels.

Potential Seawater Contamination due to Routine Discharges from Vessel Operations and Occasional Spills

During the installation/ construction phase, the following routine and occasional discharges from support and installation vessels/barges to the marine environment that may locally affect water quality are expected:

- treated sewage, grey water and kitchen waste; and
- open drainage systems and bilge water potentially containing traces of hydrocarbons.

<u>Sewage, Grey Water and Kitchen Waste</u>

The discharge of untreated black and grey water into the sea can create a health hazard as it can contain harmful microorganisms, nutrients, suspended solids, organic material with chemical and biological oxygen demand and residual chlorine from sewage treatment leading not only to a decrease in water quality but also to a depletion in oxygen content and to visual pollution. Treated sewage will be discharged into the water or taken onshore for treatment depending on distance to coast and according to MARPOL regulations (MARPOL requirements and provisions specified in its Annex IV – Sewage). Macerated food wastes will also be disposed overboard beyond 12 miles from the coast or taken onshore for treatment. Discharge to the sea will introduce small quantities of nutrients and organic material to well-mixed, well-oxygenated surface open waters.

Grey water (water from showers, baths, washbasins and the galley) is disinfected prior to disposal overboard.

The extent of sewage discharged from the FPSO and other vessels during sub-sea facilities and pipeline installation works and drilling is approximately 20- 30 m^3/day (100 l per person) that will extend for a period of 40 months of wells drilling and 51 days of offshore pipeline installation.

It is expected that all these discharges will dilute and disperse quickly in the offshore environment resulting in a temporary and localised reduction in water quality.

<u>Drainage and Bilge Water</u>

Water that accumulates in the drains and bilges of the drillship and support vessels is likely to become contaminated with low levels of hydrocarbons and other chemicals. Unmanaged discharge of this water to the sea represents a potential impact on localised water quality and marine organisms.

For the current project the drainage systems of the various vessels involved will collect water generated from washing and the storage areas. These with bilge water will enter a drainage system where the effluent will be treated to be discharged with less than 15 ppm oil in water (in accordance with MARPOL Annex I).

Ocassional spills

During refueling procedures at sea, minor fuell spills may take place leading to surface water pollution.

Ballast water

Ballast water is taken onboard to maintain safe operation and maneuvering of vessels. Depending on where this water is taken onboard, it may contain harmful microorganisms (pathogens), marine organisms from other locations (potentially invasive species) and contaminated sediments in suspension.

All ballast water will be stored in specifically designated tanks to avoid cross contamination and remain free of oil. Any ballasting operations will also comply with IMO regulations and standards and guidelines for ballasting management based on the International Convention for the Control and Management of Ship's Ballast Waste and Sediments (BWM Convention).

As a result no significant impact on water quality is expected from the discharge of ballast water.

Potential Seawater Contamination due to Drilling Waste Discharges

The mud and cuttings as a result of drilling activities that are discharged close to the surface create a suspended solids plume that can potentially affect the quality of the water column. Muds and cuttings which are discharged at seabed level create a plume that stays close to the seabed and potentially affects the deeper section of the water column.

Drilling waste (mud and cuttings) discharges have the potential to result in water quality impacts as a consequence of high suspended solid loads with an increased turbidity of water column, increased oxygen demand and water and sediment contamination due to use of drilling chemicals.

The extent of this impact will vary depending on the point of dishcarge (seabed or surface level), the volumen and rate of the discharge as well as on the physical and chemical properties of the cuttings and base fluids (*e.g.* water based or synthetic based).

In compliance with Ghana's legislation the expected discharges of cuttings and muds will include the following:

- Cuttings and muds generated from the top sections of the wells, drilled with WBM, which are released at the seabed given the absence of the riser. The estimated quantity of cuttings to be discharged to the seabed is approximately 400 m^3 per well from the riserless sections.
- Cuttings generated from the bottom sections (approximately 400 m^3 per well) will be drilled with Non Aqueous Drilling Fluid (NADF), which will be recovered and treated onboard to reduce synthetic material retention on cuttings to a maximum of 2% of weight content of NADF in the cuttings and then will be discharged from the drillship.

The contaminants of major environmental concern in drilling wastes (due to their potential toxicity and/or abundance in drilling discharges) include hydrocarbons and heavy metals. Some heavy metals are present in drilling muds as metal salts or organo-metallic compounds; others are trace contaminants/impurities in bentonite clay (*e.g.* arsenic, mercury, cadmium, lead, nickel and zinc) or may be derived from the penetrated rock formation or drill pipeline corrosion. Water-based drilling-derived cuttings and muds (which will be released into the sea) tend to have low levels of both hydrocarbons and heavy metals, if at all.

The Project foresees the drilling of three NAG wells and the re-entry in two additional wells. Drilling activities will take place at seadepths vvarying between 520 m and 947 m, though for of the five wells will be at depth higher than 811 m.

Discharge of Water-based Muds (WBM) and associated cuttings will take place very near the bottom and material will settle fairly rapidly, reducing contact with the water column, and once settled the leaching of contaminants into the water column will be slow. Therefore, at most low concentrations of contaminants will be released to the water column, which will be dispersed and diluted. Following cessation of the top hole drilling activities, contaminant concentrations in seawater would be expected to return to background levels rapidly, with the assistance of currents and the mixing capacity of the water body.

Because WBMs are essentially non-toxic and they will be discharged in compliance with Ghana EPA requirements and consistent with World Bank Group guidelines, there is no predicted water quality or secondary ecological impacts associated with this discharge (with the exception of smothering effects that are considered in section G.5.6, impacts on marine fauna), and impacts on water quality will be temporary and localised.

With regards to the NADF cuttings, following their discharge at the sea surface after being treated to eliminate the muds to a maximum 2% in weight, cuttings will pass down through the water column and gradually be dispersed before settling on the seabed. This will create a plume of increased suspended solids During this time, marine life, such as pelagic fish, may become exposed to suspended solids (*eg* fine particles that may interfere with respiration) or toxic substances (such as certain metals or organic compounds) associated with the suspended solids or dissolved in the surrounding water. An oxygen demand may also be exerted on the water.

The constituents of the NADF, which will be discharged adhered to the cuttings accounting for a maximum 2% in weight are characterized by being non water-soluble organic compounds (i.e. esters) and are therefore not expected to dissolve in the water. As a result they will settle rapidly onto the seabed and any potential affection to seawater quality will be limited and of temporary nature.

Increases in concentration of total suspended solids (TSS) will present higher values at the point of discharge from the drillship or at the seafloor during upper well section drilling, and decrease over time and distance as the suspended solids plume dissipates and settles. 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. Impacts related to elevated TSS may occur if light penetration is impeded significantly for long periods of time reducing the ability of plants and phytoplankton to photosynthesize. Increases in TSS may also decrease water clarity and clog fish gills. The guidance value for TSS provided by the IFC is 35 mg/L for effluent discharges of hydrotest water at LNG Facilities (IFC, 2007).

According to the screening model of the discharge of cuttings performed, the maximum TSS concentration added above ambient concentrations as a result of top hole drilling near the seafloor was 2.5 mg/l. The maximum TSS concentration added above ambient as a result of surface discharges from the drillship was 0.7 mg/l, both increases on TSS concentration are considered to lead to minor effects on marine organisms, due to both, the small increase in TSS concentration and to the short duration of such an increase. The estimated maximum concentrations are slightly offset from the discharge location assuming the floating small particles suspended in the water column mix together at different locations. Larger particles do not remain suspended but quickly settle to the seafloor.

As a result, and considering that the NADF cuttings discharged from the surface do not disperse readily in seawater and tend to settle rapidly through the water column and onto the seabed, these impacts on the water quality are unlikely to represent a concern. In addition, most pelagic species are sufficiently mobile to avoid being exposed periods of time that could potentially be harmful.

Cement Discharge

Well completion involves the insertion of casings in the well hole as it is drilled. The casing provides structural integrity to the newly drilled wellbore. Cement is placed between the outside of the casing and the borehole. The excess of cement will be discharged directly at seabed level. The cement discharge at seabed could lead to water contamination due to the use of cementing chemicals, with consequential exposure to chemicals of marine flora and fauna.

Potential Seawater Contamination due to Use and Discharge of Treated Seawater Resources

During the installation/construction phase it is also envisaged the use of seawater in order to proceed with hydrotesting activities. Sea water, will be used for the offshore pipeline hydrotesting.

During the hydrostatic test, seawater is transformed into the testing fluid by the addition of certain chemicals in the form of corrosion inhibitor, oxygen scavenger and biocide. Oxygen scavenger is necessary for preventing corrosion due to the presence of oxygen, while biocide is necessary for preventing corrosion due to the presence of aerobic bacteria. All the chemicals planned for use for the pipeline hydrotesting will be eco-friendly inhibitors that will adhere to international standards and industrial best practice for the oil and gas sector.

Once the hydrotest has been accepted, the system shall be depressurised to ambient pressure and then the pipeline shall be dewatered and discharged into the sea.

Table G57 summarises the seawater consumption required for installation/construction and pre-commissioning activities.

Table G57 Seawater consumption during installation/construction and pre-commissioning phase

Typology	Quantity	Comments
Seawater	15,000 m^3	For hydrotesting of offshore pipeline

Potential contamination from the discharge of hydrotest water is expected to be temporary considering that only one discharge will be performed and the quick dispersion expected of the chemicals used. In addition the chemicals considered shall be environmentally friendly and as such are expected to quickly dilute and therefore affect only a localised area in the vicinity of the discharge point.

Mitigation Measures

Increase in Turbidity and Release of Contaminants and Nutrients

Dredging equipment will be selected appropriately to the depths and material types to be dredged to reduce the resuspension of sediments from seabed intervention works and to minimise the creation of turbidity plumes.

Contamination from Routine Discharges from Vessel Operations and Occasional Spills

The drilling rig, the pipeline laying ship and other support vessels will comply with MARPOL standards, and will be equipped with waste water treatment Unit/STU for the treatment of civil wastewater. Such treatment unit will ensure the following concentration levels:

- BOD5 < 30 mg/l;
- COD < 125 mg/l;
- Total Nitrogen < 10 mg/l;
- Total Phosporus < 2 mg/l;
- Suspended solid < 50mg/l;
- Total Coliform < 400 MPN/100ml;
- Cl2 < 50mg/l.

The vessels will also include oil/water separators to treat drainage and bilge water and ensure the water discharges contains less than 15 ppm of oil content.

Chemical, fuels and oil storage will be kept or stored in bunded areas on board the vessels to contain leaks and spills. Other sources will have drip trays to contain accidental spills or leaks.

Regarding the ballast water, and in compliance with IMO Guidelines for the Control and Management of Ship's Ballast Waste and Sediments (Ballast Water Management Convention) all vessels involved in the Project, including the FPSO, will develop a Ballast Water Management Plan and carry a Ballast Water Record Book where all ballasting operation will be registered.

With regards to the refuelling processes, the fuel will be pumped into the ships´ tanks via the tanker and all precautions will be taken to prevent spills. The vessels will include sufficient mops, pads and absorbents available during the fuelling process, whereby in the unlikely event of any spill occurring it will be dealt with immediately. In addition, no refuelling will take place in bad weather conditions so as to limit the risk.

To reduce the risk of these spills, re-fuelling will be restricted to moments of suitable weather conditions and will be supervised at all times. In addition alarm systems are expected to be fitted to fuel tanks so they can warn of high levels and avoid spilsl due to excess fuel transfer. Spill drills will also take place every month on each vessel involved in the Project to ensure an efficient response in case such an event occurs.

Drilling Waste Discharges

Measures to reduce the water quality impacts associated with drilling waste discharges include the following:

- Additives to be used in the WBM will be inert and eco-friendly, preferably included in the PLONOR list (Pose little or No Risk to the environment)(OSPAR, 2013), in any case WBM and associated cuttings discharged must accomplish the toxicity requirements set by the EPA in the authorization for the drilling of Sankofa East 3A;
- optimise the operation of solids control system to maximise the useful life of drilling fluids by effective liquid/ solids separation and to minimise the quantity of fluid "lost" overboard with the cuttings;
- Use the lowest feasible chemical contents in the NADF, prioritising those included in the PLONOR list and those with lowest hazard according to the CHARM methodology developed by OSPAR;
- The NADF cuttings to be discharged overboard will be monitored to ensure compliance with Ghanaian regulations that state a maximum of 2 % content of NADF in the cuttings discharged. In case of exceedance of these values due to technical reasons, they will be compliant with IFC draft 2014 O&G, that set a maximum value of 7 % NADF content in the cuttings for such cases.
- Cleaned cuttings will be discharged via a caisson at least 15 m below water surface;
- Additional modelling of the fate of the cuttings discharged and the associated turbidity plume generated will be required.

Cement Discharge

Cement will be prepared on board of the drill rig in marginally greater quantity than is expected to be required. For top hole any excess cement is discharged at seabed as per standard international practice. Thereafter no cement returns are expected to surface as the casings will not be cemented to seabed.

The vast bulk of the cement mixture will be comprised of cement and barite, which are inert and pose no risk for water quality or biota; chemical additives will be in very small proportion and preference will be given to additives included inthe PLONOR list.

Use and Discharge of Treated Seawater Resources

The seawater used during the precommissioning activities of the offshore and onshore pipelines will be added with chemicals which will be respondant to international standards and industrial best practice for oil and gas.

Once the hydrotest has been accepted, the system shall be depressurised to ambient pressure and then the pipeline shall be dewatered. The seawater used during the hydrotesting activities of the offshore pipeline will be discharged from ORF to the pipeline end terimation or the sub-sea isolation valve.

The release of the seawater used for the hydrotesting will be done according to an Hydrotesting Control Plan to be developed prior to the release and that will include protocols to ensure that concentations of additives remain below toxic levels.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on seawater resources associated with the installation/construction phase are summarised in Table G58.

Table G58 Ranking of residual impacts and risks on seawater during installation/construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilienceof Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Seawater Resources – Installation/Construction Phase					
Increase in Turbidity	Between 1 and 5 years	Local scale: the proposed operating site (well site, pipeline route) and its immediate environments	Moderate value/ sensitivity of receptors or resources, able to adapt with some difficulty and which may require intervention	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6- Low**
Score	*2*	*1*	*2*	*1*	
Release of Contaminants and Nutrients	Between 1 and 5 years	Local scale: the proposed operating site (well site, pipeline route) and its immediate environments	Moderate value/ sensitivity of receptors or resources, able to adapt with some difficulty and which may require intervention	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential Contamination from routine discharges of Vessel Operations and occasional spills	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may	Affecting small no. of individuals, households, individual enterprises and/or small	**6 - Low**

Impacts	*Duration*	*Extent*	*Importance / Resilienceof Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Seawater Resources – Installation/Construction Phase					
			require interventions	no. of species	
Score	*2*	*1*	*2*	*1*	
Drilling waste (mud and cuttings) and cement discharges	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Use and discharge of Treated Seawater Resources	Less than 1 year / Temporary	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*1*	*1*	*2*	*1*	

The impacts on the seawater component, due to Project installation/construction activities have been assessed as **Low**, given the moderate sensitivity of the receiving environment in terms of water quality, the volumes to be discharged and the localised areas expected to be affected with regards to drill cuttings and muds discharges and sediment re-suspension. In addition the mitigation measures considered will contribute to reduce the impact of the proposed activities.

G.5.1.4 Operations and Maintenance Phase

Impacts upon the water column during the operational phase are related to FSPO water discharge, vessels operation as well as the release of metals from anti-corrosion anodes in place on the offshore pipeline. The sources listed below could potentially cause impacts on water resources.

Table G59 Seawater impacts and risks - operational and maintenance phase

Source of Potential Impact	Potential Impact
FSPO and vessels routine discharges	Potential seawater contamination from FPSO and support vessels (unplanned events)
FSPO and vessels operations	Potential seawater contamination from FPSO and support vessels routine discharge
Presence of anti-corrosion anodes on the pipeline	Potential contamination due to metal release

Impacts identification and Assessment

The potential impacts on seawater will largely be confined to the FSPO operation and wells site. Key potential impacts on seawater may occur as a result of the following sources:

- Potential contamination of seawater from FPSO and support vessels operation;
- Potential contamination of seawater from routine discharges (black and grey waters, drainage water) of support vessels.
- Potential contamination of seawater from pipeline's anticorrosion anodes.

Potential Contamination of Seawater from FPSO and Support Vessel Operations

Potential direct contamination of seawater can be generated by FPSO operational discharges. During operational phase the waste water effluents from the FPSO operation are related to:

- Civil uses, as domestic, potable fresh water and services water;
- Industrial uses, as for cooling system, processing, HVAC system, cargo tank washing.

In the table below the estimated quantities for each type of waste water are reported. All the streams will be discharged only after treatment.

Table G60 Wastewater emissions from FPSO operation

Discharge Sources	Location	Substance	Emissions Flowrate
Cooling Water	FPSO Topside	Hot Water treated with biocides and antifouling	1,700 m^3/h with a maximum discharge temperature of 31 °C Biocide concentration 2-5 ppm
Civil Water	FPSO Topside	Seawater	6 m^3/year
Service Water	FPU Hull	Seawater	TBD
Bilge Water	FPSO Topside	Oily Water	10-15 m^3/month

The cooling water will be discharged at a temperature of approximately 31ºC. As sea surface Temperatures (SST) in offshore Ghana typically vary between 27 - 29°C, the impact of hotter waters discharged will generate a limited increase of temperature of the seawater that will only be noticeable in the immediate vicinity of the discharge point.

Main impact derived from the operational discharges of the FPSO are the potential presence of hydrocarbons (bilge water) and the biocides included with the cooling water, that could lead to reductions in seawater quality. However, given existing currents it is expected that any potential pollutant entering the seawater after treamtents will quickly disperse.

In summary, any potential effect in water quality from the operations will be of local nature affecting only the vicinity of the operations area.

Potential Contamination of Seawater from Routine Discharges of Support Vessels

Potential direct contamination of seawater can be generated by support vessels operational discharges of black and grey water, bilge water and also when refuelling. These discharges will follow MARPOL requirements as the vessels involved will include approved water treatment units. The likely effects produced by these discharges are similar to those described for the installation/construction phase, main difference beign the duration of such discharges.

During refuelling process, the fuel will be pumped into the tanks via the tanker and all precautions will be taken to prevent spills. Additionally there will be sufficient pads and absorbents available during the refuelling process, whereby in the unlikely event of any spill occurring it will be dealt with immediately.

Potential Contamination of Seawater from Pipeline's Anti-Corrosion Anodes

In order to protect the offshore pipeline from corrosion, anti corrosion anodes are commonly used. These are made by metals that are more easily corroded than the one forming the pipeline acting therefore as a "sacrificial metal". As a result, this corroded metal is slowly released into the environment potentially leading to a reduction in seawater quality. Generally these anodes are made by aluminium, considered as a non critical metal by its toxicity. These anodes, however, may contain also traces of zinc and iron among other metals.

Considering the expected low release rate and the quick difussion no significant changes in water quality are expected and chronic Ambient Water Quality Criteria (AWQC) set by USEPA, are expected to be met. The impact will be therefore temporary during the lifespan of the pipeline and is expected to affect only to the vicinity of the pipeline.

Mitigation Measures

Potential Contamination of Seawater from FPSO and Support Vessel Operations

All the wastewater effluents from FPSO will be discharged only after treatment. Wastewater treatment and disposal is designed to meet national and international requirements.

In addition, the following mitigations measures will be in place:

- No refuelling will take place in bad weather conditions so as to limit the risk of occasional spills
- The decks on the FPSO will be equipped with a drainage system to collect run off water into a holding tank for treatment prior to discharge overboard.
- A bilge pump and a bilge water separator will be installed for draining the bilge water tank (fitted with a high oil alarm to meet IMO requirements), which discharges to sea. Separated oil will be contained in dedicated tanks (bilge holding tank; dirty oil tank and contaminated drain holding tank) and then sent to shore for disposal at licensed facilities.
- As per Ghanaian Pollution Prevention and Control regulations the discharge of garbage, with the exception of food waste, is prohibited from any vessel involved in the Project and the FPSO.
- The disposal of food wastes into the sea from support vessels will only be allowed if previously macerated to pass through a 25 mm mesh, and in areas located more than 12 nautical miles from land. Additionally, the support vessels shall not discharge comminuted food waste within 500 m of the FPSO location.

- Sewage from support vessels and FSPO will be treated in an approved sewage treatment unit in compliance with MARPOL Annex IV requirements prior to discharge; such treatment plant will ensure the following concentration levels:
  - BOD5 < 30mg/l;
  - COD < 125 mg/l;
  - Total Nitrogen < 10 mg/l;
  - Total Phosporus < 2 mg/l;
  - Suspended solid < 50mg/l;
  - Total Coliform < 400 MPN/100ml;
  - Oil and grease < 10 mg/l
  - Cl2 < 50mg/l.

- Water collected from the bilge, engine spaces and drainage will be treated to MARPOL Annex I requirements, that is to a level lower than 15 ppm oil content in water. To achieve this, water will be treated in an oil/water separator and continuously monitored by an automatic oil content meter.
- Produced water will be re-injected. However, if needed treated produced water will only be discharged to the sea if it meets WB/IFC guidelines. For this effect, sampling points will be made available to sample and test eventual produced water discharges.

Potential Contamination of Seawater from Pipeline's Anti-Corrosion Anodes

The composition of the anti-corrosion anodes to be used will not include toxic metals such as mercury or cadmium to avoid their introduction in the environment.

<u>Conclusions</u>

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on seawater resources associated with the operational phase are summarised in Table G61.

Table G61 Ranking of impacts on seawater during operational phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Seawater Resources – Operational Phase					
Potential Contamination due to FPSO operations	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 – Medium**
Score	*4*	*1*	*2*	*1*	
Contamination from routine discharge from Vessel Operations	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 – Medium**
Score	*4*	*1*	*2*	*1*	
Potential Contamination from pipeline anti corrosion anodes	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 – Medium**
	4	*1*	*2*	*1*	

The impacts on the seawater resources due to Project operational activities is **Medium;** this is mainly due to the duration criteria (Project lifetime is about 20 years).

G.5.1.5 Decommissioning Phase

In the decomissioning phase impacts will be similar to installation/construction phase as there will be several vessels involved in the process (routine discharges). However the duration and intensity of works will be reduced and therefore impact expected will also be reduced. In this context impacts on seawater quality will be mainly due to the presence of working vessels.

As the wells will not be removed but permanently abandoned by setting cement plugs on top of the openhole of each well, no adiditional discharges are expected.

Main difference with the construction phase is the pipeline that will not ve removed removed from the seabed once the project life is finished, but cleaned up through pigging process and flushing seawater. The seawater used to clean it shall be properly treated before discharge; finally the two ends of the pipeline will be plugged and the pipeline left there offering hard substrate to benthic organisms.

he related impacts as a result of the decomissioning of the Project on seawater quality will be **Not significant**.

G.5.2 Seabed

G.5.2.1 Overview

The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on seabed. In particular, this section identifies and assesses the main impacts on the seabed and marine sediments, proposes mitigation and management measures and then discusses the conclusion and impact ranking defined in section G.2.

Box 8 Key sources of impact, potentially impacted resources and receptors

Sources of Impact

- Installation/construction phase: FPSO installation, drilling of wells, pipeline laying activities, other sub-sea facilities installation (flowlines, umbilicals).
- Operations and Maintenance Phase: presence of pipeline resulting in sediment accumulation along the pipelines and seabed erosion.
- Decommissioning Phase: pipeline remains underground (nearshore) and on the seabed and are filled with a suitable material.

Potentially Impacted Resources and Receptors

- Seabed
- Marine water quality (as a result of increased turbidity - assessed in Section G.5.1)

Baseline Influencing Factors

- Seabed morphology is generally gently sloping to relatively short distance from the coastline up to 175 m depth, where a steep continental slope follows. Depth varies between 0 m in the pipeline landfall site to about 1,000 m on the location of the deepest well.
- Seabed habitat in the region may support a number of species of ecological significance, including isolated individuals of corals.

Project Influencing Factors

- Specific techniques used for trench excavations, direct seabed positioning, waste management and installation methods.

The following table presents the key impacts of the project on the seabed component during the key project phases.

Table G62 Key impacts and risks – seabed quality

Installation/Construction Phase	Operational Phase	Decommissioning Phase
• Sediment contamination due to use of cementing/drilling chemicals (unplanned event due to well completion and discharge of drilling waste/cement and resuspension and deposition of contaminated sediments). • Physical alterations to the seabed (including smothering of habitat) due to well completion, discharge of drilling waste/cement, seabed works and pipeline laying activities and introduction of hard substrate due to hardening of excess cement on the seabed surface	• Release of pollutants and degradation of sediment quality by deposition (produced water, sewage, sanitary and kitchen wastes, spillage and leakage). • Sediment accumulation and/or scouring/ erosion.	• None

The *sensitivity* of the seabed component is reported in the following Sections. Then potential impacts relating to each of the three main project phases are described with the mitigation measures that will be adopted by the Project.

G.5.2.2 Seabed Sensitivity

Seabed quality was investigated through a field survey performed by eni Ghana in two steps, February 2013 along the proposed pipeline route and on April 2013 along the wells area to analyse the seabed composition and the presence of heavy metals or hydrocarbons.

Based on the analytical results and the comparison with the quality standards, as reported in Environmental Baseline Section, seabed sediments are composed by:

- Sandy sediments dominate along the pipeline route on the continental shelf with a proportion of fines (about a third) in many places;
- Predominance of mud, along the deeper sections of the pipeline route and wells area at depths greater than 200 m.

High levels of chromium and nickel were observed in the deeper stations coinciding with the predominance of finer sediments. High levels of arsenic were also recorded along the pipeline route at less than 200 m depth. The elevated levels in the deeeper areas may be related to historic oil and gas activities, while arsenic values along the pipeline route may be related to local geology.

Additionnally, elevated values of total hydrocarbons were recorded in the vicinity of the Gye Nyame well, to be re-entered during this project, at sampling station 41.

Seabed distrurbance activities foreseen (i.e. seabed trenching in the nearshore and pipeline laying) might re-suspend contaminated sediments, with the potential effect in the food-cycle and spatial distribution in sensible and valuable ecosystems.

Therefore, considering that recorded high level of heavy metals the seabed sediment sensitivity can be considered **High,** despite the supected natural origin of the arsenic found.

G.5.2.3 Installation/ Construction Phase

Regarding the installation/construction phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on marine sediments.

Table G63 Seabed impacts and risks- installation/construction and pre-commissioning phase

Source of Potential Impact	***Potential Impact***
Pipeline-laying	Re-suspension and dispersion of sediments. Physical alteration of the seabed, directly and secondarily by the spreading of re-suspended sediments.
Anchor handling activities (FPSO)	Physical alteration of the seabed due to seabed depressions (anchor handling). Re-suspension and spreading of sediments.
Seabed intervention works (installation of additional sub-sea facilities)	Physical alteration of the seabed (including smothering), directly and by the spreading and deposition of re-suspended sediments.
Well completion and discharge of drilling waste / cement	Physical alteration of the seabed, directly and by the spreading and deposition of re-suspended sediments (backfilling), and due to the creation of depressions and mounds of sediment. Sediment contamination due to use of drilling/cement and other chemicals

The impact assessment on sediment reported in the following sections is based on the analysis of the sources of potential impact reported in Table G63.

<u>Impacts identification and Assessment</u>

The aim of this Section is to identify the possible impacts on seabed during the installation/construction and pre-commissioning phase. The potential impacts on seabed will largely be confined to the area of the pipeline corridor and wells sites.

Physical Alteration of the Seabed

Seabed intervention works carried out for pipeline laying, drilling and FPSO positioning by anchor handling in the offshore project area during the installation/construction phase are likely to result in the re-suspension and spreading of sediments, and physical alteration of the seabed, directly and by the spreading of re-suspended sediments.

In addition, direct physical alteration of the seabed is likely to result from anchor handling activities performed for the installation of the FPSO. This will likely create scars on the seabed as well as depressions and mounds of sediment. These effects will not themselves represent a significant impact on the seabed, since the impact is of a low magnitude and will also be temporary and localised. In the long term, and even earlier depending on sediment particle size, the gradual action of underwater currents and gravity will result in sediment deposition and movement resulting in a refilling of any generated trench and the reduction of generated mounds. The presence of the non-buried pipeline and other infrastructures will also result in an alteration of the seabed morphology with no direct or indirect impacts associated.

Main alteration of the seabed morphology will be associated to the installation of the buried pipeline, which will be laid in a pre-excavated trench for a section of approximately 0.55 km from the shore, and by post-trenching techniques for an additional 1.5 km, in particular to the excess material set aside of the trench as a longitudinal causeway to allow construction operation. This element will remain temporarily during construction phase.

However, main impact from these activities is the re-suspension of sediments, that is expected as a result of any activity in the seabed. The re-suspension of sediments, if polluted, will result in the mobilisation and dispersion of contaminants. As a result, there may be larger areas polluted and these resuspended pollutants may negatively affect marine biota.

It must be noted, however, that only a small fraction of this pollutants are expected to dissolve in the water and will deposit again in the seabed , usually at less than 1 km from the point of origin. Considering that during seabed sampling activities high levels of chromium, nickel and arsenic (Cr, Ni and As) have been found along several stations, it is expected a mobilisation of these pollutants as a result of planned activities resulting potentially in an increased mortality of benthic organisms and a temporary shift of benthic communities that would be dominated by opportunistic species or pollutant tolerant species.

In addition to the drill cuttings discharged, excess cement used during well completion will also be discharged directly at seabed leve which will harden as this settles. This will introduce a hard substrate on an muddy bottom, that may result in physical damage and habitat loss or disruption over a defined area of the seabed and at a later stage resulting in a different micro-habitat, and also could result in sediment contamination due to chemicals added to the cement.

This impact will result in temporary effects, as the communities will need a time to adapt to changs in the seabed, and will be limited to the vicinity of the area where works have been performed.

Sediment Contamination due to Drilling Wastes and Cement Discharge

The major waste product of drilling activities is the generation of mud and rock cuttings. Drill cuttings and associated seawater based muds from the riserless section will be discharged directly at the seabed. Approximately 400 m^3 of cuttings per well are expected to be discharged at the seabed from the drilling of these sections. Additionnaly, cuttings from the riser sections of the well (approximately 400 m^3 per well) will be discharged overboard from the drillship after treatment to include a maximum of 2% of adhered synthetic based muds, for a total of 800 m^3 of cuttings.

The discharge of WBM and cuttings will result in short term increases in suspended sediment concentration from the finer particles released and the formation of cuttings piles around the drill centers as the heavier, coarser cuttings and the bulk of the seawater drilling fluid solids content will sink rapidly to the seabed within a short distance from the point of release.

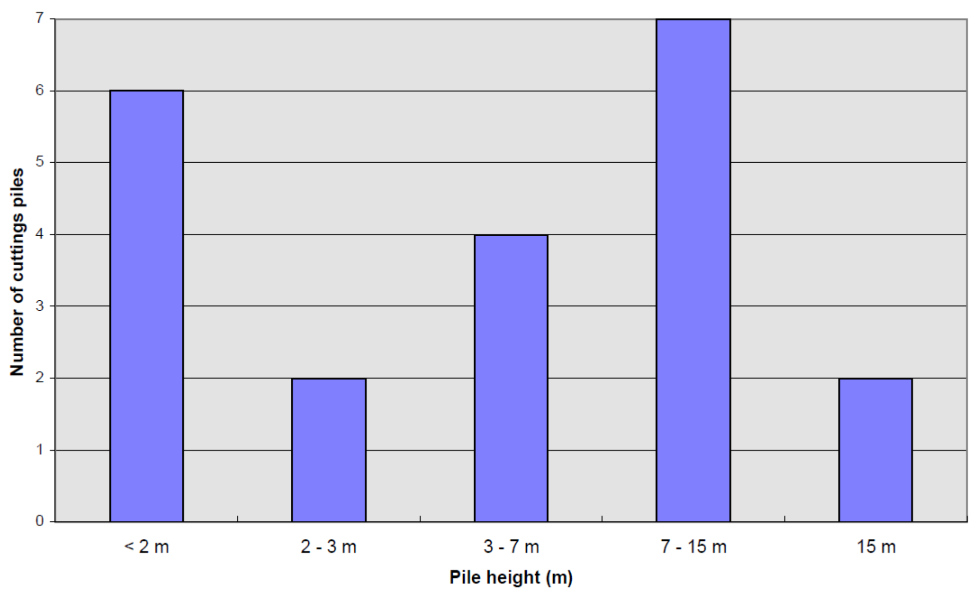
The NADF cuttings released from the surface will, on the contrary spread over a wider area subject to currents, however, it is expected that the majority of cuttings will still settle on the seabed within the local vicinity of the well. Compared to shallower water depths, deep water will allow greater initial dispersion of cuttings on the seabed. In general, cuttings discharges into deep water will form thinner accumulations because cuttings will spread over a larger area.

Impacts will include changes to seabed sediments due to sediment redistribution in the immediate area, changes in the chemical characteristics and composition and contamination (oxygen, metals, organic materials and hydrocarbon content) of the surface seabed sediments and disturbance or loss of benthic habitats and fauna within the footprint as a result of direct smothering or changes to sediment composition.

Cuttings pile dimension (height and radius) can vary depending on the volume of cuttings disposed and on environmental and climatic conditions, such as tides, waves and storms. The cutting pile can be some meters height with a radius of approximately 50m (*H.L.Koh and S.Y.Teh, 2011*). According to literature data (*Bakke et al., 1986*), impacts from smothering are expected to occur where the depth of cuttings is 1 mm or more, though final impact will depend on the species as tolerance to smothering varies (see section G.5.6 – impact assessment on flora and fauna).

Figure G2 indicates the maximum pile dimensions from a study of about 50 cuttings piles in the North Sea (*Cripps, S.J. et al.,1998*).

Figure G2 Frequency distribution of pile heights (Cripps, S.J.,1998)



The material discharged directly at the seabed from the upper sections is deposited in the area directly adjacent to the well head and according to the model of the discharge of the cuttings performed, results in the thickest layers of deposited material, which can be described as a footprint of cuttings above 1 mm thick within a 300 m radius from the well.

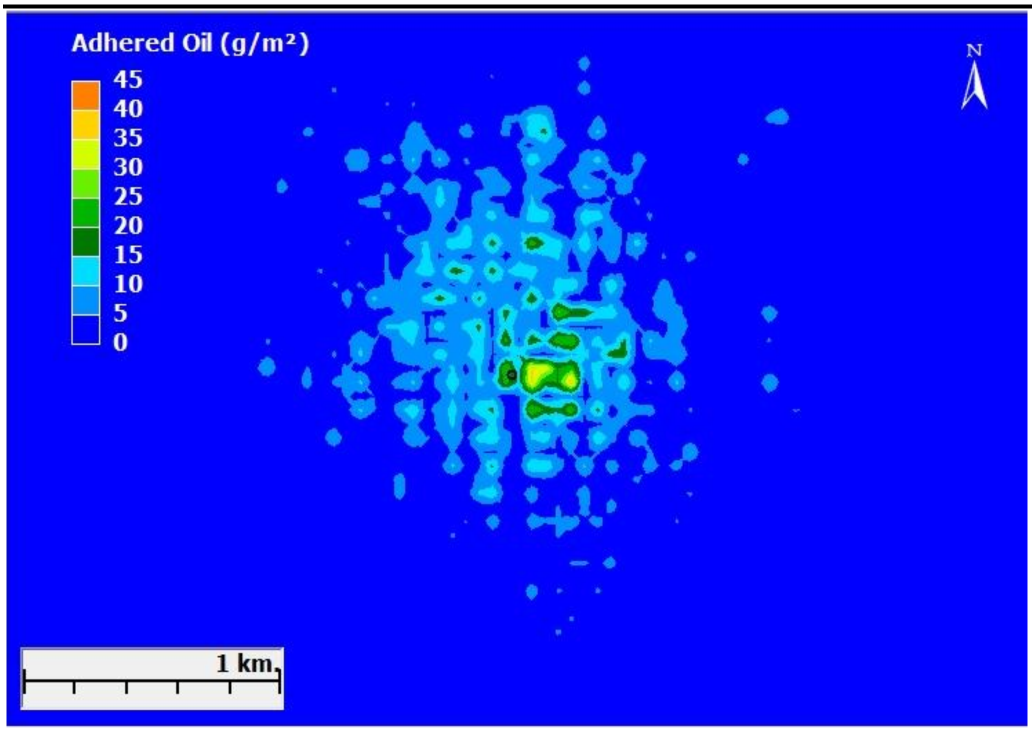
The area affected will increase with the subsequent deposition of the NADF discharged from the surface, as a greater amount of thin particles is expected to settle around the well in a 1 km radius. However at the end of the discharge the top mound slumped slightly from its state seen at the end of tophole drilling. The model also indicated that the maximum expected thickness reaches a maximum height of 34.9 mm in the immediate vicinity of the well.

Other effects derived fro the release of NADF cuttings could include organic enrichment of sediments through organic carbon loading and toxicity from organic enrichment and the drilling fluids.

These effects are related to the degree of accumulation of drill cuttings on the seabed and the toxicity of the drilling fluids. The type of NADF that are expected to be used does not contain any aromatics and is readily biodegradable in aerobic conditions. Solid control equipment will be used to reduce the NADF on cuttings to a target concentration of less than 2% as per Ghana's legislation, therefore reducing the risk of any potential contamination of sediments from the chemicals included in the NADF. In addition, the hydrocarbons included in the NADF adhered to the cuttings once settled to the seafloor, will degrade over time, and may enter the pore water within the sediments or become dissolved in the water column, depending on each specific hydrocarbon's tendency to remain partitioned to the solids.

The model of cuttings discharge performed Figure G3 indicates that in each well, the NADF adhered to the cuttings would settle primarily within a region with an area on the seafloor of approximately 1.2 km². Within that region, the total hydrocarbon concentration is expected to reach a maximum of 40.8 g/m². Concentrations above 5 g/m² according to the model would occupy 0.9 km².

Figure G3 Total deposit adhered oil



Candler et al., (1995) investigated the effects of discharging 45 tonnes of PAO NADF from an exploration well in 39 m of water. They found that TPH levels dropped by between 60 – 98% at all sampling stations (out to 200 m) except the closest (25 m), just 8 months after drilling had ceased. Further reductions in TPH levels were not observed 16 months later. After 2 years, only 7% of the originally discharged NADF was found within a 200 m radius of the discharge. It was not determined whether TPH concentrations during this study decreased as a result of biodegradation or sediment redistribution. In any event, species abundance and richness were reduced at a distance of 50 m from the operation two years after drilling had stopped, but areas further afield had recovered.

Candler et al., (1995) also reported that 1000 mg/kg of TPH from NADFs was required before benthic community structure was affected. These study results are similar to those of NADF discharges in the North Sea where benthic community effects were restricted to a small area down current of the discharge.

Mitigation Measures

The spreading of sediment as a result of seabed intervention works will be limited to the pipeline route and the place where the anchors of the FPSO will be installed, therefore limiting the area potentially affected by sediment disruption. Also the effect of wells drilling will be localised in the vicinity of each well drilled, specially due to the cuttings disposal. No additional seabed disruption is expected from the drill ship as it employs a dinamic positioning system and avoids the use of anchors.

Mitigation measures for drilling discharges include the following:

- No discharge of NADF will take place, with the exception of a maximum 2 % of NADF in weight associated to the cuttings after treatment on-board;
- Additives to be used will be inert and eco-friendly, preferably included in the PLONOR list (Pose little or No Risk to the environment) to the extent possible;
- Optimise operation of solids control system to maximise the useful life of drilling fluids by effective liquid/ solids separation and to minimise the quantity of fluid “lost” overboard with the cuttings.
- Limit the use of additives in the cement mixture to the extent possible and ensure that chemicals conform to OSPAR HOCNF standards.
- Monitor and limit the rate of WBM and cuttings discharge to the sea to 1,000 bbls / hr.
- Monitor the content of Hg and Cd of the barite used to ensure lower levels possible and within the relevant limits as per IFC EHS Guidelines for Offshore Oil and Gas Development (< 1 mg/kg and < 3 mg/kg dry weight of Hg and Cd content respectively).
- Monitor the NADF content in cuttings to be discharged overboard.
- Develop a plan to monitor the recovery of the seabed ecological conditions.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on seabed component associated with the installation/construction phase are summarised in Table G64.

Table G64 Ranking of impacts and risks on seabed during installation/construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilienceof Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Seabed Quality – Installation/Construction Phase					
Physical alterations to the seabed (including smothering of habitat)	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7 -Medium**
Score	*2*	*1*	*3*	*1*	
Sediment contamination due to use of cementing/ drilling chemicals	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7 -Medium**
Score	*2*	*1*	*3*	*1*	

The impacts on the seabed component due to Project construction activities is assessed as **Medium**. Impact Rank at medium level for the potential re-suspension and spreading of sediments is due by the high levels of Cr, Zni and As recorded in several sampling locations. In fact, seabed distrurbance activities foreseen (i.e. seabed trenching and pipeline laying) might re-suspend sediments, with the potential effect in the food-cycle and spatial distribution. The impact of the cutting piles on the seabed will be limited to the immediate vicinity of the well and any potential toxicity introduced will likely remain deposited there.

G.5.2.4 Operations and Maintenance Phase

During the operational phase, seabed occupation and waste production will be related to FPSO and wells operation. The sources listed below could cause potential impacts on seabed.

Table G65 Seabed impacts and risks - operational and maintenance phase

Source of Potential Impact	Potential Impact
FPSO and support vessel operation, including hazardous and non-hazardous spills, and improper handling of hazardous and non-hazardous wastes and discharges	Potential seabed contamination (unplanned event)
Presence of the pipelines	Sediment accumulation and/or scouring/ erosion.

For the assessement of the potential impact on seabed due to operation, all the sources identified in the table above have been considered together, letting to provide an overall assessement on the component.

Impacts identification and Assessment

Key potential impacts on seabed along the pipeline route, wells sites and FPSO from operational phase are the following:

- Potential seabed contamination, due to waste water discharge from FPSO and support vessels;
- Sediment accumulation and/or scouring/ erosion.

Potential Seabed Contamination

During FPSO operation, hazardous and non-hazardous spill and treated wastewater discharge could potentially contaminate the seabed by deposition of chemicals released. This includes organic pollutants (hydrocarbons from any incidental spill), trace metals, nutrients, etc.

Sediment Accumulation and/or Scouring/ Erosion

The presence of the pipeline on the seabed may result on sediment accumulation and scouring/erosion depending on local hydrodinamics. This presence could therefore result in minor changes on the flow conditions of sea currents in the pipelines' vicinity, and potentially alter the erosion/accumulation zones of fine seabed material around the pipeline.

These effects are expected to be limited to the vicinity of the pipeline, with a potential slight increase in erosion in the downcurrent side of the pipeline (mainly along the eastern side of the popeline) and slight sediment deposition in the western side of the pipeline. In any case these changes are expected to be insignificant and do not have implications outside the immediate vicinity of the pipeline .

Mitigation Measures

With regards to contamination of sediment by deposition of pollutants discharged from vessels and the FPSO, all discharges will be compiant with MARPOL Annex I and IV requirements.

To reduce the possibility of seabed erosion, pipeline route will preferably avoid major rocky outcrops where these effects could be more noticeable and would be located on soft bottoms.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on seabed component associated with the operational phase are summarised in Table G66 .

Table G66Residual impacts and risks on seabed during operational and maintenance phase

Impacts	*Duration*	*Extent*	*Importance/ Resilience of Receptor/ Resource*	*No. of Elements Involved*	*Impact Rank*
Seabed Quality – Operational Phase					
Potential seabed contamination	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Sediment accumulation and/or scouring/ erosion	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

The impacts on the seabed component due to Project operation activities is **Medium;** this is mainly due to the duration criteria (Project lifetime is about 20 years) and the frequencies of treated wastewater discharge (it is continuous). However, considering the nature of the potential pollution any impact will have limited consequences.

G.5.2.5 Decommissioning Phase

No impacts on seabed quality are expected for the decommissioning phase as the pipeline will remain laid in the subsea (no further changes to it after 20 years of use) and wells will be permanently abandoned by setting cement plugs on top of the openhole of each well with no intervention on the seabed. The related impacts on seabed will therefore be **Not significant**.

G.5.3 Air Quality

G.5.3.1 Overview

This section assesses the potential impacts on air quality that may arise as a result of the offshore Project activities. Impacts on local air quality are likely to occur during each phase of the Project: construction, operation and decommissioning.

The Project's contribution to air pollutants' concentrations might produce exceedances of current air quality standards that determine air pollution. The latter may affect atmospheric properties, materials, vegetation, human health and, in general, contribute to safety hazards and interfere with the enjoyment of life and property.

The key sources of impact, potentially impacted resources and receptors, baseline and Project related influencing factors associated with the Project impacts on local air quality as show in Table G67.

Table G67 Key Sources of Impact, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Construction Phase offshore: vessel operations for FPSO installation, drilling activities and pipeline installation resulting in emissions of pollutant gases.
- Operation and Maintenance Phase offshore: FPSO operations, vessels operations for external inspections and routine maintenance works resulting in emissions of pollutant gases.
- Decommissioning Phase offshore: emissions of pollutant gases resulting from the operation of the vessels involved in FPSO tow and scrap activities; pigging, purging and filling of the offshore pipeline; well closing activities.

Potentially Impacted Resources and Receptors

- Climate and air quality.

Baseline Influencing Factors

- High dispersivity of atmospheric environment
- No sensitive receptors

Project Influencing Factors

- Equipment selection according to BAT
- Operation according to air emission management practices

G.5.3.2 Air Quality Receptors Sensitivity

The FPSO and the production wells are located at a significant distance from the coast, at about 60 km south of the village of Sanzule; moreover, the high probability of winds over the offshore Project area permits a complete and rapid dispersion of pollutant emitted from the fuel combustion. During wells drilling the receptors located on the shoreline are unlikely to be affected by impacts; only during nearshore pipeline installation the coastal villages may experience adverse impacts from vessels' operations. As a consequence of the distance of human settlement from offshore installations, the sensitivity of onshore receptors is assessed as low.

Workers on FPSO and ships may be exposed to air emissions, however personnel will be equipped with personal protective equipment and workers sensitivity is considered as medium.

G.5.3.3 Construction Phase

Impacts Identification and Assessment

During the construction of the offshore pipeline and production wells, an impact on the air quality may arise from: a discharge of exhaust gases from the engines of the drilling unit, a discharge of exhaust gases from the engines of the supply vessels, emission of gas burning during production tests.

For the drilling of the 5 NAG wells, a Maersk Voyager drilling rig will be used, supported by two vessels. The wells drilling activities will last about 25 months.

The installation of the offshore gas export pipeline be done by two laying barges, for shallow and deep waters, and one to two supply and support vessels. Near the shoreline, a trench will be dug to accommodate the pipeline. The trench is necessary to protect the pipeline and ensure its stability. The installation of the offshore gas export pipeline will be completed in 4 months.

Air emissions associated to the offshore construction phase are temporary. Moreover in terms of local air quality the highly dispersive nature of the marine environment and the great distance of settlements determine negligible impacts on local air quality.

Only during nearshore pipeline installation the coastal villages may experience adverse impacts from vessels' operations near the coast. However vessel's operation in the nar shore will be extremely limited in time and unlikely to cause any adverse impacts at receptors located along the coast.

The assessment of impact on local air quality produced by offshore Project construction is supported with a quantitative estimation of vessels emissions presented in Annex H.

Atmospheric emissions arising during the offshore Project construction have been quantified on the base of available Project data. The calculation of vessels' emissions was based on the Methodology for Estimate Air Pollutant Emissions from Transport (MEET); the latter has been developed by the UK Transport Research Laboratory, under the Transport RTD programme of the 4th Framework programme, funded by the European Commission.

The wells drilling and completion, FPSO installation and pipe laying activities will not occur simultaneously, therefore three atmospheric emission estimates were performed for each activity following the detailed the detailed MEET method.

A detailed description of the MEET methodloghy is reported in Annex H along with the inputs used in the performed vessel's emissions estimates and their results in terms of kg of of NO_X, CO, CO_2, VOC, PM, SO_X emitted.

Mitigation Measures

No specific mitigation measures have been defined to mitigate impacts on local air quality arising from the offshore construction phase, as they have been classified as low. General mitigation measures will be applied, such as the selection of vessels and equipment according to the best available technologies in terms of minimization of air pollutant emissions (i.e use of low sulphur fuels, proper maintenance of engines, etc.). Furthermore, it will be guarateed the compliance with Marpol Annex VI requirements on air pollution from ships.

Conclusions

The impact on air quality due to offshore construction activities is negative, direct, and local in extent, and limited to the period of construction.

Considering the mitigation measures described in the previous section and the evaluation criteria applied, the residual impact significance on air quality associated with the construction phase is summarised in Table G68.

Table G68 Ranking of Residual Impacts on Air Quality during Offshore Construction Phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Air Quality–Offshore Construction Phase					
Increased atmospheric pollutant concentrations (mainly SO2, CO, NOx) due to emissions from vessels' involved in the wells drilling and completion	Between 1 and 5 years	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 intervention	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*2*	*1*	*1*	*1*	
Increased atmospheric pollutant concentrations (mainly SO2, CO, NOx) due to emissions from vessels' involved in the FPSO installation	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 intervention	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**4 - Low**
Score	*1*	*1*	*1*	*1*	
Increased atmospheric pollutant concentrations (mainly SO2, CO, NOx) due to emissions from vessels' involved in the Pipe laying and Installation	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 intervention	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**4 - Low**
Score	*1*	*1*	*1*	*1*	

G.5.3.4 Operational Phase

<u>Impacts Identification and Assessment</u>

The FPSO operation under normal operative conditions will release atmospheric emissions of airborne gaseous pollutants. In particular continuous atmospheric emissions will be related by the activity of the power generation unit, one boiler and of the compressor unit. The above mentioned facilities will be fuelled with gas and will primarily release gaseous emissions NOx and CO into the atmosphere. The fuel gas is contaminated with H2S therefore minor SO2 emissions are also expected, whereas PM emissions are not expected to occur from the combustion of gaseous fuel.

Therefore, the operation of the FPSO is likely to determine a change of the existing air quality conditions (in terms of NOx, SO2 and CO concentrations), resulting in a potential impact on local air quality.

These impacts have been quantitatively assessed by means of a dedicated ADMS. This ADMS is labelled as FPSO ADMS hereinfater. Annex H presents the FPSO ADMS, its input, output, model set-up and description.

The FPSO ADMS included two simulations representative of the following development steps:

- First development step representative of the FPSO operation and related emission up to 2026, when the continuous atmospheric emissions will be emitted by:
    - The power generation unit: which consist of two gas turbines with an installed power of 34 MW each.
    - One boiler fuelled with gas and producing 2 x 45 tons ofvapour per hour;
- Second development step representative of the FPSO operation and related emission from 2026 onwards, when a boosting compression unit will be added to the FPSO due to the decrease of pressure of the reservoir. The boosting compression unit consist of two gas turbines with an installed power of 25 MW each.

The FPSO ADMS highlighted that:

- Atmospheric concentration of airborne pollutants induced by the FPSO operation comply with national and international AQS both for its 1st and 2nd development steps;
- Predicted short-term concentration maxima (1h, 24h) fall within a distance of 8-10 km from the FPSO and do not affect permanent human receptors located along the coast.
- Predicted long-term concentration maxima (annual) fall on the coast, downwind to the FPSO. This is mainly due to the presence of a coastal upland downwind with respect to the FPSO and to interaction between the atmospheric dispersion of pollutants and the local orography. However, maximum annual concentration predicted over the sampling domain are two orders of magnitude lower than regulatory limit and one order of magnitude lower than monitored baseline concentration; they are not likely to cause any harm on human receptors.

The outcome of the FPSO ADMS supported the assessment of impact on ambient air quality presented in this Section. A detailed description of the modelling study input, assumption and results is provided in Annex H.

Mitigation Measures

Identified impacts are considered medium due to the duration of the operation and the assessment methodology. In addition to general mitigation measures listed in the construction phase, the following measures will be implemented during operation:

- All offshore facilities (including fixed and floating drilling rigs and other platforms) and support vessels will be compliant with the air pollution criteria set forth in Marpol Annex VI, except for:

   - i) the emissions associated solely and directly with the treatment, handling, or storage of sea-bed minerals; and
   - ii) emissions from diesel engines that are solely dedicated to the exploration, exploitation and associated offshore processing of sea-bed mineral resources.

- Gas turbine emissions will be compliant with EHS Guideline for Thermal Power Plants (above 50 MWth).
- VOCs emissions will be limited by tank blanketing.
- Flare, vent and blowdown system will be designed to satisfy the zero flaring philosophy adopted for the entire Project.

Conclusions

The impact on air quality due to offshore operational activities is negative, direct, and local in extent, occurring for the entire Project life.

Considering the mitigation measures described in the previous section and the evaluation criteria defined, the residual impact significance on air quality associated with the operational phase is summarised in Table G69.

Table G69 Ranking of Residual Impacts on Air Quality during Offshore Operational Phase

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Air Quality–Offshore Operational Phase					
Increased atmospheric pollutant concentrations (SO_2, CO, NOx) due to exhaust emissions released by the FPSO operation (power generation unit, compressor unit, boiler)	Over 10 years / Irreversible	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 intervention	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7 - Medium**
Score	*4*	*1*	*1*	*1*	

The resulting Medium impact significance is a consequence of the duration of the impact along the whole of the project life cycle, but it does not imply the need of further mitigation. The FPSO ADMS, presented in Annex H, highlighted that induced concentration comply with National and International AQS and predicted concentration maxima do not affect the closest human receptors. Therefore further mitigation are not needed.

G.5.3.5 Decommissioning

Impacts Identification and Assessment

At the end of its useful life (foreseen in 20 years), the FPSO, subsea facilities, offshore pipeline and the production wells will be decommissioned safely and in accordance with International Guidelines for abandonment of oil and gas facilities.

The decommissioning operations require a smaller number of vehicles and equipment compared to the construction phase. Therefore, lower air pollutant emissions are expected to be generated.

Mitigation Measures

The same mitigation measures anticipated for the construction phase will be implemented.

Conclusions

The impact on air quality due to offshore decommissioning activities is negative, direct, and local in extent, and limited to the period of decommissioning.

Considering the mitigation measures described in the previous section and the evaluation criteria defined, the residual impact significance on air quality associated with decommissioning is summarised in Table G70.

Table G70 Ranking of Residual Impacts on Air Quality during Offshore Decommissioning

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Air Quality–Offshore Decommissioning					
Vessels exhausts for decommissioning activities	Between 1 and 5 years	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 intervention	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**5 - Low**
Score	*2*	*1*	*1*	*1*	

G.5.4 GHG Emissions

This Section describes Greenhouse Gas (GHG) emissions associated with the offshore planned activities, namely wells drilling and offshore pipeline installation. Operation of the FPSO will generate emissions However, this source of impacts is considered in the ESHIA phase 1, and is again mentioned in the Cumulative Impacts section. Details on the offshore construction programme and required vessels are not available at this time so only a qualitative overview of the potential GHG emissions sources resulting from Project activities are provided, without a quantitative estimation of the emission levels.

The latest available detailed inventory of Ghana's national GHG emissions is reported in Chapter 6.

GHG emissions are likely to occur during each phase of the Project: construction, operation and decommissioning.

The main GHG sources identified for each Project phase are reported in Table G71.

Table G71 GHG Emission Sources from Offshore Project Activities

Project Phase	**GHG Emissions**
Construction	• CO_2 and CH_4 emissions from vessels' engines, power units, drilling rigs well testing and vent/flaring.
Operation	• CO_2 emissions from power generation; • CO_2 and CH_4 emissions from FPSO processes and from flaring limited to the drilling process upsets, maintenance, fugitive. • CO_2 and CH_4 emissions from vessels involved in maintenance works and helicopter flights.
Decommissioning	• CO_2 and CH_4 emissions from vessels for facilities dismantle and for personnel and material transport.

The vessels involved in the offshore drilling, installation and pre-commissioning activities will support the wells drilling, as well as the preparation of the seabed and installation of subsea facilities, mooring chains and anchors associated to the FPSO and the installation of the gas export pipeline. Thus different types of vessels will be involved in these activities (i.e., construction vessel, supply vessel, security vessel) which will release greenhouse gas. FPSO related emissions have already been considered in the ESHIA phase 1, and are again mentioned in the Cumulative Impacts section G.10.

Fugitive emission of natural gas, which mainly consists of methane (CH_4) emissions, may arise from pipes, junctions, equipment, valves, flanges, seals and connectors, gas turbines associated with gas treatment and FPSO processing, as well as the storage tanks and from the ship loading systems. These could contribute to total Project GHG emissions.

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

A prelimary assessment of the GHG emissions related to the entire Project life time, focused on operations, has been performed according to the IFC's GHG reduction accounting methodology and using IFC's Carbon Emissions Estimator Tool. As detailed in Section G.4.2, the Project is estimated to emit approximately 400,000 tonnes of CO2-eq per year during entire lifetime.

G.5.5 Noise

G.5.5.1 Overview

This section takes into account the effects of the different activities in the existing noise levels in the environment. The assessment of these effects on marine fauna are addressed globally (from all activities) in the following section G.5.6.

The noise associated to the proposed offshore Project phases, mainly drilling activities and FPSO operation, can be divided as follows:

- Underwater noise: Drilling operations, drill ship and support vessels engines and anchoring operation that will introduce noise from different sources to the marine environment.
- Airborne noise: Vessel diesel engines, helicopters and flaring during well testing.

The key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on underwater noise are shown in Box G9. In particular this section identifies and assesses the main impacts on noise and underwater noise in the offshore environment, proposes mitigation and management measures and then discusses the conclusion and impact ranking defined in section G.2.

Box G9 Key sources of impact, potentially impacted resources and receptors

Sources of Impact

- Installation/Construction phase: drilling activities; drillship and support vessels engines; anchoring operation; pipeline laying activities; seabed intervention works.
- Operations and Maintenance Phase: FPSO operation.
- Decommissioning Phase: support vessels engines.

Potentially Impacted Resources and Receptors

Marine Fauna (fish, cetaceans).

Baseline Influencing Factors

- Presence of marine species of ecological significance in the area.
- Human receptors and terrestrial fauna on the coast are too far to be affected by noise emissions from drilling activities.

Project Influencing Factors

- Specific techniques used for trench excavations and drilling; type of vessels and equipment in use.

The following table presents the key impacts of the project on the underwater noise component during the key project phases.

Table G72 Key impacts –noise

Installation/Construction Phase	Operations Phase	Decommissioning Phase
• Increased underwater noise and vibration levels due to pipeline laying, trench excavation and general shipping activities • Increased underwater noise and vibration levels due to, drilling activities	• Increased underwater noise (due to FPSO operation and vessels leading to disturbance of fish and marine mammals)	• Increased underwater noise (due to vessels traffic leading to disturbance of fish and marine mammals)

The *sensitivity* of the marine fauna due to underwater noise is reported in the following Section. Then potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project. Residual impacts are presented taking into account the implementation of the identified mitigation measures.

G.5.5.2 Potential Receptors Sensitivity

The underwater noise emissions generated by offshore project activities may induce a range of adverse effects on marine life. Physiological damages from high levels of noise may lead to mortality of individuals and serious injuries that may hinder animal survival. According to scientific literature (Parvin et al., 2007; Yelverton, 1975; Turnpenny et al., 1994; Hastings and Popper, 2005) death can occur when peak to peak level [1] is higher than 240dB re 1μPa, while serious physiological damages may happen when peak to peak level is higher than 220dB re 1μPa.

Behavioural disturbances depend on the different abilities and auditory sensitivity of the species. Changes in the species behaviour take place even without presenting physical injuries and include different reactions such as the temporary abandonment of the area affected by noise, breeding failure, feeding disruption,, etc.

Marine mammals, given that they rely on sound for echolocation, detection of predators and prey, and communication within or between social groups are considered as the most sensitive species within the AoI of the Project in relation to underwater noise.

However, marine mammals are unlikely to intentionally approach operations producing continuous or semicontinuous sounds that are powerful enough to lead to auditory damage. Continued exposure often results in habituation to the sound, followed by a recommencement of normal behavior.

In addition, different species and even individuals of the same species respond differently to different noise levels and sound frequencies. Richardson et al. (1997) showed that baleen whales (whales that do not possess teeth), which are known to communicate at low frequency sounds may be affected by sound at levels above 120 dB with avoidance behaviors at levels greater than 150 to 180 dB (McCauley 1994, 2000; Malme et al 1985; Southall et al 2007). In the case of "mid frequency cetaceans" (toothed whales, that includes dolphins and

(1) [1] The Peak to Peak value is calculated considering the maximum noise pressure variation (from positive to negative) induced by an acoustic wave. This parameter is used for short high intensity sounds, such as during air gun activities.

beaked whales), a criterion of 160 dB re 1 µPa (rms) has been adopted as the level at which behavioral disturbance is likely (Haley et al., 2010). Finally, the high frequency cetacean hearing group includes the dwarf sperm whale and a criterion of 140 dB is suggested for behavioural responses (Southall *et al* 2007).

According to baseline information, up to 18 cetacean species belonging to five families could be present, permanent or temporary, in Ghanaian waters: 14 species of Delphinidae (dolphins) and one species each of families Ziphiidae (beaked whales), Physeteridae (sperm whales), Kogiidae (pygmy sperm whales) and Balaenopteridae (rorquals).

Little is known about marine turtle hearing ability or their dependency on sound (passive or active) for survival cues (Croll *et al*. 1999; Bartol and Ketten 2006). The maximum hearing sensitivity of marine turtles has been estimated to be around 100 to 700 Hz (Wever, 1978, cited in McCauley, 1994), therefore, they are likely to detect sounds generated by project activities. Landon and Pannozzo (2001) state that, in general, turtles begin to show erratic behaviour when they are exposed to noises of 166 dB. Samuel et al. (2005) demonstrated that anthropogenic noise may increase surface time of turtles, as they may rise to the surface as a 'startle' response to noise disturbance. As a general consideration.

In addition several fish species, including some threatened of extinction are expected in the AoI. Available information on marine fish indicates that they are not particularly sensitive to underwater sound at a distance. Fish may be attracted by the noise of operational vessels (Røstad et al 2006) but are likely to avoid areas where noise levels are at a level to cause harm. The noise levels produced by drilling operations, however, have the potential to affect the behavior of some species of fish that are sensitive to sound and Behavioral effects in fish have been observed between 182-207 dB re 1 µPa (rms) and between 160 - 186 db re 1 µPa (peak) (Pearson et al. 1992, McCauley et al. 2000, Wardle et al. 2001).

Therefore, considering the species present in the area, the sensitivity of marine fauna, in particular marine mammals and threatened species, is considered to be **Moderate**.

G.5.5.3 Installation/ Construction Phase

Regarding the installation/construction phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts from underwater noise.

Table G73 Noise impacts - installation/ construction and pre-commissioning Phase

Source of Potential Impact	***Potential Impact***
Pipeline laying activities	Increased noise emissions due to trench excavation and vessels traffic inducing disturbance of the marine fauna
Drilling activities	Increased noise emissions due to drilling activities and support vessels traffic inducing disturbance of the marine fauna and human receptors

The impact identification and assessment on noise and underwater noise reported in the following sections is based on the analysis of the sources of potential impact reported in Table G73.

Impacts identification and Assessment

The aim of this Section is to identify the possible impacts on receptors during the installation/construction and pre-commissioning phase, mainly related to noise emissions from:

- Pipeline laying activities, trench excavation in the nearshore section and general shipping activities;
- Drilling Activities.

The potential impacts will largely be confined to the area of the pipeline corridor and wells site.

The following sub-sections presents the impacts derived from the expected noise emissions on installation/construction phase.

Increased Underwater Noise Levels due to pipeline Laying, Trench Excavation and General Shipping Activities

The activities during offshore pipeline construction that are likely to cause disturbance from noise and vibration are mainly the trench excavation and general shipping activity.

Trenching activities generate peak noise levels of 178 dB at 1 metre from the source at 160 Hz. Trench excavation will be performed up to 2 km from the coastline; then the pipeline will be laid on the seabed. Therefore, underwater noise emissions due to excavation works will be limited to the first 2 km of length pipeline, reducing the potential impact area for marine environment. A potential disturbance on sea turtles nesting may be generated, causing the turtle to return to the sea without laying eggs.

Support vessels and barges have a blade rotation tone of around 10 – 11 Hz, which is a low to moderate frequency and noise levels between 170 and 180 dB. However, as noise depend both on power and speed, during installation/construction phase vessels, specially pipeline laying vessels will operate at reduced power and speed, reducing noise emission levels.

In any case the average noise output of the construction fleet is expected to be similar to small to medium size traffic occasionnaly present in the offshore area (160-170 dB at 10-500 Hz), characterised mainly by fishing boats, crewboats and some cargo vessels.

As previously indicated noise levels capable to induce injuries or mortality on mammals and fish are above expected Project noise levels. Therefore, no significant impact is foreseen to be produced on marine fauna, except certain behavioural effects as temporary displacement from the working area, always affecting a reduced number of individuals in the vicinity of the works. These impacts are described in Section G.5.6.

Increased Underwater Noise Levels due to Drilling Activities

Drilling operation associated with the project will be conducted using a semi-submersible rig. Noise emissions of primary concern are generated by the drill rig and support and supply vessels.

Expected noise levels from supply vessels, as indicated previously have a maximum between 170 and 180 dB re 1μPa at 1 m.

Drill ships can generate relatively high sound levels of up to 174 to 185 dB, although at relatively low frequencies, with a maximum broadband source level of about 190dB re 1µPa rms at 1 m (10 Hz – 10 kHz). Drillships and semi-submersible rigs generally use their thrusters to remain in location, resulting in a mixture of propeller and drilling noise (*Richardson et al., 1995; NRC, 2003*).

However, it must be noted that the propagation of sound through water is affected by spreading (distance) losses and attenuation (absorption) losses, with sound energy decreasing with increasing distance from the source. Richardson et al (1995) reported that broadband levels did not exceed ambient levels beyond 1 km from a well drilling operation, although weak tones were received approximately 18 km away.

It is expected that these sound levels would decay to a level of 120 dB within a 1 km radius of the source, resulting in effects limited to the environs of the working area.

Indicative underwater noise frequencies, source levels and attenuation levels associated with standard drill rigs are presented in Table G74. For comparison purposes, noise frequencies, source levels and attenuation levels for other offshore activities have also been listed.

Table G74 Noise sources from offshore drilling activities (source: Evans & Nice, 1996; Richardson et al, 1995)

Activity	Frequency Range (kHz)	Average Source level (dB re 1mPa-m)	Estimated received level at Different Ranges (km) by Spherical Spreading			
			0,1 km	1 km	10 km	100 km
Jack-up drilling rig	0.005 - 1.2	163	123	102	77	2
Production drilling	0.25	-	208	187	162	87
Semi-submersible rig	0.016 - 0.2	85 - 127	45 – 87	24 - 66	<41	0
Drill ship	0.01 - 10	167 - 171	127 – 131	106 - 110	81 - 85	6 - 10
Large merchant vessel	0.005 - 0.9	179 - 191	139 – 151	118 - 130	93-105	18 - 30
Super tanker	0.02 - 0.1	190 - 203	150 – 163	129 - 142	104-117	29-42

Note: In water the decibel scale is used with a reference pressure of 1 µPa, as opposed to 20 µPa in air

Drilling activities will generate noise emissions especially at low frequencies, not interfering with the most of auditory spectrum of marine species. In fact, as described in Section 0, among marine mammals observed in the Project area, only baleen whales are known to communicate at low frequency sounds and only one species of baleen whale (*Megaptera novaeangliae*) is expected to be present in the Area.

Considering the species present and noise values expected, that are considered not to be enough to result in physiological damages or death, underwater noise emissions may result on behavioural changes, mainly avoidance of the working area by fish species and marine mammals.

For a description of potential impacts of noise on marine fauna, see Section G.5.6.3.

Mitigation Measures

Mitigation measures considered to limit the potential impact derived from underwater noise emissions include:

- The Project will ensure that vessel engines are not left to idle unnecessarily. Where possible, vessels will be powered down to safe operational levels.
- Vessels will not be allowed to intentionally approach marine mammals and, where practicable, will alter course or reduce speed to further limit the potential for disturbance.
- A visual monitoring program (Marine Mammals Observation Program) will be performed during the construction activities, foreseeing the presence on board of trained observers to scan the ocean surface visually for the presence of marine mammals and sea turtles. These observers must have successfully completed a visual observer training program.
- Development of a Marine Traffic Management Plan.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on noise environment associated with the construction phase are summarised in Table G75.

Table G75 Ranking of residual impacts on underwater noise during installation/ construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Underwater Noise – Installation/ Construction Phase					
Increased underwater noise emissions as a result of pipeline laying, trench excavation and general shipping activities	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Increased underwater noise emissions as a result of drilling activities	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 – Low**
Score	*2*	*1*	*2*	*1*	

The impact due to Project construction activities on underwater noise is **Low**.

G.5.5.4 Operational Phase

Regarding the operational phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on noise climate and underwater noise.

Table G76 Underwater noise impacts - operational phase

Source of Potential Impact	***Potential Impact***
FPSO operation and general shipping activities	Increased underwater noise emissions due to support vessels traffic inducing disturbance of the marine fauna

The impact assessment on noise environment reported in the following sections is based on the analysis of the sources of potential impact reported in Table G76.

Impacts identification and Assessment

Underwater noise during the operational phase is expected to be limited to the engines, propellers and thrusters of the support vessels. Support vessels have a blade rotation tone of around 10 – 11 Hz, which is a low to moderate frequency and noise levels between 170 and 180 dB re 1μPa at 1 m (*R.C. Gisiner et al., 1998*). AS a result noise levels above the 120 dB will be limited to an extent of less than 1 to 3 km from the vessel or activity.

Considering the duration of the project and the expected presence of semi-continuous underwater noise emissions, it is expected that marine fauna, and specifically marine mammals, after an avoidance behaviour will show an habituation pattern, potentially returning to the area and to normal activities. However, sensitive species will maintain an avoidance behaviour in case noise levels are above damage thresholds, which is expected to occur only in 1-3 km radius from noise sources

Mitigation Measures

Mitigation measures to be applied during installation/construction phase with regards to underwater noise are also applicable to the operational phase, specifically to the vessels involved in maintenance and supply operations of the FPSO.

Moreover, crew will be trained for the identification of marine mammals and sea turtles; marine mammals observers will be present on board for monitoring the presence of sensitive marine species.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on freshwater resources associated with the installation/construction phase are summarised in Table G77.

Table G77 Ranking of residual impacts on noise and underwater noise during operational phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Noise and Underwater Noise – Operational Phase					
Increased underwater noise emissions due to general shipping activities and FPSO operation	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	

The impact due to Project operational activities on noise and underwater noise is **Medium**; this is mainly due to the duration criteria (Project lifetime is about 20 years), and the frequencies of noise disturbances (semi-continuous), therefore it is expected that appropriate management and monitoring measures are sufficient to manage the expected impact.

G.5.5.5 Decommissioning Phase

In this phase potential impacts on underwater noise will be generated mainly by vessels operational for offshore installations decommissioning. The associated impacts are expected to be similiar though of reduced intensity and duration than during installation/construction phase.

For pipeline decommissioning, considering that the pipeline will remain underground and they will be only filled with a suitable material, the related impacts due to underwater noise generation on decommissioning phase will be **Not significant**.

G.5.6 Marine Fauna and Flora

G.5.6.1 Overview

The key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the project on marine fauna are shown in Box G10. In particular this section identifies and assesses the main impacts on offshore environment, proposes mitigation and management measures and then discusses the conclusion and impact ranking defined in section G.2.

Box G10 Key sources of risks and impact, potentially impacted resources and receptors

Sources of Impact

- Installation/ construction and pre-commissioning phase: sea bed intervention works (pipeline laying, flowlines installation, etc.) resulting in re-suspension and spreading of sediments which will

involve physical disturbance; decreased marine water quality from discharges from drilling activities and vessels increasing turbidity; increased underwater noise and vibration emissions.
- Operations and Maintenance Phase: inspection and routine maintenance works; decreased marine water quality from vessel and FPSO discharges (unplanned events) presence of pipelines resulting in increased noise and vibration and physical disturbance of the seabed.
- Decommissioning Phase: pipes remain underground/on seabed and are filled with a suitable material.

Potentially Impacted Resources and Receptors
- Fish, marine mammals, benthic communities, sea turtles and seabirds.

Baseline Influencing Factors
- The area has a moderately diverse nekton and benthic community.
- Potential presence of endangered fish and mammals.
- Turtles nest in Sanzule beaches.
- No marine habitat of particular ecological sensitivity has been identified in the area.

Project Influencing Factors
- Specific techniques used for drilling, trench excavations, direct seabed positioning and waste management.

The following table presents the key impacts of the Project on aquatic organisms during the key project phases.

Table G78 Key impacts and risks – Marine fauna and flora

Installation/Construction Phase	*Operations Phase*	*Decommissioning Phase*
• Potential disturbance to marine fauna due to increased noise emissions as a result of vessel movement and activities and FPSO installation; • Potential disturbance to marine fauna, including seabirds, cetaceans and turtles, derived from the physical presence of the FPSO and vessels, resulting in increased light emissions, loss of benthic habitat and turtle nesting habitat and increased risk of collision (unplanned event); • Potential disturbance of benthos and nekton communities, including smothering, as a result of the discharge of drill cuttings and muds and the associated decrease in water quality. • Potential disturbance to ecosystem due to introduction of alien species due to the discharge of ballast water	• Potential disturbance to marine fauna due to increased noise emissions as a result of vessel and FPSO operation activities; • Potential disturbance to marine fauna, including seabirds, cetaceans and turtles, derived from the physical presence of the FPSO, vessels and subsea structures, resulting in increased light emissions, loss and changes of benthic habitats and increased risk of collision (unplanned event); • Potential disturbance of benthos and nekton communities, including smothering, as a result of routine inspections and maintenance activities. Potential disturbance to ecosystem due to introduction of alien species due to the discharge of ballast water	• Physical and visual disturbance from vessels; • Disturbance to benthonic and pelagic organisms, marine birds and mammals due to light, noise and air pollution . • Potential disturbance to ecosystem due to introduction of alien species due to the discharge of ballast water

G.5.6.2 Marine Fauna Sensitivity

The Project area is characterised by a moderate value of benthic species richness, dominated by annelids and crustaceans. The species recorded during the benthic samplings did not reveal communities dominated by species adapted to pollution suggesting healthy communities. As a result of the surveys carried out, no sensitive habitats or threatened or endangered species were identified. Variations observed in benthic fauna along pipeline route and wells area are mainly related to sediment composition and variation in depth.

No coral reefs communities have been identified in the area, though the presence of isolated coral individuals in the AoI cannot be discarded. In the nearshore area, given the hydrodynamic conditions no seagrasses are present.

With regards to the nekton communities (e.g. plankton, larger invertebrates, fish and their predators living in the water column), survey result and desktop studies indicate that marine water quality is good and able to support a relatively diverse fish community that may include several endangered species. No habitats of special interest has been recorded in the immediate project area and the closest seems to be located within the Amansuri River mouth where mangroves grow, providing suitable shelter for various species of fish, shrimp, and shellfish, functioning as nursery and spawning ground.

According to the data gathered from by-catches and beach strandings, up to 18 cetacean species belonging to five families could be present, permanent or temporary, in Ghanaian waters: 14 species of Delphinidae (dolphins) and one species each of families Ziphiidae (beaked whales), Physeteridae (sperm whales), Kogiidae (pygmy sperm whales) and Balaenopteridae (rorquals). Among them one species assessed as vulnerable is included, the spermwhale (*Physeter macrocephalus*).

Five species of sea turtles are known to occur along the coast of Ghana: loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill (*Eretmochelys imbricate*) considered to be Critically Endangered or Endangered by the IUCN, and the olive ridley (*Lepidochelys olivacea*) and leatherback (*Dermochelys coriacea*) considered to be Vulnerable. Three of them (green turtle, leatherback and olive ridley) are known to nest in the beaches along the project area.

Considering the different richness species as described above, the sensitivity of marine fauna in general can be considered **Moderate**.

G.5.6.3 Installation/ Construction Phase

Regarding the installation/construction phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on aquatic organisms.

Table G79 Marine fauna and flora impacts and risks - installation/ construction and pre-commissioning phase

Source of Potential Impact	*Potential Impact*
General shipping activities	Potential disturbance of marine fauna due to increased underwater noise emissions Potential disturbance to ecosystem due to introduction of alien species due to the discharge of ballast water

Source of Potential Impact	***Potential Impact***
Seabed intervention works (trench excavation, installation of sub-sea facilities) and pipeline landfall installation works	Temporary effects of re-suspension and spreading of sediments, increase in turbidity, and direct physical interaction; temporary effects of noise and vibration Potential disturbance of Seabirds, Cetaceans and Turtles due to Physical presence
Pipeline laying and anchor handling activities	Potential Disturbance of Benthos and Nekton Community due to Discharge of Drilling Wastes and Decreased Water Quality Potential disturbance of Seabirds, Cetaceans and Turtles due to Physical presence
Drilling activities	Discharge of drilling wastes with increase of turbidity and suspended solids

The impact assessment on marine fauna reported in the following sections is based on the analysis of the sources of potential impact reported in Table G79.

<u>Impacts identification and Assessment</u>

Aim of this section is to describe the potential impacts on marine biota related to construction activities, in particular:

- impacts due to the operations of the drill rig and support vessels during drilling activities including noise, vibration and physical presence. The main resource/receptor groups that could be susceptible to impact are marine mammals and turtles;
- impacts due to discharges to sea during drilling. The main resource/receptor groups that could be susceptible to impact are benthos, fish, and their predatory fauna higher in the food chain;
- impacts due to pipeline laying and trench excavation, resulting in noise and vibration, physical presence and increase of turbidity. The main resource/receptor groups that could be susceptible to impacts are benthic communities, marine mammals and turtles in the offshore section and nesting turtles in the landfall approach.
- impacts due to the potential introduction of alien/invasive species due to ballast water discharges.

From the above sources, the following potential impact assessment has been completed for the aquatic fauna where all sources of impact are grouped so that an overall assessment can be made of the key impacts associated with the project as outlined at the beginning of this section.

Potential Disturbance of Marine Fauna due to Increased Underwater Noise Emissions

The impact on aquatic organisms, in particular on marine mammals, due to underwater noise depends on the frequencies they can hear and communicate. The impacts of the Project on underwater noise levels is described in Section G.5.5 above and the results of the impact assessment are used to assess the effect of the increased noise levels on marine fauna in particular.

Richardson et al. (1997) showed that baleen whales (whales that do not possess teeth), which are known to communicate at low frequency sounds may be affected by sound at levels above 120 dB with avoidance behaviors at levels greater than 150 to 180 dB (McCauley 1994, 2000; Malme et al 1985; Southall et al 2007). In the case of "mid frequency cetaceans" (toothed whales, that includes dolphins and beaked whales), a criterion of 160 dB re 1 μPa (rms) has been adopted as the level at which behavioral disturbance is likely (Haley et al., 2010). Finally, the high frequency cetacean hearing group includes the dwarf sperm whale and a criterion of 140 dB is suggested for behavioural responses (Southall *et al* 2007).

Little is known about marine turtle hearing ability or their dependency on sound (passive or active) for survival cues (Croll *et al*. 1999; Bartol and Ketten 2006). The maximum hearing sensitivity of marine turtles has been estimated to cover the spectrum between 100 and 700 Hz (Wever, 1978, cited in McCauley, 1994), therefore, they are likely to detect sounds generated by project activities. Landon and Pannozzo (2001) state that, in general, turtles begin to show erratic behaviour when they are exposed to noises of 175 dB and increase swimming activity at noise levels of 166 dB, beign therefore less sensitive to noise than cetacean species.

There is a wide range of susceptibility among fish; however, those with a swimbladder will be more susceptible than those without this organ (McCauley, 1994). Many adult fish, including elasmobranchs (sharks and rays), do not possess a swim bladder and are not susceptible to swimbladder-induced trauma. Most pelagic fishes are expected to swim away when noise reaches levels which might cause pathological effects; however, previous anecdotal reports of open sea fish near operating vessels suggest that some of these species are less susceptible to impacts from sound.

As described in Section G.5.5, sound levels capable of inducing auditory trauma or injuries on marine fauna will only occur very close to the vessels or project activities. Additionaly species potentially affected are highly mobile and therefore capable to avoid noisy areas. In any case it is expected that noise levels will decrease to levels unlikely to have effects on fish, turtles or mammals within 1 to 3 km from the source. Additionally, the continuous nature of noise produced also reduces the chances of startle reactions in marine fauna.

Impacts are therefore expected to be direct, localised and temporary, during installation/construction activities, ending at the moment when the noise source disappears. As a result underwater noise impact on marine fauna can be considered negligible, as it is supposed to produce in the worst case the temporary avoidance of the area by marine species.

Potential disturbance of Marine Fauna including Seabirds, Cetaceans and Turtles due to Physical presence

Aside from the noise generated by these vessels and the drilling rig, their physical presence and movements could have potential impacts on cetaceans, turtles and seabirds. These impacts may also be due to collision with moving vessels or disturbance related to the light emissions from vessels.

Impacts related to physical presence are expected to occur primarily in the offshore environment, in the area directly around each wells planned and along the pipeline route. It is anticipated that activities will last for approximately 40 months for the drilling of the wells and 27 months for the pipeline laying activities and will involve a drill ship, a barge and several supply vessels as well as presence of the FPSO. Vessels will be involved in the ship-to-shore transfer of drill cuttings and muds during well drilling, extending the impact into the near-shore and coastal environment.

The potential behavioural modifications exhibited by cetaceans and turtles that are close to physical structures in or near their habitat may include:

- movement away from the area;
- avoidance of the area and/or obstruction of normal movement patterns;
- mother/calf separation; and
- interrupted feeding.

Given the broad ranges and mobility of the marine mammal species considered, the likelihood that they will be somewhat habituated to the presence of vessels, and the mitigation measures applied by the Project (listed below for risk of collision), it is not expected that disturbance will be significant.

The movement of vessels implies also a risk of collision with cetaceans or turtles (unplanned event). The consequence of a vessel collision with a marine animal may range from minor disturbance or injury to a worst case of fatality to an individual. Collisions have been known to occur worldwide and also in West Africa (Félix and Van Waerebeek 2005; Van Waerebeek et al 2007) and increased marine vessel traffic during the drilling and construction/ installation phase of the project will increase the risk of collisions. The increased risk of collision is considered to be low given the relatively low volume of Project related traffic and the speed that these vessels move at (typically less than 12 knots).

The continuous presence of vessels and FPSO will also generate light emissions during night periods that may affect offshore fauna. The pipeline laying activities across the beach and associated lighting could affecct turtle hatchlings are attracted to artificial light sources. These light sources have the potential to distract them from their path to the sea and can make them susceptible to increased predation on the beach.

As the FPSO and wells location is more than 40 km away from the closer point in the coast, and the presence of artificial lights in the villages along the coast, it is considered highly unlikely that the artificial light associated with the drilling spread will be visible at any turtle nesting or foraging areas and no impacts are expected to turtles from artificial lighting from offshore aspects. However, turtle hatchings may be affected by the lights in the onshore section of the project, specially from works conducted in the beach (i.e pipeline landfall installation), when moving from nest to sea.

Impacts due to artificial lighting on the vessels may also affect seabirds present as these lights may attract migrating birds. Nocturnally migrating birds may die or deplete their energy reserves during migration as a result of encountering artificial light sources (Poot 2008). The level of impact, however, is dependent on the location of offshore lighting, time of year, and weather conditions. For example, birds tend to be attracted to offshore lighting during poor weather, *i.e.* overcast nights (OSPAR, 2009).

Light emissions from Project vessels and FPSO during the night may be visible at considerable distances, depending on weather and sea conditions. Birds may be attracted by the lights during nights with fog and/or >80% cloud cover (Van de Laar 2007), leading to an increase in energy expenditure, although the frequency and duration of periods when this impact may occur will be limited. On the other hand the presence of the drill ship, FPSO and other vessels may serve as a refuge or a place to rest during bad weather conditions. Disturbance will be localised, only affecting a small number of birds offshore, and will be temporary, occurring periodically throughout the Project.

The physical presence of infrastructures such as the chains and anchors associated to the FPSO and the pipeline installation may also affect benthic communities living in the seabed. The installation of these features will result in a loss of habitat. This loss is however considered insignificant considering that the benthic habitats affected are widely represented along the coasts of Ghana. The installation works will also imply the re-suspension of sediments that may affect sessile benthic fauna that will not be able to avoid the sediment plume and therefore be affected from smothering. This impact is condiered as temporal, lasting only for a limited period of time after finishing installation/construction activities at a given point and ending with deposition of sediments.

Finally, the intervention works in the beach and the nearshore area may affect turtles nesting in beaches potentially leading to a loss of nesting habitat and a reduction in breeding success. However, considering the small section to be occupied within the beach for the pipeline landfall works, the limited duration of the activity and the abundance of suitable beaches for turtle nesting along the coast this impact will have limited consequences for individual turtles with no effect expected at a population level.

The presence of the workforce may also result in an increase of the disturbance to seaturtles if these are observed laying eggs in the beaches, that could also result in a potential increase of the poaching of turtle eggs in the beach area close to the Project construction works.

Potential Disturbance of Benthos and Nekton Community due to Discharge of Drilling Wastes and Decreased Water Quality

Impacts deriving from drilling discharge (cuttings, water based mud, cuttings with associated synthetic based muds and cement) may affect the quality of seawater and seabed and consequently influence marine biodiversity, due to:

- deposition on seabed, that may affect benthic community;
- increase of suspended solids, that may disturb and smother phytoplankton, invertebrates and fish species which are sensitive to turbidity.

Drilling activity will have a minimal seabed footprint, consisting on the well heads and the deposition of tophole drilling-derived cuttings and WBM and the cuttings with associated NADF discharged from the sea surface. As the rig will be dynamically positioned, there will be no seabed footprint from anchoring to the seabed. However, some overspill cement may be released to the seabed surrounding each of the wells which will result in habitat loss over a defined area of seabed.

During drilling of the upper well sections, mud and cuttings will be directly returned to the seabed. Approximately 400 m^3 of cuttings per well are expected to be discharged from these sections. Cuttings from the lower well sections, accounting for an additionnal 400 m^3 per well, will be discharged from the sea surface after treatment to ensure a maximal content of 2% in weight of adhered NADF.

This will result in short term increases in suspended sediment concentration along the water column and the formation of cuttings piles around the drill centers. Impacts will include changes to seabed sediments due to sediment redistribution in the immediate area (as discussed in Section G.5.2), and disturbance or loss of benthic habitats and fauna within the footprint as a result of direct smothering or changes in sediment composition.

The finer particles from WBM released at the seabed are likely to form a dense plume, which may interfere with the respiration of benthic and demersal communities in the immediate vicinity of the well. The area affected by the plume is expected to be limited to a few kilometers radius. The plume derived from the discharge of NADF cuttings from the surface is expected to affect only to the immediate vicinity of the drillship (see section G.5.1.3 – seawater quality impact assessent)

Given the depths at which wells will be drilled (more than 500 m) no impact from the sediment plume due to the release of the upper section cuttings is expected to affect phytoplankton communities, which are located in the photic zone and not at these depths from the lower sections of the well. Plankton may be however affected from the surface discharge, though any impact will be temporary and restricted to the vicinity of the discharge point.

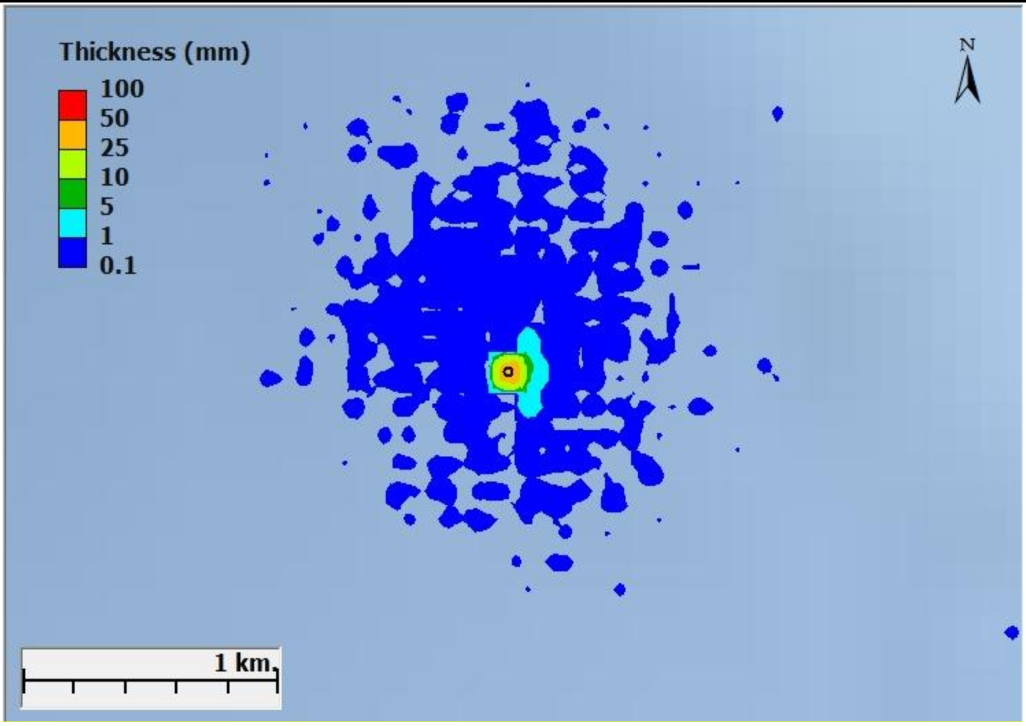
Drill cuttings discharges will also create a footprint on the seabed. The deposition of cuttings and adhered muds may result in physical damage and habitat loss or disruption over a defined area of the seabed. The discharge of muds and cuttings may affect seabed habitats through physical smothering.

Burial by drilling muds and cuttings may cause physical impacts upon benthic communities. The specific thickness of burial which may cause an impact can vary depending on the benthic species and the amount of oxygen depletion which may occur, causing anoxic conditions beneath the depositional layer.

The severity of burial impacts depends on the sensitivity of the benthic organism, the thickness of deposition, the amount of oxygen depleting material, and the duration of the burial. Thickness thresholds vary by species and sediment impermeability. In general, mobile and burrowing species such as crustaceans and annelids had a high tolerance to burial, while encrusting species such as ascidians and bivalves have a lower tolerance. Within benthic community, sessile organisms are more likely to be affected by smothering by the deposition of cuttings and muds According to the site survey (Fugro, 2013) benthic communities in the vicinity of the wells are dominated (60%) by mobile and burrowing species (crustaceans and annelids). Therefore, the communities are assumed to have a lower sensitivity to smothering effects.. *Last et al* (2012) assessed the tolerance of different benthic species to burial in fine sand against a benchmark of 50 mm burial depth. This value of 50 mm for a month deposition impacting benthic communities is suggested as a threshold by by Ellis and Heim (1985) and MarLIN (2011). Smaller threshold values as low as 1 mm have been reported (e.g., Smit et al., 2006), however they are associated with instantaneous burials on benthic species, not gradual smothering effects.

The results of the model performed indicate that (Figure G4) the maximum mound height of deposited material expected after 33 days since the begginng of the depositions would be of 34.9 mm in the immediate vicinity of the well, and therefore below the smothering threshold value of 50 mm. Most of the area affected would result in a fine layer of cuttings of less than 1 mm depth. This area is expected to cover approximately a 1 km radius from the well

Figure G4 Maximum depositional thickness



According to these results existing benthic communities are expected to be slightly affected, though any potential smothering impacts will be limited to a relatively small area around each well. Recovery will be expected over time as the new sediment layers are recolonised. However, in the deep waters where the wells are planned it is expected that recovery times are likely to be longer than in shallower waters of the continental shelf.

Leaching of chemicals, hydrocarbons and heavy metals from cement, cuttings and muds deposited on the seabed could contaminate sediments around the wells and result in indirect effects on benthic organisms. The WBM used during tophole drilling will be mainly formed by non toxic compounds or characterized by low toxicity levels and TPH levels in the sediments derived from the discharge of NADF are expected to not affect significantly the benthic communities (see section G.5.2.3 – impacts on seabed).

The low volumes of material involved and the slow leaching process mean that secondary impacts are unlikely to occur from the drilling and discharge of the upper well sections.

The constituents of the NADF are characterized by being non water-soluble organic compounds (i.e. esters) and therefore by their persistence in the environment. Their toxicity levels are still considered relatively low as they are typically free of Polycyclic Aromatic Hydrocarbons (PAHs) (EPA, 1996). The organic nature of the NADF may also lead to an increase in the oxygen demand on the areas where it is discharged and the subsequent potential for anoxic conditions. As main mitigation measures, and in line with Ghana's requirements, NADFs will not be discharged to sea but recycled for further use. A small portion of the NADF, less than 2 percent in weight, will remain adhered to the cuttings discharged to the sea. This represents a small quantity.

Based on these assumptions the potential impact on benthos from smothering effects and from the potential release of associated chemicals, the potential impact on biodiversity is considered low and limited to local benthos.

Potential Disturbance to Ecosystem due to Introduction of Alien Species due to the Discharge of Ballast Water

The transportation of the drilling ship and the support vessels, if these are not local from other marine areas at the beginning of the Project could lead to the introduction of "invasive" or "alien" species into Ghanaian waters. These species have the potential to disturb or alter the ecosystem of a local environment, which may contribute to the extinction of native species, presenting a threat to biodiversity, altering the native food web, and impacting human health due to consumption of contaminated seafood.

These risks are also generally much lower in deep offshore waters than in coastal areas, estuaries and ports. Considering that most of the construction activities will take place in deepwater areas this will contribute to reducing any effect due to such potential introduction.

<u>Mitigation Measures</u>

Potential Disturbance of Marine Fauna due to Increased Underwater Noise Emissions

The mitigation measures that will be in place to minimise impacts to marine fauna, especially to cetaceans, correspond to those indicated for underwater noise emissions (see Section G.5.5.3)

Potential disturbance of Marine Fauna including Seabirds, Cetaceans and Turtles due to Physical presence

The following mitigation measures will be put in place to minimise impacts to cetaceans, turtles and seabirds:

- Support and small vessel movements in the vicinity (100 m) of cetaceans will be strictly forbidden unless absolutely necessary for personnel safety.
- Maintain a record of cetaceans observed during the development activities to gain a better understanding of presence in the area.
- Compliance with vessel speed and wake restrictions.
- Project vessels to avoid approaching or sailing through areas with large aggregations of seabirds when these occur within the Project AoI.
- Control and reduce overall light intensity to the extent practicable, without adversely affecting maritime or operational safety, including the works offshore and at the pipeline landfall site.
- Flaring will be avoided on foggy weather to the extent possible.
- A biodiversity Management Plan (BMP) with special attention on marine turtles shall be developed and implemented.
- Laying of the pipeline within the nearshore area will be avoided during peak nesting season between October and February if possible. If activities do continue within this period, and as part of the actions derived from the BMP, prior to any activities that involve work the Project will conduct a pre-work inspection of the area to determine whether there are turtles nesting. If sea turtle nesting activity is discovered in the work area, Project will consult with an ecology specialist to determine the appropriate course of action. Action may include relocation of the turtle nest to a safe area.

Potential Disturbance of Marine Fauna including Benthos and Nekton Community due to Discharge of Drilling Wastes and Decreased Water Quality

Measures to reduce drilling wastes discharge are the same than those presented in Section G.5.1.3.

Potential Disturbance to Ecosystem due to Introduction of Alien Species due to the Discharge of Ballast Water

In order to reduce the risk of introduction of alien species due to ballast water discharge, the Project will adhere to IMO Guidelines for the Control and Management of Ship's Ballast Waste and Sediments (Ballast Water Management Convention). As a results all vessels involved in the Project, including the FPSO, will develop a Ballast Water Management Plan and carry a Ballast Water Record Book where all ballasting operation will be registered.

In addition no ballast activities will take place in the near shore area and over the continental shelf, being limited to deep offshore waters.

<u>Conclusions</u>

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on marine fauna associated with the installation/construction phase are summarised in Table G80.

Table G80 Ranking of residual impacts and risks on marine fauna during installation/construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Marine Fauna – Installation/ Construction Phase					
Potential disturbance of marine fauna due to increased underwater noise emissions	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential disturbance of marine fauna including seabirds, cetaceans and turtles due to physical presence (collision risk,	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential disturbance of marine fauna including benthos and nekton community due to cuttings deposition on seabed, decreased marine water quality and increase of suspended solids	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	
Potential disturbance to ecosysym due to the introduction of alien species due to the discharge of ballast water	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

The impacts on the marine fauna component due to Project installation/construction activities is **Low**.

G.5.6.4 Operational Phase

Regarding the operational phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on marine fauna.

Table G81 Marine fauna - operational phase

Source of Potential Impact	*Potential Impact*
General shipping activities	Physical and visual disturbance; temporary noise; collision risk.
Physical presence of the pipelines and FPSO	Alteration of the composition and abundance of the benthic community.
Routine inspections.	Local disturbance of the seabed resulting in direct loss of benthic fauna.
Potential repair and improvement works.	Local disturbance of the seabed resulting in direct loss of benthic fauna and smothering due to sediment re-suspension.

The impact assessment on marine fauna reported in the following sections is based on the analysis of the sources of potential impact reported in Table G81.

Impacts identification and Assessment

The impacts that will arise throughout the operational phase are anticipated to result from physical presence of vessels and infrastructures, the associated noise and vibrations and by physical disturbance of the seabed.

Potential Disturbance of Marine Fauna due to Increased Underwater Noise Emissions

The noise levels from vessels operational are expected to be lower than the ones resulting from installation/construction, considering the minor number of trips foreseen. It is expected that fauna will avoid noise sources (vessel engines) when these can generate damages to them. The continuous nature of the sounds also reduces the chances of startle reactions in marine organisms and may even lead to habituation behaviours.

The noise levels of natural gas movement through the pipeline are expected to be of much smaller magnitude than the one resulting from installation/construction, thus it is unlikely that any fish, mammal or turtle species will be adversely affected by the sounds emitted from the pipeline and, as they do with shipping noise, these species that can detect the noise will quickly become habituated to it. Similarly inspections and routine maintenance works on the pipelines are assumed to have a low intensity.

Potential disturbance of Marine Fauna including Seabirds, Cetaceans and Turtles due to Physical presence

The project footprint on the seabed from project facilities will be limited to the wells, the pipeline, the anchors of the FPSO and the additional sub-sea infrastructures (flowlines, umbilicals, etc). The total surface occupied is considered insignificant with regards to the total surface in the area and therefore the habitat loss during operational is considered negligible, specially if we considere no sensitive habitat will be directly affected.

The physical presence of the pipeline on the seabed may alter the composition and abundance of the benthic community. Solid surfaces that are placed in marine environments often are colonised by marine organisms. Initially, a surface film is created, and subsequently colonised by a variety of micro-organisms. Secondary colonists such as algal spores and the planktonic larvae of barnacles are the following group to settle, and they form a habitat for tertiary colonists including a wide variety of invertebrate species. The pipelines will form a hard surface in what is a mixed sand and soft bottom area which will support a different community of benthos to that of the surrounding seabed. An overall increase in localised biodiversity and abundance may result.

Movement of vessels may also lead to collision risk and disturbance of marine fauna. However the intensity of such activity will be lower than during the installation/construction phase, therefore limiting the distrubance and reducing the likelihood of collision.

Finally, lights from vessels and FPSO may affect seabirds by attracting them. If attracted, birds may get lost and never reach the shore, or either spend necessary energies during their migration.

Potential Disturbance of Marine Fauna including Benthos and Nekton Community due to Physical Disturbance due to Routine Inspections and Maintenance Activities

The pipelines will require routine inspections that will be infrequent and restricted to the pipeline itself, causing only low levels of disturbance to the seabed. Moreover, repair and improvement works may also be required which will result in local disturbance of the seabed resulting in direct loss of benthic fauna and smothering due to sediment re-suspension, and temporarely abandonemnt of the are by fish species.

Species due to the Discharge of Ballast Water

As during the construction/ installation phase, the presence and use of the drilling ship and the support vessels could lead to the introduction of "invasive" or "alien" species into Ghanaian waters which have the potential to disturb or alter the ecosystem of a local environment, may contribute to the extinction of native species, presenting a threat to biodiversity, altering the native food web, and impacting human health due to consumption of contaminated seafood. As above, the effects are generally much lower in deep offshore waters than in coastal areas, estuaries and ports. Considering that most of the operational phase activities will take place in deepwater areas this will contribute to reducing any effect due to such potential introduction.

<u>Mitigation Measures</u>

Due to the limited extent and duration of maintenance and inspection operations and the fact that such intervention works will only occur at specific points on the pipelines route, identified impacts are considered not significant and no mitigation measures will be undertaken. However, given the inspections will take place during the whole life of the Project, estimated to be 20 years, inspections will be recurrent and therefore the impact may be considered as of Medium significance.

With regards to vessel presence, collision risk, and light emissions and ballast water impacts mitigation measures defined for installation/construction phase (see section G.5.6.3) apply equally.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on marine fauna associated with the operational phase are summarised in Table G80.

Table G82 Ranking of residual risks and impacts on marine fauna during operational phase

Impacts	*Duration*	*Extent*	*Importance / Resilienceof Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Marine Fauna – Operational Phase					
Potential disturbance of marine fauna due to increased underwater noise emissions	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Potential disturbance of marine fauna including seabirds, cetaceans and turtles due to physical presence (collision risk,	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**
Score	*4*	*1*	*2*	*1*	
Potential disturbance of marine fauna including benthos and nekton community due physical disturbance of the seabed (inspections and routine maintenance works)	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 - Medium**

Impacts	*Duration*	*Extent*	*Importance / Resilienceof Receptor / Resource*	*No. of Elements Involved*	*Impact Rank*
Marine Fauna – Operational Phase					
Score	*4*	*1*	*2*	*1*	
Potential disturbance to ecosysym due to the introduction of alien species due to the discharge of ballast water	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6 - Low**
Score	*2*	*1*	*2*	*1*	

The impacts on the marine fauna component due to the Project operational phase is **Medium**; this is mainly due to the duration criteria (Project lifetime is about 20 years), and the frequencies of noise emissions, therefore it is expected that appropriate management and monitoring measures are sufficient to manage the expected impact.

G.5.6.5 Decommissioning Phase

For the pipeline decommissioning, considering that the pipes will remain underground/on the sea bed, the related impacts on marine biota will be **Not significant** as no changes and almost no intervention is envisaged.

Wells will be permanently abandoned, setting cement plugs on top of the openhole of each well. FPSO and drill rig will be towed and scrapped. Potential impacts will therefore be limited to the physical presence and movements of the vessels as well as to the noise they generate. These impacts will be similar to those on the installation/construction phase though of reduced intensity and duration. Impacts will be direct and temporary.

As the worst case a temporary distrurbance of the benthonic species due to anchoring and a temporary abandonment of the area by cetaceans and turtles may occur.

G.5.7 Coastal Processes

G.5.7.1 Overview

The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the project on coastal processes (coastal erosion and accretion). In particular this section identifies and assesses the main impacts on existing beach environment, proposes mitigation and management measures and then discusses the conclusion and impact ranking defined in section G.2.

Box G11 Key sources of risks and impact, potentially impacted resources and receptors

Sources of Impact
- Installation/ construction and pre-commissioning phase: Offshore pipeline construction, including trenching activities.
- Operations and Maintenance Phase: presence of buried pipeline.
- Decommissioning Phase: pipes remain underground/on seabed and are filled with a suitable material.

Potentially Impacted Resources and Receptors
- Coastal processes (erosion and accretion) in the AoI.

Baseline Influencing Factors
- Erosion and accretion over the last 14 years seems to be neutral with no significant net loss or gain of beach.

Project Influencing Factors
- Specific techniques used for trenching and pipeline installation.

The following table presents the key impacts of the Project on coastal processes during the key project phases.

Table G83 Key impacts and risks – coastal processes

Installation/ Construction Phase	***Operations Phase***	***Decommissioning Phase***
• Changes in patterns of coastal erosion and accretion	• Changes in patterns of coastal erosion and accretion	• None

G.5.7.2 Coastal Processes Sensitivity

According to the baseline data gathered, the beach in the surroundings of the proposed pipeline landing location is stable, showing no significant changes in the accretion and erosion balance over the years. The area receives a constant input of sediments that is compensated with a constant loss due to currents and waves action (with seasonality), resulting on a neutral balance.

This balance allows the beach to be self-maintained and maintain all the services it provides, as habitat for several species (including seabirds, turtles, invertebrates), and as a protection barrier between the sea and the habitats onshore, including plantations and human settlements.

Considering the stability recorded, the sensitivity of existing coastal processes can be considered as **Low**.

G.5.7.3 Installation/ Construction Phase

Regarding the construction phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on aquatic organisms.

Table G84 Coastal processes - installation/ construction and pre-commissioning phase

Source of Potential Impact	*Potential Impact*
Pipeline installation by trenching	Disturbance of existing coastal processes

The impact assessment on coastal processes reported in the following sections is based on the analysis of the sources of potential impact (Table G84).

<u>Impacts identification and Assessment</u>

This section discusses the impacts on coastal process related to installation/construction activities, in particular:

- Impacts due to installation of the pipeline in the nearshore, leading to changes in patterns of coastal erosion and accretion.

Impacts due to the Installation of the Pipeline in the Nearshore

The nearshore pipeline installation is planned to last 21 days and extend over 2 km long. The presence of these works will imply dredging activities and the installation of cofferdams. A cofferdam is a type of temporary sheet piling construction designed to facilitate construction projects in areas which are normally submerged. The cofferdam is installed to prevent natural backfilling and retain the depth of the dredged channel until the pipeline can be laid. The coffer dam is removed following installation.

As a result a temporary disruption of normal sediment transport processes along the shore could occur. In that case the normal flow of sediments would be stopped and sediments would be deposited on western side of the pipeline as per normal currents, flowing eastwards, in the area. This deposition could affect areas east of the proposed pipeline that would not receive the sediments, leading potentially to a retreat in the coastline.

The beach in the AoI is characterised by the presence of sandy sediments of moderate size and as a wide and gently sloping beach of dissipative type. As a result any change in vertical bathymetry would result in changes in the shoreline. However, horizontal variations of several metres in the shoreline are considered to be within the tolerance of natural seasonal changes.

To evaluate the effect of the Project on coastal processes, a modelling study (Saipem, 2014) was carried out to predict the effects by comparing the scenario with and without infrastructure. It must be noted that this modelling was performed on a very conservative scenario where a small material offloading facility (like a small temporary port) was considered. The effects expected from the construction of the pipeline are lower.

The results of the model indicate that the situation does not change very much between the two scenarios, and the coastal dynamics remain therefore in relative equilibrium as only a small sediment accumulation is visible in the construction area. Some degree of erosion is foreseen, also in the east side of the construction due to sheltering effect that would lead to a deficit of sediment by deposition in the west side of the construction activity of around 2000 m^3 of sand per year, though it is not expected to affect the beach, and affects would, in the worst case, be limited to 1 km west of the pipeline.

The duration of works is, however, temporary of less than a year, limiting the extent of the potential impact.

In conclusion, it is expected that the pipeline installation works will temporarily disrupt the sedimentation process leading to the accumulation of sediments west of the pipeline and a lack of input immediatly east of the pipeline. No significant consequences are, however,expected given the duration of the installation/construction activities.

Mitigation Measures

Impacts due to the Installation of the Pipeline in the Nearshore

The direct impacts of the installation of the pipeline can be mitigated by the implementation of sand pumping/redistribution from the western to the eastern side of the pipeline during installation/construction activities. In addition, the final design of the pipeline and installation methodologies will minimise potential scouring.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the potential impacts on coastal processes associated with the installation/construction phase are summarised in Table G80.

Table G85 Ranking of impacts on marine fauna during installation/construction phase

Impacts	***Duration***	***Extent***	***Importance / Resilienceof Receptor / Resource***	***No. of Elements Involved***	***Impact Rank***
Marine Fauna – Installation/ construction Phase					
Impacts due to the Installation of the Pipeline in the Nearshore	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 individuals, households, individual enterprises and/or small no. of species	**4 - Low**
Score	*1*	*1*	*1*	*1*	

The impacts on the coastal processes component due to Project installation/construction activities is **Low**.

G.5.7.4 Operational Phase

Regarding the operational phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on coastal processes.

Table G86 Coastal processes. Operational phase

Source of Potential Impact	***Potential Impact***
Physical presence of the pipelines	Alteration of the composition and abundance of the benthic community.

The impact assessment on coastal processes reported in the following sections is based on the analysis of the sources of potential impact reported in Table G86.

Impacts identification and Assessment

The impacts that will arise throughout the operational phase are anticipated to result from physical presence of the nearshore pipeline.

Physical Presence of the Nearshore Pipeline

The permanent presence of the nearshore pipeline could result in an alteration of sedimentation transport and deposition patterns along the coast of Sanzule.

However, considering that the pipeline will remain buried, apart from small mounds generated during installation/construction phase no artificial infrastructure will remain to disrupt the normal sediment flow.

As a result impact on coastal processes from operational phase are considered as **Not significant**.

G.5.8 Decommissioning Phase

For the pipeline decommissioning, considering that the nearshore pipeline will remain underground, the related impacts on coastal processes will be **Not significant** as no changes and almost no intervention is envisaged.

G.6 FISHERIES IMPACT ASSESSMENT

G.6.1.1 Overview

This section presents the potential impacts on local fishing resources (fishes, crustaceans and molluscs) population impacts, as a result of Project related activities. Impacts on the economic aspects of fishing are described in Section G.7.1. This Section should be considered together with the Section G.5.6which describes impacts on flora and fauna, where impacts on species which could be prey or related to species of commercial interest are assessed.

The box below shows the key sources of potential impacts, resources and receptors, baseline and Project influencing factors associated with the impacts of the project on marine fisheries.

Box g12 Key Sources of Impact, Potentially Impacted Resources and Receptors

Sources of Impact
- Project vessel presence and movement;
- Drilling activities of NAG wells;
- Offshore pipeline construction activities;
- FPSO installation and operation.

Potentially Impacted Resources and Receptors
- Fishes, crustaceans and other fishing resources;
- Fishermen in the Area of Influence;

Baseline Influencing Factors
- Commercially exploited fishing resources in the area;
- Fishing activity in the area.

Project Influencing Factors
- Pipeline route;
- Pipeline, flowlines, wells, construction and installation activities;
- Safety zone;
- Duration of offshore construction activity.

The following table presents the key impacts of the Project on marine fisheries during the key Project phases.

Table G87 Key Potential Impacts – Fisheries environment

Construction Phase	*Operations Phase*	*Decommissioning Phase*
• Disturbance of fish and other species populations due to underwater noise; • Disturbance of fish and other species populations due to an increase of turbidity and suspended solids; • Temporary impacts on fish and other species populations due to water quality changes from project discharges; • Disturbance to fish and other species populations due to light emissions; • Loss of habitat.	• Temporary impacts on fish and other species populations due to water quality changes from project discharges. • Disturbance to fish and other species populations due to light emissions; •	Same impacts of the Construction Phase

G.6.1.2 Commercial fish, crustaceans and cephalopods sensitivity

Among the resources exploited there are several species of conservation concern as is the case of some of the tuna species, whose fishing stocks are monitored by the ICCAT (International Commission on the Conservation of Atlantic tunas), though these are higly migratory species that are not present throughout the.

There is no fish habitat of special interest (spawning, re-stocking, migration) in the immediate Project AoI and the closest would likely be located within the Amansuri River mouth where mangroves grow, providing suitable shelter for various species of fish, shrimp, and shellfish, functioning as nursery and spawning ground.

As a consequence, sensitivity of fishing resources has been considered as Low in the deep waters-offshore area given the relatively low fishing pressure in that area, and moderate in the nearshore area considering the importance of these resources for local communities livelihood.

G.6.1.3 Construction Phase

Regarding the construction phase of the Project, the following impact sources have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on fishing resources.

Table G88 Species of Commercial interest. Construction and Pre-commissioning Phase

Source of Potential Impact	***Potential Impact***
General shipping activities	Physical and visual disturbance; temporary noise; Project discharges.
Seabed intervention works (mainly trench excavation)	Temporary effects of re-suspension and spreading of sediments, increase in turbidity, and direct physical interaction; temporary effects of noise, vibration and light ; Temporary loss of habitat;
Pipe-laying	Temporary effects of re-suspension and spreading of sediments, increase in turbidity and direct physical interaction
Drilling activities	Discharge of drilling wastes with increase of turbidity and suspended solids; Temporary effects of light emissions.

G.6.1.4 Impacts Identification and Assessment

Aim of this section is to describe the potential impact related to offshore construction activities on marine fish species of commercial interest, in particular:

- Impacts due to routine discharges of the drill rig, supply vessels and FPSO, ballast water discharge;
- Impacts due to light emissions;
- Impacts due to underwater noise;
- Impacts due to pipe laying and trench excavation resulting in noise and vibration, physical presence and increase of turbidity.

No impact derived from the discharge of drilling wastes (muds and cuttings) on commercial species has been considered as, given the location of the wells in deep offshore areas (more than 500 m depth), only demersal and benthic populations could be temporary affected due to smothering effects and the plume of suspended solids generated and no fishing activities are expected on such resources at those depths. In addition these effects are of temporary nature and spatially limited to the immediate vicinity of the wells (effects within approximately 1 km radius from wells), and are thus considered as not significant on commercially exploited species.

Routine Operational Discharges

During the construction phase, routine discharges of treated black water, grey water and from bilge water will take place from vessels involved in the project (supply vessels, drilling rig, barges and FPSO). These discharges will be mainly formed by organic substances, though some toxic components may also be present (i.e oil content in bilge water).

The volumes expected to be discharged correspond to an average of 100 l per day per person. Expected crew size in vessels is not known at this stage of the project, however, an estimate of 60 people on board the FPSO, 150 on the drilling rig and 25 per supply vessel can be made, leading to a total discharge of would lead to a total discharge of 26 m^3 per day assuming 2 supply vessels.

As a result, temporary changes to the distribution of fish species may occur as opportunistic feeders are attracted to organic discharges as a potential source of food. The magnitude of changes expected will be small and within natural variation, and therefore considered to be negligible.

The discharge of organic matter could also lead to an increase of phytoplankton production that would, eventually, lead to an increase in fish biomass. However it could also result in algal blooms that could affect fish populations.

Discharges could also contribute to the proliferation of the algae *Sargassum* sp. that affects fishing activity as it accumulates on the nets used. Recently the amount of *Sargassum* sp in Ghanaian waters has significantly increased and it has been reported the fishermen in the region attribute this increase to existing oil and gas activities, while the reason for such increase in *Sargassum* in Ghana is unknown but some researchers suggest an increase in coastal nutrient concentrations (*e.g.* from run-off from land that has been fertilized), resulting in increased algal growth, as part of a regional or even global phenomenon (CRC, 2011).

The toxicity of some discharges (e.g. drainage / bilge water, could also potentially have harmful impacts on the health of fish species.

However compliance with MARPOL requirements on discharges, and considering the intermittent nature of the discharges, the rapid dilution and dispersion in the marine environment and the ability of mobile fish species to avoid polluted waters, effects will be temporary and limited.

In addition and as discussed in section G.5.1.3, impact in water quality due to operational discharges has been assessed as of low significance for the construction phase and therefore secondary impacts on fish populations are expected to be limited.

As discussed within the impact on marine water quality, the introduction of invasive or alien species into Ghanaian waters is possible through the discharge of ballast water. These changes have the potential to disturb or alter the ecosystem of a local environment including negative impacts on fish,which may contribute to the extinction of native species, presenting a threat to biodiversity, altering the native food web, and impacting human health due to consumption of contaminated seafood. These risks are generally much lower in deep offshore waters than in coastal areas, estuaries and ports

Physical Presence and Light Emissions

Large pelagic fish species (e.g. tuna and billfish) and deep water (demesal) fish species (e.g. grunts and croaker) will be present in the Project area. Pelagic species which inhabit the surface layers of the water column are likely to be impacted by the presence of the FPSO, rig and support vessels as many pelagic fish species are known to readily associate with floating objects (known as Fish Aggregating Devices) (Røstad *et al* 2006).

Fish may be attracted also to the artificial lights on the Project vessels, as light acts as an stimulus for many fish species and they are attracted to the surface waters when the moon is full following vertical migration of zooplankton and other prey species. Fish aggregations around the FPSO, rig, and support vessels are therefore likely to occur on night time, aggregating in the vicinity of these vessels and therefore remaining in the safety zone where no fishing is allowed.

It must be noted also that the main pelagic species found in offshore deepwater locations in the Gulf of Guinea that are targeted by fishermen are highly migratory and will not be permanent residents in one area, and those attracted to the FPSO and other infrastructure are not likely to spend significant periods of time under the FPSO. Commercial species associated with the FPSO, drilling rig and support vessels and their safety zones will be afforded some protection from fishing activity but it is considered insignificant considering the temporary nature of the residency of fish near these structures.

Underwater Noise

As previously discussed in the underwater noise impact assessment section (see section G.5.5) available information on marine fish and other species indicates that they are not particularly sensitive to underwater sound. Fish may be attracted by the noise of operational vessels (Røstad et al 2006) but are likely to avoid areas where noise levels are at a level to cause harm.

The noise levels produced by drilling operations, however, have the potential to affect the behavior of some species of fish that are sensitive to sound, namely 'hearing specialists'. These effects have been observed between 182-207 dB re 1 μPa (rms) and between 160 - 186 db re 1 μPa (peak) (Pearson et al. 1992, McCauley et al. 2000, Wardle et al. 2001).

However, sound levels approaching these ranges will only occur very close to the vessels or Project activities, and it is expected that noise levels will decrease to levels unlikely to have effects on fish within 1 to 3 km from the source. The continuous nature of noise produced also reduces the chances of startle reactions in fish. Impacts to fish are therefore expected to be direct and of temporary occurring as long as Project vessels are present.

Considering the existing noise sources, underwater noise effects on fish populations are more likely to affect pelagic fish in the offshore environment and neither near-shore populations nor demersal and benthic species.

Pipeline Installation Works

Potential effects on commercially exploited species of fish, crustaceans and cephalopods may arise during the pipeline laying activities. This effect could be more intense on the nearshore area given the trenching activities planned to bury the pipeline and the nature of the local fisheries, characterized by the use of beach seine fishing techniques.

Both demersal and pelagic species could be affected by the re-suspension of sediments and the plume generated. However, marine sediments, specially in the nearshore area, are characterised by low pollutant levels (with the exception of arsenic levels probably due to geological nature of the area), and therefore no toxic effects beyond natural levels are expected.

With regards to the habitat loss due to pipeline project footprint it is considered as not significant provided the habitat that will be occupied by the pipeline corresponds to sandy bottoms that are located widespread along the project area of influence.

As a result main potential impact due to pipeline installation would be the disturbance generated by the human presence and the sediment plume generated that will result in a temporary displcaement and avoidance of the species of commercial interest to nearby areas.

Mitigation Measures

Routine Operational Discharges

All the wastewater effluents from FPSO and Project vessels will be discharged only after treatment. Wastewater treatment and disposal is designed to meet national and international requirements. As such the following mitigation measure will be in place:

- sewage from support vessels and FSPO will be treated in an approved sewage treatment unit in compliance with MARPOL Annex IV requirements prior to discharge; such treatment plant will ensure the following concentration levels according to World Bank General EHS guidelines:
  - BOD5 < 30mg/l;
  - COD < 125 mg/l;
  - Total Nitrogen < 10 mg/l;
  - Total Phosphorus < 2 mg/l;
  - Oil and Grease < 10 mg/l
  - Suspended solid < 50 mg/l;
  - Total Coliforms < 4000 MPN/100ml;
  - Cl2 < 50mg/l.
- the decks on the FPSO will be equipped with a drainage system to collect run off for treatment prior to discharge overboard.
- A bilge pump and a bilge water separator will be installed for draining the bilge water tank (fitted with a high oil alarm to meet IMO requirements), which discharges to sea. Separated oil will be contained in dedicated tanks (bilge holding tank; dirty oil tank and contaminated drain holding tank) and then sent to shore for disposal at licensed facilities.
- Water collected from the bilge, engine spaces and drainage will be treated to MARPOL Annex I requirements, that is to a level lower than 15 ppm oil content in water. To achieve this, water will be treated in an oil/water separator and continuously monitored by an automatic oil content meter.
- As per Ghanaian Pollution Prevention and Control regulations the discharge of garbage, with the exception of food waste, is prohibited from any vessel involved in the Project and the FPSO.
- The disposal of food wastes into the sea from support vessels will only be allowed if previously macerated to pass through a 25 mm mesh, and in areas located more than 12 nautical miles from land. Additionally, the support vessels shall not discharge comminuted food waste within 500 m of the FPSO location.

- In addition, no refuelling will take place in bad weather conditions so as to limit the risk of occasional spills
- As discussed in impacts on marine water quality, in order to reduce the risk of introduction of alien species due to ballast water discharge, the Project will adhere to IMO Guidelines for the Control and Management of Ship's Ballast Waste and Sediments (Ballast Water Management Convention). As a result all vessels involved in the Project, including the FPSO, will develop a Ballast Water Management Plan and carry a Ballast Water Record Book where all ballasting operation will be registered. No ballast activities will take place in the near shore area and over the continental shelf, being limited to deep offshore waters.

Physical Presence and Light Emissions

In order to minimise impacts to commercially exploited species derived from physical presence of project vessels and light emissions, the Project will control and reduce overall light intensity to the extent practicable, without adversely affecting maritime or operational safety.

Underwater Noise

In order to minimise impacts to commercially exploited species derived from underwater noise the following mitigation measures will be adopted:

- The Project will ensure that vessel engines are not left to idle unnecessarily. Vessels will be powered down to safe operational levels;

Conclusions

The following table presents a summary of the residual impact associated with the impacts identified.

Table G89 Residual Impacts on Commercially exploited species during Construction Phase

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Impact derived from FPSO, drilling rig and vessel discharges.	Between 1 and 5 years	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 individuals, households, individual enterprises and/or small no. of species	**5-Low**
Score	2	1	1	1	
Impact derived from discharge of ballast waters	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 individuals, households, individual enterprises and/or small no. of species	**4-Low**

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Score	1	1	1	1	
Impact derived from the physical presence and light emissions on commercially exploited species.	Between 1 and 5 years	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 individuals, households, individual enterprises and/or small no. of species	**5-Low**
Score	2	1	1	1	
Potential impact of underwater noise commercially exploited species	Between 1 and 5 years	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 individuals, households, individual enterprises and/or small no. of species	**5-Low**
Score	2	1	1	1	
Pipeline underwater noise activities potentially affecting commercially exploited species	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/ sensitivity of receptors or resources able to adapt to changes with some difficulties and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	

The impact on commercially exploited species from construction activities is assessed as Low.

G.6.1.5 Operation and Maintenance Phase

Impacts Identification and Assessment

Aim of this section is to describe the potential impact related to operation activities on marine species of commercial interest, in particular:

- impacts due to routine discharges of the supply vessels and FPSO;
- Impacts due to physical presence and light emissions;
- Impacts due to underwater noise;

Routine Operational Discharges

Similarly to the construction phase, discharges of black, grey and bilge water from Project vessels may have an impact on water quality that could indiectly affect the species of commercial interest.

These impacts could range from a temporal disturbance by turbid waters and increased suspended solids that would result in an avoidance of the affected area by the species, to potential contamination of the fishing resource by the ingestion of toxic compounds and to changes in fish assemblages favouring opportunistic species due to the increase in organic matter.

Other potential effects of these discharges would be an increase in algal bloom risk that would temporarily affect fishing resources or a contribution to the development of the algae *Sargassum sp*. that is known to affect fishing activities by entering into the nets, though the reasons behing the increase of *Sargassum* remain still unknown.

The expected dishcarges will be of intermittent nature and with the exception of those from the FPSO will take place while vessels are in movement and therefore will be more easily dispersed. Existing currents in offshore areas will also contribute to the quick dispersion and dilution of the discharge.

Underwater Noise

During the operation phase underwaternoise emissions will be limited to those generated by project vessels. As previously discussed these sources are unlikely to reach levels capable of leading to injuries or damages on fishing resources and the more likely effect would be an avoidance behaviour of the noise sources. However, considering the continuous nature of the noise and the duration of activities, it is expected that fish species will get used to noise leading to no permanent changes.

On the other hand, the potential avoidance behaviours shown by predatory species (such as tunas, sharks, etc. could result in an increase of certain fishing resources as the pressure on them by their natural predators could be relieved. However this effect, if any, is likely to be restricted to a small area.

Physical Presence and Light Emissions

Physical presence of floating structures as the FPSO, and lights emitted could result in an attraction of fishing resources leading to changes in their spatial distribution and protecting them from fishing activities given the safety area that would prevent fishing. This effect would be, however, of small nature considering the limited surface of the FPSO, the migratory nature of several fishing resources and the distance to the coast where the FPSO will be installed as most fishing activity takes place in the near shore area.

Similarly, deep water fish are known to aggregate around seabed structures that provide new substrate for sessile organisms and therefore increase the amount of food available as well as the provision of a variety of habitats and shelter. As a result the addition of seabed structures (pipeline, wellheads, flowlines, etc.) is likely to attract deep water fish.

However, the impact of this aggregation is not considered to be significant in terms of population ecology considering the area occupied by the infrastructure in relation to the large area of seabed over which deepwater species range.

Mitigation Measures

Mitigation measures to be applied are the same as those stated for the construction phase in Section G.6.1.3.

Conclusions

The following table presents a summary of the residual impact associated with the impacts identified.

Table G90 Residual Impacts on Commercially exploited species during Operation Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Impact derived from FPSO, and vessel discharges.	Over 10 years / Irreversible	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 individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	*4*	1	1	1	
Impact derived from the physical presence and light emissions on commercially exploited species.	Over 10 years / Irreversible	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 individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	*4*	1	1	1	
Potential impact of underwater noise commercially exploited species	Over 10 years / Irreversible	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 individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	*4*	1	1	1	

The impact on commercially exploited species from operation activities is assessed as Medium given the duration of the Project expected to be of approximately 20 years.

G.6.1.6 Decommissioning Phase

Impacts Identification and Assessment

Potential impacts will need to be reassessed given the period of time that will pass before decommissioning activities are expected to take place. Decommissioning activities performed will apply to the offshore pipeline and wells. Thus potential impacts during Project decommissioning are likely to be similar to impacts during construction but less significant than during the construction phase due to the smaller affected area and duration of activities.

Mitigation Measures

Mitigation measures are expected to be similar to construction, with the benefit of being improved based on lessons learned during construction. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life.

Conclusions

The residual impacts are likely to be similar to construction that is of low significance.

G.7 IMPACTS ON THE SOCIO-ECONOMIC AND HEALTH ENVIRONMENT

This Section assesses the potential socio-economic and health impacts associated with the Project. The assessment of each socio-economic and health impact is divided into the three main phases of the Project: construction, operation and decommissioning. The mitigation measures that will be adopted by the Project are provided for each impact and residual impacts are presented taking into account the application of the identified mitigation measures. Where possible a quantitative matrix has been applied to measure the residual impacts of the Project.

The Project Description and the baseline information about the social, economic and health conditions (see Chapters 8 and 9) have been used to assess the possible socioeconomic and health impacts.

G.7.1 Economy and Employment

G.7.1.1 Overview

This Section assesses the potential economic and employment impacts associated with the Project. Box G13 presents the key sources of potential impacts, resources and receptors, baseline and Project influencing factors associated with the impacts of the Project on the existing Economy and Employment.

Box G13 Key Sources of Impacts and Risks, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Revenue generated from the Government's equity share in the Project.
- Revenue generated from company taxes.
- Taxes paid by Project employees and expenses for local content that are then taxable through company.
- Short-term employment opportunities will be created during the construction phase.
- Employment opportunities will be created during the operation phase.
- Local procurement of goods and services.

Potentially Impacted Resources and Receptors

- Project workers and their households;
- Local, regional and national suppliers;
- Economy of the Ellembelle District and Ghana; and
- Local communities impacted by inflation.

Baseline Influencing Factors

- *Education and Skills:* Access to education is limited in the DAoI and while most children receive basic education, a limited number of people go on to complete high school, and fewer still receive a tertiary education. As such, the skills base is low.
- *Economy and Employment:* The majority of the population in the Project area are engaged in subsistence farming and artisanal fishing. Formal employment opportunities are limited to teaching and nursing, and some government sector jobs.
- *Local Content Policy Framework:* Policies put in place by the Government of Ghana in 2010 serve to minimise the negative economic impacts of Project procurement and maximise benefits to affected communities and to Ghana with minimum local content requirements for supply chain and workforce.

Vulnerable Groups

- Unemployed People (youth and women): There are high levels of unemployment, especially for the youth in the DAoI.
- Low Income Households: Low-income households have fewer resources to rely on and are less likely to have savings and/or access to credit, which make them vulnerable to change and price inflation.

Project Influencing Factors

- Number of expatriates and locals employed by the Project;
- Wage levels and benefits paid to workers by eni and contractors;
- Duration of employment contracts offered by eni and contractors; and
- Project programmes to enhance opportunities to the local community.

Table G91 presents the key potential impacts of the project on the economy and employment during the key Project phases.

Table G91 Key Potential Impacts and Risks – Economy and Employment

Pre-Construction and Construction	Operation	Decommissioning
• Increased government revenue from taxes and fees, procurement and worker spending	• Increased government revenue from taxes and fees, procurement and worker spending	• Increased government revenue from taxes and fees, procurement and worker spending
• Short-term direct and indirect employment opportunities	• Long-term direct and indirect employment opportunities	• Short-term direct and indirect employment opportunities

Pre-Construction and Construction	Operation	Decommissioning
• Long-term benefits of capacity enhancement (on-the-job and formal training opportunities).	• Long-term benefits of capacity enhancement (on-the-job and formal training opportunities).	-
• Procurement opportunities	• Procurement opportunities	• Procurement opportunities
• Enhanced hospitality and tourism business development	• Enhanced tourism development	-
• Price inflation and economic vulnerability	• Price inflation and economic vulnerability	• Price inflation and economic vulnerability

G.7.1.2 Economy and Employment Sensitivity

Education levels and opportunities for schooling area limited in the DAoI, and while all five communities in the DAoI have primary schools, there are limited junior high schools, and no senior high schools. There are two vocational training institutes in the DAoI.

Technically skilled personnel required for the construction and operation of the Project are limited in the Study Area, and are generally scarce in the Western Region. There is a lack of formal employment opportunities in the DAoI, which indicates that people will have limited exposure to formal working condition and little opportunity to enhance their skills through the workplace. Although there is an emerging oil and gas sector in the Western Region, the majority of the population are engaged in subsistence agriculture or artisanal fishing activities. As a result, the pool of experience of the local workforce is relatively small, and will likely only fill unskilled labour positions (which will be 20 percent of the employment opportunities available), while a limited number of people will be sufficiently trained to qualify for semi-skilled positions or skilled positions.

There is no industrial activity in the DAoI, and limited industrial activity in the Extended AoI and the wider Ellembelle District, meaning that locally-owned businesses are not well equipped to supply goods or services that will be required by the Project. At a regional and national level there are some suppliers/businesses that will be able to meet the Project procurement needs, but at a limited scale.

Within the DAoI, many households are highly dependent on incomes from labour intensive subsistence farming and artisanal fishing, and have limited skills to take up alternative economic opportunities to increase income. These undiversified livelihood strategies coupled with low education levels and limited employment opportunities in the DAoI, mean the majority of the population will be vulnerable to inflationary effects of Project procurement and the increase of salaried employment. In already low income communities the most vulnerable sectors of society such as unemployed youth, women and the elderly, are particularly susceptible to negative impacts of price inflation on already fragile livelihoods.

At a national level, a number of policies have been put in place by the Government of Ghana which partly serve to minimise potential negative impacts of Project procurement and employment strategies, and enhance the benefits. These include, a Local Content Policy for Oil and Gas-related Projects. The Local Content Policy Framework (2010) requires that local content and participation should be embedded in the planning and development phases of every oil and gas -related project. The policy requires that a minimum of 90 percent of supplies and services should be sourced within Ghana within ten years of the commencement of a Project. These minimum local content requirements increase from 10 percent at the commencement of the Project, to 20 percent in the second year and a further 10 percent each year thereafter until the targeted 90 percent is reached.

The policy also outlines that the submission of a detailed annual recruitment and training programme for recruiting and training Ghanaians within 12 months of receiving a grant or license. The staffing requirements of the policy are as follows:

- Management staff: at least 50 percent Ghanaian from start of Project activities, increasing to a target of 80 percent in the first five years.
- Core technical staff: 30 percent at commencement increasing to 80 percent in five years and further to 90 percent in ten years.
- Other staff: a target of 100 percent Ghanaians.

G.7.1.3 Construction Phase

Economic and employment impacts anticipated during construction are discussed below.

<u>Impact Identification and Assessment</u>

Increased Government Revenue

Increased government revenue refers to the tax payments that the Project will make to the Government of Ghana. It also includes taxes paid by Project employees during construction, as well as substantial expenses for local content that are then taxable through company tax.

During Construction there will be no taxes on the Project, and royalities will not yet be applicable as it will not be generating profit as of yet. However, income will be generated as Ghanaian individuals employed on the Project will be liable for personal taxes. Ghanaian employees are taxed at a progressive rate with the top marginal rate of 25 percent and non-resident individuals taxed at 15 percent (Ghana Fiscal Guide 2012/13, kpmg.com). Further revenue will be generated through duties on imported services paid by employees, contractors and supporting services to the project.

The direct impact of project revenues cannot be accurately quantified at this stage as the allocation of increased government revenue to development locally or nationally or into other purposes is unknown. Government will be solely responsible for the allocation of revenue based on internal government policies and the country's development needs. The Project is not responsible for how government spends the revenue.

Employment and Skills Enhancement

The construction phase will take an estimated three years, during which time approximately 628 employment opportunities will be available at the peak of construction for the ORF.. The majority of the workforce will be sourced from construction contractors with a small portion of eni staff representatives. The workforce required for each construction component, along with their proposed origin is listed in Table G92. The breakdown of skills required during the construction phase will be as follows:

- skilled labour: 60 percent,
- semi-skilled labour: 20 percent and
- unskilled labour: 20 percent

Table G92 Construction Employment Opportunties

Activity	Project activities dates and duration	Total workforce	Contractor Locals	Contractor Expatriates	eni's representatives/ supervisors
Drilling and Completion	Beginning 2016 - End 2019	300	98	196	6 (2 local, 4 expats)
Offshore Installation Campaign	Mar 2018 – Mar 2019	210	123	83	2 (1 local, 1 expat)
Gas Export Sealine	Sept 2016 – February 2018	200	50	150	-
ORF & related infrastructures – Early Works	Oct 2015 – Aug 2016	210	200	-	10
ORF & related infrastructures – Construction	Feb 2016 – Feb 2018	418	320	80	18 (all expats)

Just under half of the employment requirements will be filled by Ghanaian Nationals. However, given the low levels of literacy, available skills and lack of technical training, it is likely that people from the DAoI will fill unskilled positions associated with the ORF early works and construction (2), therefore approximately 20 percent of employment opportunities will be available to people from the DAoI (and EAoI) The highly skilled positions associated with the offshore works will be filled by people from elsewhere in Ghana, and internationally.

Indirect employment through the construction supply chain will be limited in the Extended AoI due to the informal nature of the businesses in the area and the lack of industrial services industry. Induced employment is also expected to be limited in the Study Area due to the limited availability of goods and services. Induced employment in the Ellembelle District may be slightly higher due to the greater number of established markets and businesses.

Those who are able to secure employment on the Project will have the opportunity to improve their skills and experience through on-the-job training, and thereby improve their opportunities for future employment.

Increased Procurement

The Project will require the purchase of equipment and other goods and services during construction, generating business for suppliers. The majority of these contracts will be for highly specialised and technical work/ equipment and will therefore be provided by specialist suppliers internationally. Locally-owned businesses in the DAoI and in the Ellembelle District are relatively basic which hinders the potential to benefit from this impact. There is, however, potential for local businesses in the Project area to feed into this supply chain.

(2) In particular, for example those already upskilled by the Ghana Gas Project

During construction, the Project will provide worker accommodation within the ORF acquisition area, and there is potential for local businesses to supply the camp with services such as catering, food supply, maintenance services for non-technical aspects, buildings and facilities maintenance, general vehicle maintenance, laundry, employee transport and land management. Consumables will need to be purchased locally, however, potential suppliers will have to meet stringent health, safety and quality standards, and may require support from the Project initially in order to achieve this. Local suppliers may.

The direct procurement opportunities for District, Regional and National levels will be developed over time. For those companies that meet eligibility criteria, become approved suppliers and enter the supply chain, there will be long-term benefits to the businesses and their employees through increased experience, capacity and training. This will come particularly from requirements to meet stringent international standards.

Enhanced Hospitality and Tourism Business Potential

Tourism in Ghana is a fast-growing sector of the national economy, however, tourism in the DAoI is limited. Tourist attractions in the Study Area include Fort Appolonia, Nzulezu Stilted Village on Lake Tadane, and Amanzule estuary at Azuleloano. A number of hotels operate to serve tourists and the demands for accommodation from the growing oil and gas industry. Most of the hotels are located in Beyin, just north of the Study Area.

The presence of the Project is likely to create a positive impact in terms of increasing demand for accommodation in the coastal Districts of the Western Region such as Jomoro, Ellembelle and Nzema East Districts due to an increase in business travel to the Region. Some expatriate workers may encourage their families to visit, thereby increasing the demand for accommodation, recreation and tourism activities within the Study Area and Western Region. Further, improvements made to the road from Takoradi to the Study Area could make the area more accessible to potential tourists, who may have been deterred from the area in the past because of poor accessibility.

The indirect impact of increased demand for leisure accommodation will likely peak during the Project's construction phase, but may experience a further increase should other oil and gas or infrastructure projects go ahead stimulating further economic development in the region.

During stakeholder consultation, concern was raised about the potential conflict between the growth and development of the tourism sector and the increase in industrial land-use associated with oil and gas projects. In the medium to long term, if more oil and gas projects are developed in the Western Region, this may be a legitimate concern. This is discussed further in Section G.10, Cumulative Impacts.

Increased Price Inflation and Economic Vulnerability

The presence of the Project will lead to increased expenditure in the DAoI, which could potentially trigger inflation in local prices. Although Project workers will be housed in an accommodation camp thereby not increasing the demand for housing, they will interact with the surrounding communities and spend earnings on local goods. Goods and services such as food, fuel, construction materials and transport may be subject to inflation due to an increased demand and an increase in disposable income.

An in-migration of job and economic opportunity seekers into the DAoI could increase the demand for land and housing, which may affect the traditional patterns of land distribution, tenure, rights of use and access.

Such inflationary trends can exacerbate adverse economic impacts, by reducing the availability and affordability of basic goods and services, in particular for the poorest and most economically vulnerable. The risk of price inflation in the local area will be highest during construction, as this phase will translate by a high increase of expenditure over a relatively short term, with limited time for anticipation and adaptation.

Impact of Workforce Demobilisation on Economic Vulnerability

Towards the end of the construction phase, there will be a downscaling of the workforce and labour contracts will come to an end. The expat workforce will leave the area in search of new opportunities and is likely that workers from elsewhere in Ghana will also leave the area in search of new opportunities. For locals employed by the Project, there will be a sudden reduction in wage labour.

The out-migration of the workforce and reduced number of community members earning a wage will result in reduced expenditure within the DAoI. This will have negative implications for small businesses which have been established in the area to service the workforce.

Individuals and households in the DAoI and EAoI that have relied on wages from the Project will lose this source of income. A limited number of individuals may be able to secure employment during the operation phase, but for the majority, this will not be the case and there will be a need for employees to find alternative livelihoods in the area or move to a different area in search of economic opportunities. Those that have worked on the Project will have a significant advantage when securing other jobs on similar projects due to the experience and training received.

While the workforce demobilisation will most likely take place over the course of six months, the impacts of the out-migration of the construction workforce and loss of income are likely to be felt over an extended period of time.

Mitigation Measures

Increased Government Revenue
The Project will have limited ability to directly optimise or manage potential impacts on the national economy. Ghana’s ability to benefit from the economic opportunities that the Project offers at a national level will depend on good governance and fiscal transparency.

The measures outlined below, however will be implemented by eni in support of this agenda.

- eni will collaborate with the Government of Ghana to make payments of taxes and royalties in a transparent, accurate, and timely manner, utilising sound financial principles and accounting processes in alignment with EITI requirements.
- Where possible, and as part of it Social and Environmental Investment Plan eni will work with Local Government to encourage use of revenues to promote economic diversification, thereby minimising dependence on the oil and gas sector.
- eni will work with local authorities to ensure that Project Social and Environmental Investment programmes are aligned with local development plans and programmes.

Employment Opportunities

Mitigation measures to minimise negative impacts and maximise benefits of employment and skills enhancement by the Project will be detailed in a Project Recruitment, Employment and Training Plan and a Local Content Development Plan. All recruitment, training and development of national staff will be undertaken in accordance with these plans. Further mitigation around employment conditions and maximising local employment are provided in *Section G.7.6* Worker Management and Rights. The plans will include but not be limited to the following:

- Information on the workforce requirements of the Project: number or personnel required, as well the specific professions and capabilities needed to fill roles.
- eni will comply with or exceed the minimum local content requirements outlined in the Ghana_Local Content Policy Framework (2010).
- eni will ensure that recruitment procedures are transparent and monitored to ensure that those recruited present their actual experience, health status, and age. No children (below the age of 18 years) will be employed on the Project by eni or the contractors.
- Where possible, priority will be given to vulnerable groups such as women, and fishing communities most directly impacted by the Project, and to ensuring that youth (18 to 36 years) are empowered to maximise employment opportunities.
- eni will advertise the employment requirements and approach to employment widely (eg, at the regional and national levels) and early as a means of managing the expectations of job-seekers. This will be written into the eni HR Strategy and communicated both nationally (in conjunction with other project announcements) and locally.
- eni will ensure that employment advertisements specify that Ghanaians originating from the project affected districts will be given priority for recruitment.
- As part of these plans, all contractors (national and international) will be required to provide details of their own national employment and training plans.
- Eni will develop a Stakeholder Engagement Plan

Skills Development and Capacity Building

Mitigation measures to maximise benefits of skills enhancement and capacity building by the Project will be detailed in the Project Recruitment and Employment and Training Plan. The plan will include the following:

- Eni will identify the existing skills in the DAoI to identify skills gaps. Based on this gap analysis, eni will initiate early training mechanisms to train local people to meet the company's needs. The plan will focus the communities within the DAoI and EAoI, and on particular needs of the youth, based on feedback from stakeholders and give them priority for training programmes and opportunities. The training plan will also have a strong female-focused component and will lay the groundwork for implementation by commissioning a Training Needs Assessment. The plan will also include measures to facilitate training at a regional and national level.

- Opportunities for development, promotions and fast tracking will be prioritised for employees who are Ghanaian nationals, and who display sufficient capacity to develop their skills and deliver high performance. Such opportunities will have a priority focus on the youth and women.

- eni will build the capacity of employees through development plans, technical, health and safety training and provide them with relevant training certificates.

- eni will identify potential partnerships with NGOs and other education organisations, particularly those focusing on the empowerment of women and youth, as well as supporting NGOs and the Regional Education management board to expand and improve school and skills training facilities in the DAoI.

Procurement Opportunities

Mitigation measures to maximise benefits of procurement by the Project will be detailed in a Project Procurement Plan. The plan will include but not be limited to the following:

- eni will comply with the minimum local content requirements for supplies and services prescribed in the Ghana Local Content Policy Framework (2010).

- eni will disseminate information regarding procurement opportunities and requirements as early as possible.

- eni will provide quality standards required by the Project for provision of goods and services to the Project.

- eni will support the development of a supplier training programme to enhance the capacity of existing suppliers.

- eni will encourage unbundling of certain contracts to allow a number of small businesses to provide goods and services rather than the supply being monopolised by one large (foreign) contractor.

- eni will consider Corporate Social Investment activities that promote sustainable projects, training and education to help communities to develop alternative livelihoods and ensure that economic dependence on the Project is limited.

Enhanced hospitality and tourism business development
Mitigation measures to maximise benefits of enhanced tourism will include:

- eni will commit to Corporate Social Investment activities, through the Social and Environmental Investment Plan, that promote sustainable tourism projects, which are aligned with the Western Region's plans for developing tourism in the area.

Increased Price Inflation and Economic Vulnerability

Mitigation measures to minimise impacts such as price inflation will include:

- eni will work with local government to develop a price index for critical goods purchased by the most vulnerable sections of the community and seeking to collaborate with local government and others to find ways of decreasing impacts.

- eni will undertake a demographic survey and rapid appraisal in order to reflect on the perceived challenges and changes to quality of life. Corporate Social Investment projects will be focused on addressing changes and impacts on economically vulnerable groups, and on helping existing organisations to assist those vulnerable groups.

- Develop an Influx Management Plan. Should it be determined through baseline monitoring, stakeholder engagement / grievances that there is need for immediate action to manage influx, a focused, short term plan must be developed by eni to minimise the negative impacts of rapid in-migration. This would include mitigation measures targeted at identified influx hot-spots, for example to relieve pressure on social infrastructure and services, and manage health risks.

Impact of Workforce Demobilisation on Economic Vulnerability

- eni will implement the mitigation included above in Skills Development and Capacity Building which will enable the local workers to be employable on other similar type Projects.

- eni will establish retrenchment processes for implementation related to completion of construction phase. This will include substantial timely stakeholder engagement efforts to discuss the process with local workers prior to construction demobilisation.

- eni will encourage and invest in alternative livelihoods development (in collaboration with relevant partners) to reduce the reliance of the local population on employment and economic opportunities linked to the Project.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined by eni Standard requirements (Environmental, Social and Health Impact Assessment Standard – Doc n° 1.3.1.47), the residual impacts on economy and employment associated with the construction phase are summarized in Table G93.

Table G93 Residual Impacts on Economy and Employment during Construction Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Economy and Employment – Construction Phase					
Increased Government Revenue	Between 1 and 5 years	National scale: Entire country	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting a great no. of individuals, households and/or medium/large enterprises.	**10-High Positive**
Score	2	3	2	3	
Employment opportunities and Skills Enhancemen t	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 small number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium-Positive**
Score	2	2	2	2	
Increased Procurement	Between 1 and 5 years	International scale: trans-boundary	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**10-High Positive**
Score	2	4	2	2	
Enhanced hospitality and tourism business development	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low Positive**
Score	2	1	2	1	

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Economy and Employment – Construction Phase					
Increased Price Inflation and Economic Vulnerability	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	1	3	2	
Workforce Demobilisation	Project duration/Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
	2	1	3	2	

G.7.1.4 Operation Phase

The potential impacts during operation phase related to Economy and Employment include the continuing generation of revenue for the Government through the payment of taxes and ongoing employment and skills development for those who are able to secure employment with the Project. These impacts are discussed in more detail below.

<u>Impact Identification and Assessment</u>

Increased Government Revenue

Gas production from the OCTP field is expected to start in the 2020 and will have a design life of 20 years. Government revenue will continue to be enhanced by the payment of royalties applicable to gas sales, and taxes in relation to production once the Project is operational, as well as 20 percent of profits which will go to GNPC as a joint venture partner in the Project. The payment of royalties and taxes is undertaken in accordance with the Petroleum Revenue Management Act of 2011.

Project revenues cannot be accurately quantified at this stage as the allocation of increased government revenue to the country's development locally or nationally or into other purposes is unknown. Government revenues from taxes are reallocated into various types of expenditure including recurrent expenditure, grants, repayment of loans and development spending, thus the increase in revenue for translation into spending has multiple impacts.

Employment, Skills Development and Capacity Building

The Project has an estimated life span of 20 years. The permanent employees on the FPSO will be shared with the OCTP Phase 1 Project and will be lodged on the FPSO. The FPSO work force will total 65 people, of which 8 will be Ghanaian nationals, 49 expats and 8 eni representatives (also expats). An estimated 45 employment opportunities will be available at the ORF, made up of 80% locals and 20% expatriates.

Similar to the construction phase, local workers are expected to be qualified to fill unskilled positions at first, whilst a limited number of people will be sufficiently qualified for semi-skilled positions. Semi-skilled and skilled positions will initially be recruited from elsewhere in Ghana and internationally. Over time, however, and with the emergence of the oil and gas industry in the Western Region, local workers will be able to fill more of the semi-skilled and skilled positions. The skills required during operation are as followings:

- skilled labour 70 percent,
- semi-skilled 30 -20 percent, and
- unskilled 0%-10 percent.

Training will be provided by the Project to the local workforce, to improve skills levels relevant to the Project. This should allow for an increasing the percentage of local people employed in semi-skilled and skilled jobs over the lifespan of the Project. In line with the Ghana Local Content Policy Framework (2010), eni will be aiming increase the local content on the Project. This will ensure that local Ghanaians continue to benefit from employment opportunities and skills enhancement throughout the Project life.

Procurement Opportunities

During the operation phase the contracts that were in place during the construction phase will be terminated and procurement opportunities will be centred around maintenance activities, and providing goods and services to the FPSO and ORF operations. For those companies that meet eligibility criteria, become approved suppliers and enter the supply chain, there will be long-lasting and sustained benefits to the businesses and their employees through increased experience, capacity and training, particularly through having to meet stringent international standards and requirements. As such, during the operation phase there will be opportunity for local business growth and development

Enhanced hospitality and tourism business development

Throughout the operation phase, the presence of the Project is likely to continue to create a positive impact through increasing demand for accommodation in the coastal districts of the Western Region due to a potential increase in business travel to the Region. However, with a much smaller work force during this phase, the positive impact will not be great.

Increased Price Inflation and Economic Vulnerability

Over time, through the operation phase, local markets will adapt to the changes that have taken place in the DAoI, leading to an increased supply of goods and services. Price inflation should therefore stabiliseafter a few years. This should contribute to reducing the negative impacts on those more economically vulnerable groups over time.

Mitigation Measures

The mitigation measures defined for the construction phase will also be implemented during the operation phase, including the development and implementation of a Stakeholder Engagement Plan and an nflux Management Plan.

Conclusion

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on economy and employment associated with the operation phase are summarized in Table G94.

Table G94 Residual Impacts on Economy and Employment during Operation Phase

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	*Impact Rank*
Economy and Employment – Construction Phase					
Increased Government Revenue	Over 10 years / Irreversible	National scale: Entire country	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting a great no. of individuals, households and/or medium/large enterprises.	**13-Critical Positive**
Score	4	3	2	3	
Employment opportunities and Skills Enhancemen t	Over 10 years / Irreversible	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 small number of individuals, communities or administrative and/or higher no. of species and habitats	**10- High Positive**
Score	4	2	2	2	
Increased Procurement	Over 10 years / Irreversible	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 small number of individuals, communities or administrative and/or higher no. of species and habitats	**10- High Positive**
Score	4	2	2	2	

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Economy and Employment – Construction Phase					
Enhanced hospitality and tourism business development	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8- Medium Positive**
Score	4	1	2	1	
Increased Price Inflation and Economic Vulnerability	Between 1 and 5 years	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 individuals, households, individual enterprises and/or small no. of species	**5- Low**
Score	2	1	1	1	

G.7.1.5 Decommissioning Phase

At the end of Project lifespan (after 20 years), all Project infrastructure will be decommissioned. While much of the offshore infrastructure (with the exception of the FPSO) will be left in-situ, the onshore facilities will be removed as far as possible. The decommissioning activities will be undertaken with equipment similar that of the construction phase and will be completed in two years.

Impacts Identification and Assessment

Decommissioning impacts will be similar to impacts during construction in terms of employment opportunities but less significant than during the construction due smaller workforce requirements. Following the decommissioning of the Project, employment, procurement and tourism opportunities associated with the Project will cease and conditions will return to the "pre-project" status quo. Given the relatively small scale of the workforce required and the limited opportunities for local communities on the Project, it is not anticipated that a boom-bust scenario will be felt by communities in the DAoI. If, however, a number of other oil and gas and infrastructure projects are developed in the area over similar time preiods, this effect may result and post-decommissioning economic dependencies could arise. This is discussed along with proposed mitigation measures in section G.10 Cumulative Impacts.

Mitigation Measures

Mitigation measures are expected to be similar to construction, with the benefit of being improved based on lessons learned. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life. The

Decommissioning Plan will include an exit strategy to minimise the negative impacts of job loss.

Conclusion

The residual impacts are likely to be similar to construction, with the benefit of the implementation of improved mitigations based on lessons learned. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

G.7.2 Land, Fisheries and Livelihoods

G.7.2.1 Overview

This Section presents the potential impacts on land and livelihoods as a result of Project related activities.

Box G14 shows the key sources of potential impacts, resources and receptors, baseline and Project influencing factors associated with the impacts of the Project on land and livelihoods.

Box G14 Key Sources of Impacts and Risks, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Permanent and temporary land take for the ORF footprint and onshore section of gas export pipeline and the connection to the GNGC pipeline;
- Exclusion zones around offshore construction activities; and
- Exclusion zones around pipeline landfall location of the gas export pipeline.

Potentially Impacted Resources and Receptors

- Households/ individuals who own and cultivate or cultivate land in the land acquisition area.
- Households/ individuals who own and/or use wells or fish ponds in the land acquisition area.
- Households/ individuals who are engaged in livestock rearing in the land acquisition area.

- Artisanal and commercial fishers in the DAoI.

Baseline Influencing Factors

- High dependence on subsistence and commercial farming in the DAoI;
- High dependence on artisanal fishing in the DAoI;
- Reportedly declining soil fertility and agricultural yield;
- Reported shortage of alternative /unfarmed agricultural land in coastal areas;
- Reportedly declining fish stocks.

Vulnerable Groups

- Households with low income, depending on subsistence agriculture and/ or artisanal fishing as main economic activity; these households have fewer resources or access to alternative livelihood strategies to rely on.
- Residents of Awonakrom will be the most disrupted by pipeline construction activities, as they are located adjacent to the pipeline landfall site.
- Migrant fishing communities are vulnerable as they have no formal rights to land, they farm very little or no crops and are almost solely dependent on fishing-based livelihoods.

Project Influencing Factors

- ORF, associated infrastructure and accommodation camps will be contained within the land acquisition area.
- Laydown areas outside the ORF acquisition area will be rehabilitated.
- Exclusion zones will be in place around offshore construction activities.

Table G95 presents the key potential impacts of the Project on land and livelihoods during the Project phases.

Table G95 Key Potential Impacts and Risks – Land and Livelihoods

Construction Phase	*Operations Phase*	*Decommissioning Phase*
• Economic displacement of land-based livelihoods in the land acquisition area (crop cultivation, animal rearing, and aqua-culture). • Economic displacement of marine fishing-based livelihoods due offshore pipeline construction and reduced access to fishing grounds as result of exclusion zones around offshore Project infrastructure	• Economic displacement of households/ individuals using land in the land acquisition (crop cultivation, animal rearing, and aqua-culture). Economic displacement of marine fishing-based livelihoods as result of exclusion zones around offshore Project infrastructure (FPSO only)	• Economic displacement of households/ individuals using land in the land acquisition area (crop cultivation, animal rearing, and aqua-culture). • Economic displacement of marine fishing-based livelihoods due to reduced access to fishing grounds as result of exclusion zones around offshore Project infrastructure (FPSO only)

The *sensitivity* of the Land and Livelihoods is reported in the following Sections. The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

G.7.2.2 Land and Livelihoods Sensitivity

Most of the land in the DAoI is used for agricultural activities including crop cultivation, aqua-culture (fish farming in ponds) and livestock rearing. The area closest to the coast is used for residential dwellings as well as for activities supporting marine fishing-based livelihoods (including beach canoe landing sites, beach seine or drag-netting landing, and fish-mongering).

There is a strong dependence on both farming and fishing activities in the DAoI, and there are few alternative livelihood or employment options due to the relative lack of development of commercial and industrial sectors in the area. Fishing and farming livelihoods are interlinked in the DAoI as people transfer between these activities depending on the season. In the farming season (the rainy season) income from fishing is used to purchase farming inputs, while investments shift back to fishing during fishing season.

Disruption to or loss of income and subsistence from fishing and farming could have a detrimental effect on those impacted as they have undiversified livelihoods strategies outside of these two primary activities and generally low education levels and low skills, and would not therefore easily be able to seek alternative livelihoods.

The sensitivity of households in the DAoI around loss of land and livelihoods relates to a number of contributing factors including their marginal living conditions and insecure and undiversified livelihood strategies, lack of income stability, household instability, and poverty. It is anticipated that marginal households including elderly and female-headed households, seasonal fishing employees,migrant fishing communities and refugees from the Krisan camp who depend on work with fishermen) and other vulnerable farmers, fishers and fishmongers will suffer the most from any loss of access to farmland or natural resources (e.g. fishing resources) because they seldom have access to alternative fixed incomes.

Farming Sensitivity
Crop farmers in the DAoI can be considered additionally vulnerable to loss of access to land and potential livelihood impacts due to a number of baseline factors which are already contributing to poverty and insecurity of income. The most significant of these include:

- Lack of farming mechanisation and agricultural knowledge, and high manual labour intensity of farming requiring participation from all family members;
- Reported decline in soil fertility and overall crop yield;
- Long distances to market, weak transport infrastructure (including poor road conditions) and lack of motorised transport to facilitate the sale of produce;
- No irrigation systems meaning farming yield is highly susceptible to rainfall levels and changes in climate. This is combined with a reported increase in extreme climate events such as flooding; and
- Lack of cold storage facilities meaning farmers cannot store food to regulate or manage supply of produce to market.

Finally, there is a reported concern about a lack of available suitable unfarmed land in the coastal areas according to some baseline survey accounts, suggesting that in the case of economic displacement, like-for-like replacement of land for the relocation of land-based livelihoods may be difficult to achieve.

Of all affected communities in the DAoI the households of Sanzule will be proportionally the most vulnerable to loss of livelihoods due to loss of access farmland. Most land users/owners in the land acquisition area are known to be Sanzule residents. However, the land owner user survey currently being undertaken in the context of the Livelihood restoration Plan (LRP) seems to indicate that there could be land users/owners from other neighboring communities (e.g. Krisan). Residents from Anwolakrom do not own land but are known to be labourers in the farms of the concession area. This information is being verified through the land owner user survey in the context of LRP. More accurate information about the affected communities will be available after the LRP finalization.

The exact proportions of the loss this land take will represent, relative to the total population of those farming and to the total agricultural land available to the Sanzule community, cannot yet be quantified. An assessment of the proportional scale of livelihoods losses to Sanzule, along with information on the availability of alternative agricultural land in the DAoI to allow for like-for-like replacement of acquired farmland, will be confirmed following supplementary baseline livelihoods survey work to be conducted by the Project in parallel with the resettlement planning process (expected to occur in April 2015).

Fishing Sensitivity
There is concern amongst fishers in the DAoI and Extended AoI that the Project will have a negative effect on fish catch due to exclusion zones which may permanently restrict their access to fishing grounds. Concern was also raised that activities during the laying of gas pipelines might disturb fish habitats and cause environmental pollution causing a further decline in catch. These concerns are raised in the context of historically declining fish stocks in the Western Region and an already a strong perception amongst fishing communities that

this, along with an increase in algal blooms affecting activities, can be partly attributed to offshore oil and gas development.

The Sanzule (including the migrant fishing settlement Awonakrom) and Bakanta communities are considered more sensitive to disruption or loss of fisheries-based livelihoods as they are located closest to the ORF site and offshore infrastructure. The main occupation of these villages is fishing which is reportedly undertaken by approximately 60 - 70 percent of the population, while farming is undertaken by approximately 30 percent. Of these, Awonakrom, which is considered part of Sanzule but is directly adjacent to the onshore pipeline landfall site can be considered especially vulnerable to disturbance impacts from the pipeline construction to both their shore-based and offshore fishing activities. This communities' vulnerability to both temporary and permanent loss of fishing livelihoods will be compounded since they have no formal rights to land, farm very little (or not at all) and are therefore almost solely dependent on fishing-based livelihoods.

Finally, a possible sensitivity linked to fisheries livelihoods exists around illegal child labour and already commonly observed (and reported by educators) involvement of school-aged children, in particular young boys in fishing activities [(3)]. There is a risk of this trend increasing if a gap is created when men start moving into other income generating activities associated with the Project, meaning younger boys are drawn to fisheries to support their families.

G.7.2.3 Construction Phase

<u>Impact Identification and Assessment</u>

During the onshore construction phase, land will be needed for:

- construction of access roads and site access;
- construction sites for ORF, including storage, accommodation, warehouse and parking;
- onshore section of the gas export pipeline;
- borrow pits and disposal areas; and
- temporary infrastructure such as pipeline and construction yard, administration buildings, temporary accommodation camp.

Table G96 summarises the land required for construction activities, as foreseen at this stage, and the impacts associated with this land take are discussed below.

(3) Child labour (often in the form of slavery) in the fishing industry is common in the Volta Lake region and this form of abuse needs to be monitored in the Study Area

Table G96 Land Use during Construction Phase

Component	Temporary Land Use
Onshore section of gas export pipeline (from landfall to ORF)	Working strip: max width 34 m length 1500 m Area: 51000 m^2
ORF and temporary associated facilities (e.g. construction yard)	190000 m^2
Connection to the Ghanaian national grid	Working strip: max width 34 m length 800 m Area: 27200 m^2
Temporary accommodation camp and related facilities	30000 m^2

Economic Displacement of Land-Based Livelihoods in the Land Acquisition Area (Crop Farming, Animal Rearing and Aquaculture)

Economic Displacement of Farming in Concession Area

According to the valuation report undertaken for the acquisition of the ORF area, there are 184 farmers (4) with some form of land use rights and currently cultivating crops or practising aquaculture in the ORF acquisition area (DELIN Consult, 2014). A range of crops are grown in the acquisition area, including cash crops, food crops (perennial and annual), coconut and oil palms. The fresh water bodies in the land acquisition area are used for aquaculture and hand-dug fishponds on the land are used for mud fish rearing.

During the construction phase the land take for the construction of ORF and ancillary facilities, including the onshore pipeline ROW, will mean that those currently using the land will have temporarily restricted access. Movement to some of the footprint area will not be possible and they will not able to practice agricultural activities within the footprint area. The restrictions to agriculture in the land acquisition area will give rise to permanent economic displacement of those farming and will result in the loss of income streams and source of livelihood and food security from both crops and on a smaller scale from farmed fish for the life of the Project.

Disruption/Economic Displacement of Marine Fisheries-based livelihoods

Based on stakeholder consultation and secondary data, at least three quarters of the populations in the villages of the DAoI depend of fisheries-based activities for their livelihoods. Temporary or permanent restrictions on access to offshore fishing grounds and a resulting reduction in catch would have a detrimental effect on livelihoods and wellbeing of these communities. Fishmongering is directly dependent upon fish catches and a loss of access to fishing grounds or significant reduction of catch size would have direct impacts on

(4) The number of farmers is based on the landtake of the original acquisition area, which has now been downsized. The information will need to be updated based on the landtake of the new acquisition area.

the subsistence of the fishmongers and food security more broadly, since women fishmongers are also key providers for the household. Similarly, though much less significant loss or disruption of livelihoods could result from temporary disruption of shore-based fishing activities such as beach landing sites, use of beach seine ('drag netting') gear as well as the physical location of fish mongering and trading.

These specific impacts on marine fisheries-based livelihoods are described below (see also Annex C of the Phase 1 EIS):

Restricted Access to Offshore Fishing

A legally enforceable safety exclusion zone around drilling vessels will be maintained throughout construction and operation to reduce the risk of collisions at sea and to ensure personnel safety. Fishing vessels will not be able to fish within the exclusion zones for safety reasons. This restriction will result in a very small reduction in the available fishing grounds within the Ghanaian EEZ and will affect only those fishermen who fish in this offshore area, approximately 60 km off shore. This effect could result in a reduction in fish catch. It is important to note, however that the main pelagic species found in offshore deepwater locations in the Gulf of Guinea targeted by fishermen are highly migratory and will not be permanent residents in one area, and those attracted to infrastructure are not likely to spend significant periods of time in those locations.

There will also be a legally enforceable safety exclusion zone around the gas export pipeline when construction activities are taking place, temporarily limiting near-shore fishing activities in this area. This exclusion zone will impact the nearshore fishers. This temporary restriction could result in reduced catch for the fishers for the duration of the construction period, which will affect their livelihoods and incomes.

Disruption of Onshore and Near Shore Fishing Activities

Construction activities nearshore (such as trenching and pipe-laying) can cause the re-suspension of sediments and increase turbidity in the water. This effect could be more intense on the near shore area given the trenching activities planned to bury the pipeline and the nature of the local fisheries, characterized by the use of beach seine fishing techniques. According to the fisheries baseline (see Chapter 7), near shore marine sediments are characterized by low pollutant levels and therefore no toxic effects are expected. The suspended sediments could result however in the temporary displacement and avoidance of fish species during construction.

Beach access will be temporarily restricted during the installation of onshore section of gas export pipeline to ensure community safety. There will be an exclusion zone of approximately 100 m either side of the gas export pipeline preventing fishers from using the beach in front of the ORF land acquisition area for landing catches and boats and gathering for fish-mongering/trading activities. This area is small however, relative to the extent of the beach, and the exclusion zone will only be enforced during the installation of the pipeline.

Vessel movements to and from onshore base during construction also have the potential to interact with fishing activity in the vicinity of the onshore bases and therefore near-shore artisanal fishing activities could be adversely affected through disturbance by these vessels. During construction, vessels traffic increase related to pipelaying barge supply and drilling rig support will increase, and there will be three supply vessels available to the Project. These vessels will move between the Port of Takoradi and the Project site as needed.

Damage to Fishing Gear
Some fishing vessels use passive fishing gear not attached to a fishing vessel. Fishing nets, hook and lines, trawling, set net fishing, purse seine fishing and lobster traps are often set several meters below the surface and left for many hours. There is the potential for this gear, which is left floating in the open ocean, to enter the exclusion zone and become entangled in Project vessels and be lost to the fishermen, causing a livelihood loss through the cost incurred for the replacement of gear. The exclusion zones around Project vessels are intended to reduce the likelihood of this impact occurring as far as possible.

Lighting
As reported in the Fisheries Baseline Chapter 7, in the offshore environment fish may be attracted to the artificial lights on the Project vessels, as light acts as an important stimulus for many fish species. Fish aggregations around the Project vessels are therefore likely to occur at night time, meaning fish remain in the exclusion zone where no fishing is allowed. This could have the effect of reducing the fish catch. However, as stated above, this is not anticipated to be a significant impact, since the main pelagic species found in offshore deepwater locations in the Gulf of Guinea targeted by fishermen are highly migratory and will not be permanent residents in one area.

Mitigation Measures

Land-Based Based Livelihoods (Crop Farming and Aquaculture)

According to IFC Performance Standard 5, all parties affected by loss of land and livelihoods are entitled to alternative land or restoration of livelihoods lost – including those without formal title or use rights to the land. All individuals using land or natural resources for their livelihoods within the Project land acquisition area will therefore be identified, and considered eligible for compensation and restoration of livelihoods as part of the Project impact mitigation and management programme. Mitigation for economic displacement of land-based livelihoods will be detailed in a Livelihood Restoration Plan (LRP) and supporting measures described in the Project Community Development Plan (CDP).

- The LRP (and later CDP) will focus on three key elements of compensation and livelihood restoration:
    - Fully characterising the loss of use rights to land and associated livelihoods incurred by all affected households, and implementing measures to provide suitable compensation at replacement cost and improved or at least restored livelihoods;
    - Providing additional support as appropriate to affected households to diversify their livelihood strategies to develop alternative economic (non-farming) activities to supplement marine fishing and farming incomes and subsistence (e.g. small scale trade, transport, service industry); and
    - In conjunction with measures in the Project CDP, exploring and developing further investment opportunities to support and enable farmers to improve their farming income: e.g. through establishing producer groups to increase efficiencies and reduce/share the burden of transport of produce, and facilitating access to microcredit to support with cold storage and marketing to enable them to better manage supply and market their products.

To this end, the Project is currently considering two displacement scenarios and compensation options based on combinations of the above to be refined and finalised in consultation with the community and fleshed out in the LRP. These options include:

- **Option 1.Permanent Displacement with Land for Land Replacement elsewhere:** Where possible and ideally, eni will identify and provide access to replacement land of equal quality elsewhere to guarantee food security, and provide additional resources and support for the rapid restoration of farming and small-scale aquaculture activities on that land (e.g. seeds, fertilisers, irrigation technologies and agricultural training/advice). Cash compensation will be avoided if possible. Additional support in the form of alternative livelihoods projects, training and capacity building will be offered as well as involvement in CDP farming improvement programmes;

- **Option 2. Permanent Displacement with Cash Compensation and Support for Livelihood Restoration:** Lastly, land users will be offered a package of cash compensation plus alternative livelihoods projects, training and capacity building, and to those still farming elsewhere, involvement in CDP farming improvement programmes. The land utilised for Project facilities and infrastructure will be fenced and secured. The remainder of the land will be left unfenced and community members will be free to traverse these areas. No re-instatement onto this or any other land in the acquisition area for the purposes of farming will be permitted.

- In all cases where cash compensation cannot be avoided, the Project will clearly describe measures taken to ensure safety nets for the community including adequate education and capacity building for affected households to avoid increased vulnerability and risks to food security which can arise when land is not replaced and cash compensation is not managed sustainably.

- eni Ghana will employ a RLO (or Land Acquisition Manager) to manage the implementation of the LRP.
- The LRP will include a stakeholder engagement plan and standalone grievance procedure which will be communicated and managed by the RLO (or Land Acquisition Manager) in consultation with the CLO and GO.

<u>Marine Fisheries-based Livelihoods</u>

Mitigation for disruption and displacement of marine fisheries-based livelihoods will be detailed by eni in a Project Fisheries Management Plan (FMP) and where appropriate supporting measures described in the Project Community Development Plan:

- Eni will develop and implement a detailed Fisheries Management Plan. The FMP (and if appropriate, supporting measures in the CDP) will focus on fully characterising the losses incurred by fishers, and describing suitable compensation and livelihood restoration measures for any temporary or permanent loss of fisheries livelihoods, or damage to fishing gear due to Project activities. Eni will consult local fishermen on the possibility of implementing a participatory monitoring plan.

- Eni will employ a Fisheries Liaison Officer (FLO) to liaise between fishermen and eni and to provide information to fishing communities, regarding eni's activities during construction. Particularly, they will explain the requirements to keep away from the operations for safety reasons.
-

- A vessel transit route will be agreed with the Ghana Maritime Authority and communicated to fishermen and other marine users through the CLO/FLO.
- The exclusion zone will be monitored with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (eg fishermen) when potentially close to Project infrastructure or vessels. Measures will be implemented to ensure that those engaged in maintaining the exclusion zones have received adequate training on the correct code of conduct and rules of engagement which will be based on the UN Voluntary Principles of Security and Human Rights.
- Interaction with fishermen and other users will be monitored through the CLO/FLO and the Project's grievance procedure.
- The Project will limit exclusion zones around Project infrastructure as far as possible, without compromising safety measures.

Conclusion

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on Land and Livelihood resources associated with the construction phase are summarized in Table G97.

Table G97 Residual Impacts on Land and Livelihoods during Construction Phase

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Land and Livelihood – Construction Phase					
Economic Displacement of Land-Based Livelihoods					
Economic Displacement of Farming in Land Acquisition Area	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, able to poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats of species	**10-High**
Score	4	1	3	2	
Disruption/Displacement of Fisheries-based livelihoods					
Restricted Access to Offshore Fishing Grounds due to Exclusion Zones	Between 1 and 5 years	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	1	2	

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Disruption of Onshore and near-shore Fishing activities	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	2	2	
Damage to Fishing Gear	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	2	2	
Lighting	Between 1 and 5 years	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	1	2	

G.7.2.4 Operation Phase

Table G98 summarises the land required for operation phase, as foreseen at this stage, and the impacts associated with this land take are discussed below.

Table G98 Land Use during Operation Phase

Component	Permanent Land Take	Permanent Constraints
Onshore section of gas export pipeline (from landfall to ORF)	NA	Width 50 m (no construction activities allowed) Length 1500 m Area 75000 m^2
ORF	190000 m^2	

Component	Permanent Land Take	Permanent Constraints
Connection to the Ghanaian national grid	NA	Width 50 m (no construction activities allowed) Length 800 m Area 40000 m^2
Accommodation camp	27000 m^2	

Impact Identification and Assessment

Impacts identified in the construction phase will continue throughout the operation phase. These are described below:

Land- based Livelihoods

Economic Displacement of Farming in Land Acquisition Area

After construction activities, and during operations, the ORF, accommodation camp and heliport will be permanently fenced for security and safety. During operation, the accommodation camp will be subject to curfew during night time and movements outside the accommodation camps or, if applicable, the facilities will be restricted. During the day, entrance and exit will be monitored for safety and security at the entrance gates of the compound. The gas export pipeline will have an onshore extent of 1.5km, which will be laid underground with a landfall corridor of 100 m. The onshore pipeline from ORF to the GNGC gas sales pipeline will be 800 m. If required, access barriers to prevent trespassing on the ROW will be established at appropriate points. All posts and markers will be located to minimise interference with agricultural activities.

The remaining land area within the footprint will remain open to allow communities access for movement and for some re-instatement for the purposes of agriculture Although access to some of the footprint area for movement e.g. for transport of produce, will be reinstated, these restrictions to agriculture will result in the continued economic displacement of those previously farming, resulting in the continued loss of income streams and source of livelihood and food security from both crops and farmed fish.

Fisheries-based Livelihoods

Restricted Access to Offshore Fishing Grounds

A legally enforceable safety exclusion zone around the FPSO maintained during operation to reduce the risk of collisions at sea and to ensure personnel safety. Fishing vessels will not be able to fish within the exclusion zone for safety reasons. This restriction will continue to result in a very small reduction in the available fishing grounds within the Ghanaian EEZ and will affect those fishermen who fish in this offshore area, approximately 50 km off shore. This effect could result in a continued reduction in fish catch. It is important to note, however given the area available to fish for the target species that occur in this offshore location, the exclusion from a small area (approximately 3-4 km^2) around the project site is not likely to significantly affect catches.

There will also be restrictions around the pipeline corridor. Such restrictions include a no anchor zone, and no trawlers or draggers will be allowed within a 500 m buffer of the pipeline.

A number of fishermen reported that they have been unduly harassed by the Ghana Navy in their role ensuring the security of the Project assets and enforcing the exclusion zone in the vicinity of the Jubilee Field. There was concern raised by fishers that another exclusion zone will lead to further harassment and disruption to fishing activities.

Eni will to provide a dedicated patrol vessel to monitor and patrol offshore FPSO buffer zone with support if required from Ghana Navy (in this case, they will remain unarmed). The security management plan and patrolling procedure will continue to be implemented both onshore and offshore. These measures will minimize the potential for aggressive interactions between fishing boats and Ghana Navy throughout the operation phase.

Disruption of Onshore and Near Shore Fishing Activities
Since there will be no exclusion zone around the gas export pipeline, beach access will be restored meaning no further disruption to onshore fishing activities is anticipated.

The construction activities which disturbed the seabed will cease during operations, and the Project associated vessel movements will be reduced. However vessel movements will continue throughout operation, associated with supply of the FPSO and for crew shift changes. Further marine traffic will be generated during the maintenance and surveillance phase of the flowlines and offshore export pipeline. These activities will continue to create the potential for interactions, collisions and or disturbance of near shore fishing boats and activities.

Damage to Fishing Gear
The potential for fishing gear to become entangled on the FPSO and be lost to the fishermen will remain throughout the operation phase, particularly for fishers using passive fishing gear such as hook and lines for tuna which are set several meters below the surface and left for many hours. However, this will only impact a small number of fishermen, fishing over 50 km offshore.

Lighting
The lighting of the FPSO and other offshore infrastructure will continue in the operations phase. As explained above, it is not likely that fish will congregated in these areas for an extended period of time.

<u>Mitigation Measures</u>

The mitigation measures described in Section G.7.2.3 will continue to be implemented throughout the operation phase. In addition:

eni will notify mariners of the presence of vessels and other marine operations and the exclusion areas will be marked on nautical charts as cautionary advice to all sea-users.

- Ongoing mitigation and stakeholder engagement will ensure that the impacts associated with economic displacement from land –based livelihoods and disruption/displacement of marine fishing-based livelihoods remain of medium significance and that those affected are able to adapt to the changes brought about by the Project.

- The gas export pipeline will be clearly marked on navigation charts.

Conclusion

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on Land and Livelihood resources associated with the operation phase are summarized in Table G99.

Table G99 Residual Impacts on Land and Livelihoods during Operation Phase

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Land and Livelihood – Construction Phase					
Economic Displacement of Land-Based Livelihoods					
Economic Displacement of Farming in Land Acquisition Area	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, able to poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats of species	**10-High**
Score	4	1	3	2	
Disruption/Displacement of Marine Fishing-based livelihoods					
Restricted Access to Offshore Fishing Grounds due to Exclusion Zones	Over 10 years / Irreversible	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	4	1	1	2	
Disruption of near-shore Fishing activities	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	4	1	2	2	

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Damage to Fishing Gear	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	4	1	2	2	
Lighting	Over 10 years / Irreversible	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	4	1	1	2	

G.7.2.5 Decommissioning Phase

Impact Identification and Assessment

At the end of Project lifespan (after 20 years), all Project infrastructure will be decommissioned. While much of the offshore infrastructure (with the exception of the FPSO) will be left in place, the onshore facilities will be removed as far as possible. The decommissioning impacts will be similar to that of the construction phase and will be completed in two years. Following the decommissioning, the exclusion zones will no longer be enforced and fishing-based livelihoods will no longer be disrupted by the Project. For those who were permanently economically displaced from access to land and natural resources in the land acquisition area, it is unlikely that they will be reinstated to the land areas acquired as it would entail further disruption to their lives.

Mitigation Measures

Mitigation measures are expected to be similar to those implemented during construction phase, with the benefit of being improved based on lessons learned. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life.

Conclusions

The residual impacts at decommissioning are likely to be similar to those felt during construction, with the benefit of being improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

G.7.3 Socio-cultural Changes

G.7.3.1 Overview

This section identifies potential Project impacts on the socio-cultural environment within the DAoI. Social systems and structures in the DAoI have developed over generations and are not static. A Project of this nature has the potential to cause change within these systems.

Box G15 shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated with the impacts of the Project on the socio-cultural environment.

Box G15 Key Sources of Impact, Potentially Impacted Resources and Receptors

Sources of Impact

- The presence of Project workers in the DAoI and their interactions with the local communities.
- An in-migration of jobseekers into the DAoI.
- The perception that some have gained more than others from the Project, leading to jealousies.
- The presence of an industrial Project in a rural setting.

Potentially Impacted Resources and Receptors

- Local communities in the DAoI and particularly those closest to the ORF acquisition area – Sanzule (Awonakrom), Krisan, Bakanta and Eikwe.

Vulnerable Groups

- Traditional leaders, chiefs and elders: new comers to area may challenge traditional leadership structures.
- Elderly, the sick and orphans: these groups depend on both formal and informal social networks and welfare structures, and may not be able to adapt should these structures be disrupted or changed.

Baseline Influencing Factors

- Existing intercommunity tensions/jealousies e.g. between Bakanta and Sazule youth arising unmet expectations concerning the location of the ORF land acquisition area and for compensation displacement from land and crops.
- Existing tensions and jealousies over Project related opportunities (e.g. jobs or social investment initiatives) between local residents and oil and gas workers or economic migrants e.g. job seekers.
- Perceptions and concerns voiced in some communities that the presence of workforce from Ghana Gas Project has led to an increase in petty crime and prostitution and that an increase is wage labour will bring unwanted social change and a breakdown in traditional values.

Project Influencing Factors

- Project workers will be accommodated in the worker camps which will be closed camps, limiting interaction with the local communities.
- A small operation phase workforce (65 people).

Table G100 presents the key impacts of the Project on Socio-cultural changes during the key Project phases.

Table G100 Key Potential Impacts – Socio-Cultural Changes

Pre-construction and construction	Operation	Decommissioning
• Changes to cultural and Social Norms. • Increased anti-social behaviour. • Tension and Conflict between Villages. • Social unrest resulting in violence towards Project or Communities or Migrants.	• Changes to cultural and Social Norms. • Increased anti-social behaviour. • Tension and Conflict between Villages. • Social unrest resulting in violence towards Project or Communities or Migrants.	• Changes to cultural and Social Norms. • Increased anti-social behaviour.

The *sensitivity* of socio-cultural change is reported in the following Sections. The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

Residual impacts are presented taking into account the application of the identified mitigation measures. Were possible a quantitative matrix has been applied to measure the residual impacts of the Project; in case of positive impacts this kind of analysis in not significant and a qualitative interpretation of residual impacts has been developed.

G.7.3.2 Socio-cultural Sensitivity

The DAoI consists of four rural communities, each with their own traditional leadership, history, sense of community identity and established social networks and relationships often tied to their subsistence fishing and farming activities. The communities are clearly characterised by a high level of social-cohesion and bound by close family and kin ties, across the DAoI with very few in-migrants or outsiders reportedly present (with the exception of Awonakrom, a migrant fishing community which has become an accepted extension of Sanzule). The traditional leadership (Chief and Council) still command a high level of respect and influence and local traditional protocol governs formal social and community interactions.

An in-migration of Project workers and jobseekers from within or outside Ghana will bring unfamiliar cultural and social norms, languages and practices which may clash with those of local residents. Although cultural norms and identities are dynamic and are subject to change depending on a person's context, the introduction of foreign cultures and 'newcomers' to a relatively small and close knit society can bring about an abrupt change, and can lead to tension between outsiders and those not welcoming change. This tension can be exacerbated where economic opportunities arising from the Project are perceived to disproportionally benefit newcomers or outsiders who may have better education or skills levels than local residents.

During baseline data gathering, it was noted that in a number of the communities engaged there are concerns (particularly amongst youth) that they will be overlooked by the Project and not benefit directly from employment opportunities or compensation. This could lead to tension and jealousy between villages that are seen to be benefitting more than others. Some existing tension was noted between Bakanta and Sanzule youths, for example, related to unmanaged expectations in both villages about the location of the ORF. During early consultations with the Project, expectations were raised in Bakanta that they may be relocated and would therefore receive compensation from the Project. This was a source of jealousy and tension with their neighbours in Sanzule. Once the Project site was re-defined to a footprint area closer to Sanzule this tension has reversed.

It was also noted that a number of communities were unhappy when they did not see the name of their village on the Project infrastructure map presented during consultations indicating an existing level of rivalry between villages and already high expectations for employment benefits in all villages in the DAoI.

G.7.3.3 Construction Phase

<u>Impact Identification and Assessment</u>

Changes to Cultural and Social Norms

- An oil and gas project of this nature is expected to bring about some change to DAoI. As noted above, there will be an influx of Project workers and jobseekers into the DAoI, each with their own associated cultural and social norms. The cultural and social values of newcomers may be different to those held within the local communities and they will not be accustomed to, or bound by, allegiance to the existing traditional leadership structures. Individuals with specific agendas or particular levels of skill and education are likely to assert the desire for more representative structures through which to engage the Project. If there is general community support for this more broadly representative approach, it is possible that traditional leadership roles will be compromised and traditional leadership may then be challenged to redefine and assert itself. Women often bear the heaviest burden of poverty, and they are often hardest hit by social and environmental problems related to large-scale projects like oil or gas developments (Oxfam, 2015).

- There will be 628 onshore Project workers in the DAoI at the peak of constructions, and although they will be accommodated in a closed camp located in the ORF acquisition area, some level of interaction with the local communities is still to be expected. Jobseekers will settle in communities closest to the Project site in an attempt to secure employment on the Project, therefore the communities of Sanzule, Krisan, Eikwe and Bakanta are likely to experience more significant disruption and changes to cultural and social norms than the other communities further afield.

- For these four communities, the extent and pace of change will be high during construction in particular, which may cause unease among the communities depending on their ability to respond to, and assimilate, these changes. People that are likely to be most vulnerable include the elderly, women, traditional leaders, and unskilled or unemployed people who are less able to adapt. Throughout the DAoI there is a high level of vulnerability in this regard.

Increased Anti-social Behaviour

Linked to the expected changes in cultural and social norms, an increase in anti-social behaviour can be anticipated in the DAoI during the Project construction phase. Anti-social behaviour in this context refers to behaviour that is perceived to lack consideration to others and cause damage to wider society, whether it is intentional or unintentional. Anti-social behaviour can be understood as actions that are contrary to the prevailing norms, and influences the way that a community functions. This may incorporate a large spectrum of actions however in this context refers to alcohol and substance abuse, the use of commercial sex-workers, crime and violence. Failure to prepare for influx of the mostly male construction workforce and jobseekers may result in increased sexual exploitation of/abuse against local women and children, as well as increase incidence of teenage pregnancy and spread of HIV/AIDS. These phenomena have been experienced in other regions where similar projects have been developed. Worker-community interaction, in particular worker interaction with women and young girls including refugees, is likely to result in increased vulnerability as they have a limited ability to negotiate safe sex practices for cultural and religious reasons.The Project workforce and most of the job seekers will be predominantly male, and as stated above, they may not be accustomed to the traditional structures and leadership of the local communities. In-migrants have the potential to change the way that the local community functions and increase the practice of activities that are currently discouraged by the local community. They will not necessarily have the same level of regard to for traditional authority and law enforcement, which will make enforcement more difficult.

Further, the potential for employment opportunities for local men may increase available cash which can be associated with higher rates of alcohol and substance abuse, and solicitation of commercial sex workers (among local people). During FGDs with women in the communities in the DAoI, there is already a reported increase in prostitution which was associated with the presence of the Ghana Gas construction activities. The potential impacts of increased anti-social behaviour on women and health is discussed further in Section G.7.7Health Impact Assessment.

Overall, a limited number of anti-social behaviours were reported and observed in the DAoI. There are reportedly very low levels of crime, drug and alcohol abuse and very little police presence in the area. FGDs with men and leadership in particular were unanimous that social order is currently easily maintained via traditional authority mechanisms and disputes resolved through the Chief and his council. However, during stakeholder consultations it was alleged that there has been an increase in petty crime (theft) in Atuabo since construction commenced on Ghana Gas, although this was unsubstantiated.

Tension and Competition over Benefits/ Economic Opportunities Between Communities

The four communities in the DAoI are all within 5 km of the proposed site for the ORF. Sanzule is adjacent to the western boundary land acquisition area for the ORF, while Awonakrom is located adjacent to the eastern boundary of the acquisition area. Bakanta is located 2 km east of the acquisition area.. As the Project commences, certain villages will be more directly affected (positively and negatively) than others and they will need to be given particular attention by the Project, such as those who will experience economic displacement. The communities further away from the Project site may feel that they are not being engaged as much by the Project and therefore, not benefitting from employment opportunities as much as the communities closer to the Project site.

These types of scenarios, real or perceived, create the possibility of jealousy, tension and conflict between the villages. This risk may be accentuated among the youth in these villages, who often have a higher propensity to tease, be competitive and potentially resort to conflict. This could in turn have an impact on relations between the Project and those villages that feel excluded from the Project benefits.

Social Unrest resulting in violence towards the Project, Communities or Migrants

In extreme cases, tension over limited jobs or economic opportunities, perceived preferential treatment of one community over another by the Project recruitment policies or social investment strategy, and in particular between local residents and incoming economic migrants, can result in a breakdown in law and order, leading to violent protest and widespread social unrest. This may manifest in attacks on Project infrastructure or personnel, or in xenophobic attacks on newly settled migrants or their homes/property, or infringements of community human rights more broadly.

Mitigation Measures

- Implement the Grievance Mechanism described in the OCTP EIS SEP, Annex A.

- Stakeholder consultation will include collaborative work with community groups to conserve and preserve and or document local cultural artefacts and traditional practices that are of particular value and significance to sections of the communities.

- All stakeholder consultation with the communities will be done through the relevant administrative and traditional authorities to ensure that they remain empowered and their roles are respected. For example, where specific participation and empowerment of youth, women or vulnerable groups is planned as part of focused provision of vulnerable support to those groups, care will be taken to explain the value of participatory approaches and to engage through leadership in a way that does not undermine the traditional system and hierarchy of patriarchal authority. Failure to do so can serve to destabilise family or community relationships.

- Employment procedures will be undertaken by the CLO in accordance with the Recruitment, Employment and Training Plan and through a local employment office (or similar centralised procedure) and or located in selected administrative centres to discourage in-migration into the nearest villages (See also 10.6.5).

  Opportunities for strategic social investment by the Project will be explored as part of the Project CDP including programmes focused in enterprise development and livelihood strategy diversification. Such initiatives can serve to engage more of those economically active individuals in the DAoI who do no benefit directly from Project jobs, empowering them to create alternative economic opportunities within the affected communities which will benefit a wider cross-section of society. This will contribute to a sustainable legacy for the Project lessening any boom and bust effect post-decommissioning, as well as refocusing certain groups e.g. unemployed youth and migrants in particular, away from crime and anti-social behaviours and into economically productive activities.

  CDP programmes will support women's empowerment and education programmes to promote women's rights and safe sexual practices (including the use of condoms and female condoms), such programmes will specifically target young girls.

- Management of Workforce and Accommodation
  Appropriate management and training for the workforce will help to ensure that they are aware and respectful of local customs, traditions and values. Management of the

accommodation camp will also limit the risk of anti-social interactions between the workers and the communities. The following mitigation will be implemented:

- A Code of Conduct for Project Personnel will be developed detailing rules to be upheld to minimise the risk of anti-social behaviours. Appropriate disciplinary procedures will be developed and enforced to ensure that the Code of Conduct is upheld by all Project employees and subcontractors.
- All Project Personnel will be provided with induction training that will include communication of the Code of Conduct, associated disciplinary procedures, and awareness raising on cultural sensitivities relevant to worker activities in and interactions with local communities.
- Induction training will also include communication of the procedures in place to ensure appropriate management of grievances and the requirement for all personnel to report any grievance through the formal channel within 24 hours of receipt.
- Work teams will be accompanied by the CLO when interaction with communities is required.
- Implement mitigation measures for worker accommodation described in Section 10.7.6.2 Workers Management and Rights.
- eni will develop an Influx Management Plan and measures within the Stakeholder Management Plan including a Grievance Procedure to ensure proper management of aspects related to socio-cultural changes and potential for community tension or social unrest associated with the Project.
- eni will develop a Security Management Plan containing measures to protect the project facilities and personnel against potential violent protest or social unrest and to train Security personnel in safeguarding of community human rights.
-

Conclusion

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on socio-cultural changes associated with the construction phase are summarized in Table G101.

Table G101 Residual Impacts on Socio-cultural Impacts

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Socio-Cultural Change – Construction Phase					

Impacts	*Duration*	*Extent*	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	*Impact Rank*
Socio-Cultural Change – Construction Phase					
Changes to cultural and Social Norms	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, able to poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	3	1	
Increased anti-social behaviour	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, able to poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	3	1	
Tension and Conflict between Villages	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, able to poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	3	1	
Social unrest resulting in violence towards the Project, Communities or Migrants	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/sensitivity of receptors or resources, able to poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	2	1	3	1	

G.7.3.4 Operation Phase

Impact Identification and Assessment

Changes to Cultural and Social Norms

Following the initial construction phase, the pace at which cultural and social values are likely to change will be less dramatic; people will have adapted to some degree to the presence of the Project and associated migrants to the area. However, this does not imply that the changes will immediately stop or reverse, but rather that coping mechanisms amongst the less vulnerable groups at least, will have been engaged. Over time, this change will cease to be felt as an impact, as adapted value systems and new sense of community identity will become the 'norm'.

Throughout the project lifetime, culture, social values and traditional structures will continue to change as the population grows (though in-migration of job-seekers and potentially tourists, and the changes brought about through the more widespread introduction of wage labour), becomes more educated and there is increased exposure to different cultures and world views.

Increased Anti-social Behaviour

The Project workforce will be significantly smaller during the operation phase, which will reduced the risk of anti-social behaviours associated with to the workforce. There is the possibility that some in-migrants will remain in the area, even when their contracts with the Project have finished. This was a trend already noted during engagements following the end of the Ghana Gas Project construction period. If there is no further employment for such people, they may resort to petty crime.

Tension and Conflict between Communities

The relatively limited unskilled or low skilled employment opportunities during the operation phase mean that competition for to secure those jobs will be high. This will be compounded by the adjustment to having no regular salary again, for those who did gain employment during construction of the ORF and by the ongoing perceptions that the villages closest to the ORF have and are still benefitting more than those further away. The effects can mean that tension and potential conflict between villages can remains an ongoing issue although less acute than during construction. This could in turn have an impact on relations between the Project and those villages that feel excluded from the Project benefits.

Social Unrest resulting in violence towards the Project, Communities or Migrants

Tension and competition over limited jobs or economic opportunities, perceived preferential treatment will continue to exist into the operational phase of the Project. Job opportunities will be even fewer during operation and the tangible effects and realities of Project's social investment strategy will start to be felt in local communities, both of these effects can increase the potential for unmet expectations. The potential for these tensions to manifest in social unrest or violent protest towards the Project or migrants/communities will remain throughout the operation phase of the Project.

<u>Mitigation Measures</u>

The mitigation measures defined for the construction phase will continue to be implemented during the operation phase.

<u>Conclusion</u>

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on socio-cultural changes associated with the construction phase are summarized in Table G102.

Table G102 Residual Impacts on Socio-cultural Impacts

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Socio-Cultural Change – Operation Phase					
Changes to cultural and Social Norms	Over 10 years / Irreversible	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	
Increased anti-social behaviour	Over 10 years / Irreversible	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	
Tension and Conflict between Villages	Over 10 years / Irreversible	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	
Social unrest resulting in violence towards the Project, Communities or Migrants	Over 10 years / Irreversible	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	

G.7.3.5 Decommissioning Phase

Impact Identification and Assessment

At the end of Project lifespan (after 20 years), all Project infrastructure will be decommissioned. While much of the offshore infrastructure (with the exception of the FPSO) will be left in-situ, the onshore facilities will be removed as far as possible. The decommissioning impacts will be similar to that of the construction phase and will be completed in two years.

Mitigation Measures

Mitigation measures are expected to be similar to construction, with the benefit of being improved based on lessons learned during construction. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life.

Conclusions

The residual impacts are likely to be similar to construction, with the benefit of improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

G.7.4 Cultural heritage resources

G.7.4.1 Overview

This Section identifies potential Project impacts on onshore archaeological and cultural heritage resources. Cultural heritage sites are those that represent a record of past or prsent human activity and which are finite, irreplaceable and non-renewable.

Box G16 shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated with the impacts of the Project on cultural heritage resources.

Box G16 Key Sources of Impacts and Risks, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Construction of the ORF and associated infrastructure in the Acquisition Area;
- Construction along the Gas Export Pipeline and GNGC pipeline routes; and
- The presence of an industrial Project in a rural setting.

Potentially Impacted Resources and Receptors

- Users of sacred sites and cemeteries; and
- Local communities closest to the ORF, namely Sanzule, Bakanta, Krisan and Eikwe.

Baseline Influencing Factors

- There is a cemetery located within 10 m of the acquisition area.

Project Influencing Factors

- The footprint of the land acquisition area has been revised so as to avoid the cemetery.

Table G103 presents the key impacts of the Project on cultural heritage resources during the key Project phases.

Table G103 Key Potential Impacts and Risks – Cultural Heritage Resources

Pre-construction and construction	Operation	Decommissioning
• Disturbance or destruction of cultural heritage resources.	• Change in sense of place for local communities.	• Disturbance or destruction of cultural heritage resources.

The *sensitivity* of cultural heritage resources is reported in the following Sections. The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

Residual impacts are presented taking into account the application of the identified mitigation measures. Were possible a quantitative matrix has been applied to measure the Residual Impacts of the Project.

G.7.4.2 Cultural Heritage Resources Sensitivity

Communal and religious cemeteries as well as shrines are found in across the DAoI. Often shrines are associated with natural features important in traditional religion such as groves and water bodies. A Royal Cemetery is located in the concession area for the ORF. This is the burial ground of paramount chiefs of the area and is approximately one acre in size. The site is characterized by heavy undergrowth, shrubs, and twines such as seregna, fuba, aloebo teke, and a handful of coconut trees. No felling of trees is allowed within the confines of the cemetery.

There may be other sites of cultural heritage significance such as shrines within the DAoI that have not been identified at this stage. Such sites may be damaged or disturbed by the Project, particularly during site clearing activities.

In terms of cultural heritage sense of place, the Project will be located in rural setting and an industrial project of this kind will alter the sense of place for local residents who may value the rural characteristics, peace and tranquillity of the area or attach religious or cultural significance to aspects of the natural environment.

G.7.4.3 Construction Phase

Impact Identification and Assessment

Heritage Resources

During the construction phase, site clearance activities within the ORF and along pipeline routes will include vegetation clearing and site levelling, which could disturb or destroy cultural heritage resources such as cemeteries, shrines and buried artefacts. The Royal Cemetery is located within 10 m of the concession area, and approximately 400 m from any planned aboveground Project infrastructure. However, based on the proposed Project description, the onshore pipeline will be burried approximately 50 m from the cemetary and precaution will need to be taken to ensure that this is not disturbed by the installation of the pipeline. The onshore gas export pipeline will pass nearby to the cemetery but will avoid disturbance or any requirement to physically relocate graves or headstones.

There is a deity within close proximity to the land acquisition area. The deity reported to be owned by a woman who resides at Sanzule. The name of the deity is 'Nana Twima' literary meaning More Harvest, and it is in two separate forms and located in two areas quite closed to each other. One has a shed covering it whilst the other is uncovered (Delin 2014). The precise location of the diety is not confirmed at this stage, and will be confirmed during supplementery surveys.

Sense of Place

Construction activities will increase ambient air, noise and light pollution as well as traffic along local roads and will impact visually on the predominantly rural setting of the area. Furthermore, the number of people living in the villages around the Project will increase in a period of time as a result of contract workers and the influx of other newcomers to the area settling close to the Project. For who are used to and enjoy the rural and undeveloped natural environment, the change will be dramatic and potentially difficult to adjust to. For residents less likely to benefit from the Project (e.g. the elderly, the sick, those unable to secure employment etc), this dramatic change in sense of place could be accompanied by a sense of loss of their pre-Project lifestyle and to the "way things were".

<u>Mitigation</u>

Following are potential mitigation measures to manage impacts associated with a changed sense of place:

Cultural Heritage Resources

- eni will develop and implement a Cultural Heritage Management Plan.
- eni will adopt a participatory approach with communities directly impacted by Project activities to agree how archaeological and cultural heritage sites will be identified and protected.
- eni will fence off the Royal cemetery and the deity (if required) during construction activities to prevent accidental damage to the cemetery. Local people will be allowed to access the cemetery. The fencing can be removed during operations.
- eni will develop a Chance Finds Procedure to define the processes aligned with relevant national laws and regulations, local customs and traditional norms that must be followed to ensure appropriate treatment of a chance find, and to minimise disruption to construction activities, including:
  - developing training and awareness material to educate Project staff and contractors in the identification of archaeological material; and
  - developing procedures for contractors to report chance finds to the Project.

Sense of Place

- Loss of sense of place will be mitigated to the extent possible by minimising Project land take and footprint for construction, to avoid disturbance to and loss of cultural and natural resources of value to the affected communities.
- Cultural Sensitivity Training for Project workforce will be implemented during induction in order to increase worker awareness of local community sensitivity to changes to their natural and cultural environment. This along with the Project od Conduct will enforce respectful and considerate behaviours in the DAoI, including when operating machinery and vehicles, managing noise levels and anti-social behaviours, littering, and defacement or misuse of natural areas and resources which may have cultural or religious significance such as trees, water bodies, and beaches.
- Implement the Workforce Code of conduct
- Implement all mitigation measure defined in Section 10.4.3 Noise, Vibrations and Emissions.

Conclusions

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on cultural heritage resources associated with the construction phase are summarized in Table G104.

Table G104 Residual Impacts on Cultural Heritage during Construction Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Economy and Employment – Construction Phase					
Cultural Heritage Resources	Between 1 and 5 years 2	Local scale: the proposed operating site and its immediate environs 1	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions 2	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats 1	**6 Low**
Sense of Place	Between 1 and 5 years 2	Local scale: the proposed operating site and its immediate environs 1	High value/sensitivity of receptors or resources, able to poorly able to adapt to changes with strong interventions 3	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats 1	**7 Medium**

G.7.4.4 Operation Phase

Impact Identification and Assessment

Heritage Resources

During the operation phase, the ORF footprint and pipeline ROWs will have been cleared and excavated, and the ORF constructed on the site. Any artefacts of cultural or heritage significance uncovered during these activities would be removed from the site or protected. Onshore operations are not likely to have any further impact on cultural heritage resources, provided care and respect is given to resources identified and fenced off during the construction phase.

Sense of Place

The number of Project workers in the DAoI will decrease by over 500 people during operations, and some in-migrants who came to the area in search of employment may leave to continue to search for employment elsewhere. As a result disturbance to the natural environment and sense of place in the DAoI may lessen.

The biggest change during the operation phase will be the presence of the ORF and the visual effect of the facility lighting at night. This is likely to have an impact on the sense of place in the area, given its currently rural setting.

As with the construction phase, for who are used to and enjoy the rural and undeveloped natural environment, the change will remain dramatic and potentially difficult to adjust to. For residents less likely to benefit from the Project (e.g. the elderly, the sick, those unable to secure employment etc), this dramatic change in sense of place could be accompanied by a sense of loss of their pre-Project lifestyle and to the “way things were”.

Mitigation

Cultural Heritage Resources

- eni will ensure that people continue to have access to the cemetery located in the acquisition area.

Sense of Place

- eni will implement all mitigation measures defined in Sections G.4.3related to Noise, Vibrations and Emissions.
- eni will minimise the use of outdoor lighting on the ORF and associated infrastructure.
- eni will continue to train its operations workforce to uphold the code of conduct and respect the cultural and natural environment.

Conclusion

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on cultural heritage resources associated with the operation phase are summarized in Table G105.

Table G105 Residual Impacts on Cultural Heritage during Operation Phase

Impacts	***Duration***	***Extent***	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Economy and Employment – Construction Phase					
Cultural Heritage Resources	Over 10 years / Irreversible	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 number of individuals, communities or administrative and/or higher no. of species and habitats	**7 Medium**
Score	4	1	1	1	
Sense of Place	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**8 Medium**
Score	4	1	2	1	

G.7.4.5 Decommissioning Phase

Impact Identification and Assessment

Similar to construction, some decommissioning activities will require site clearance and excavation activities which could disturb or destroy cultural heritage resources such as cemeteries of shrines. Any cultural heritage resources in the land acquisition area would have been identified and fenced off by this stage of the Project, decreasing the likelihood of damage to resources. New shrines or graves may have been established near the optional pipeline from ORF to GNGC CPF in Atuabo, and this ROW would need to be surveyed prior to any decommissioning activity to prevent damage to cultural heritage resources.

Sense of Place

Decommissioning activities will increase ambient air, noise and light pollution as well as traffic along local roads. This change will be temporary in nature, and following the decommissioning of the ORF, the visual impacts associated with a change in sense of place.will cease to exist.

Mitigation

eni will implement the mitigation measures undertaken during the construction phase.

Conclusion

The residual impacts are likely to be similar to construction, with the benefit of improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

G.7.5 Social infrastructure and Public Services

G.7.5.1 Overview

This section presents the potential impacts on existing social infrastructure and public services as a result of Project related activities and Project-induced in-migration.

Box G17 shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated with the impacts of the Project on social infrastructure and public services.

Box G17 Key Sources of Impact and Risks, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Worker camp in the acquisition area for the ORF approximately 600 workers involved in the onshore works;
- Establishment of temporary construction sites (pipe yards, lay down areas) along the Gas Export Pipeline route;
- Existing local business investment in new services (*e.g.* restaurants, hotels); and
- Increased vehicle movement from Project associated activities

Potentially Impacted Resources and Receptors

- Road users in the DAoI and along transport routes;
- Emergency services and hospitals;
- Education facilities;
- Local accommodation facilities;
- Utilities such as water, sanitation, electricity.

Baseline Influencing Factors

- Poor social infrastructure and services in the DAoI, with no formal waste management system and inadequate sanitation facilities.
- Limited health facilities (one hospital in Eikwe services the DAoI and the broader Ellembelle District).
- Road conditions are poor and there is very limited public transport.

Vulnerable Groups

- The elderly have limited access to health facilities as there is no transport available to access the hospital;
- Low-income households have fewer resources to rely on and have limited options in terms of health care and education.

Project Influencing Factors

- Worker accommodation will be self-sufficient and will not rely on local sources of electricity, waste disposal, sanitation, and health facilities.

Table G106 presents the key impacts of the Project on infrastructure and public services during the key Project phases.

Table G106 Key Potential Impacts and Risks – Infrastructure and Public Services

Pre-construction and construction	Operation	Decommissioning
• Pressures on local infrastructure and public services (*e.g.* electricity, waste sanitation)	• Pressures on local infrastructure and public services (*e.g.* electricity, waste sanitation)	• Pressures on local utilities and public services (*e.g.* electricity, waste sanitation).
• Pressure on road infrastructure.		• Pressure on road infrastructure.
• Pressure on health infrastructure	• Pressure on health infrastructure	
• Disruption to marine traffic	• Disruption to marine traffic	• Disruption to marine traffic

The *sensitivity* of social infrastructure and public services in the area is described in the following Sections. The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

Residual impacts are presented taking into account the application of the identified mitigation measures. Were possible a quantitative matrix has been applied to measure the Residual Impacts of the Project.

G.7.5.2 Social Infrastructure and Sensitivity

The Project and associated DAoI are located in a largely rural setting, characterised by small fishing settlements along the coast line. In Ghana settlements are described according to population size and they are graded by the services available. Settlements with populations of under 5000 people are classified as villages in Ghana. By virtue of population numbers, the five communities in the DAoI are classified as villages.

The provision of services and related infrastructure in the DAoI is limited, and the roads are in poor condition. The development of the Project will prompt an increase in pressure on already limited resources. The increased pressure will arise through both direct Project activities and as a result of expected in-migration of people to the DAoI.

The DAoI is not serviced by regular and reliable public transport (only a small number of taxis). Waste is not collected by a removal service, rather each village has designated, informal, unfenced sites for dumping refuse located mostly on the edge of settlements and often close to residential structures. Water is typically sourced from boreholes with hand pumps (many of which are not functioning) and access to adequate improved sanitation [5] in the DAoI is limited.

The health care system in the DAoI is also limited both in terms of capacity and availability of resources (personnel, medicine and equipment). The main hospital in the Study Area is St Martinde Porres Hospital in Eikwe. The hospital has 200 beds and although it is primarily an obstetrics and gynaecology hospital it also provides general outpatients services, general surgery and HIV testing and counselling. The hospital serves an area that extends beyond Ellembelle District, covering a population of over 100,000. Additional health resources are available to the community but are limited. Any new activities which increase demand on health care facilities are likely to have a negative impact on the community.

While all five of the communities in the DAoI have primary schools, there are limited junior high schools, and no senior high schools. There are two vocational institutes and a Information Communication Technology (ICT) centre. The schools are all almost all in a poor state of repair and lacking in vital equipment such as furniture and teaching materials, despite large class sizes, meaning they are often inadequate to meet the needs of the population.

The communities in the DAoI are connected to the national grid, however, the power supply is not stable or consistent and majority of households use wood or and charcoal for cooking.

The Port of Takoradi is closest port to the Project. It receives high traffic volumes and in 2012 handled 31 percent of national sea-borne traffic. The Gulf of Guinea experiences high maritime traffic and has established shipping lanes.

(5) Improved sanitation refers to the provision of facilities and services for the safe disposal of human urine and faeces (WHO, 2015).

G.7.5.3 Construction Phase

Impact Identification and Assessment

Social Infrastructure

The Project will increase the population in the DAoI during construction, largely through introduction of a migrant workforce but also through other economic in-migrants settling in the area with the intention of securing employment with the Project or seeking other economic opportunities. This has the potential increase demand on services and existing infrastructure in the DAoI. An estimated 600 construction workers will be accommodated in a camp located in the land acquisition area, (this does not account for family members or dependants who might also relocate to the area with the employee). The worker camp will be largely self-sufficient in terms of utilities and electricity, water, waste management will be provided for by eni within the footprint of the ORF. However, no housing or services provision can be made by the Project for economic in-migrants and the villages that are located closest the ORF acquisition area, such as Sanzule, Krisan and Eikwe, are likely to feel pressure on accommodation facilities and other services, as this influx of people will try to settle near the Project site.

The new population will increase demands on housing, water, power, sanitation and waste facilities, as well as on education facilities, and telecommunications, placing strain on the already limited services currently available to residents. Some of these needs will be immediate (like health and education), while others (like banking) will emerge more gradually as people enter the cash economy or participate at a greater level than at present.

As the population increases and more cash and material wealth emerges in the area from an increasing presence of salaried workers, the likelihood for increased anti-social behaviours such as petty crime and prostitution will also increase and this will create stress on public protective services. Currently there is little or no police presence in the DAoI, reportedly very low levels of crime, drug and alcohol abuse and social order is maintained largely via traditional authority mechanisms and disputes resolved through the Chief and his council. The effects of the presence of Project workforce and a growing in-migrant population will therefore create a need for more substantial and formal policing and judicial infrastructure than that currently in place.

It will not be possible for existing infrastructure and services to cater for the increased demands. The social, environmental and health risks that arise from a failure to adequately provide for the needs of a larger population will have consequences for the Project, the existing communities, as well as for the in-migrants and for government service providers. This impact will be compounded if oil and gas and other industrial developments proposed in the Ellembelle District and Western Region more broadly are implemented. This is discussed further in the Cumulative Impacts Section G.10. Coordinated planning by government in collaboration with Project developers looking to identify opportunities for Strategic Social Investment in the area will be required to address this increased pressure. This will require, however, that the government commit suitable budgets and human resource capacity is in place to achieve a collaborative planning approach.

Road Infrastructure

The construction phase will require large amounts of material and equipment to be transported to Ghana, and between the various onshore and offshore locations. Goods required for the onshore component will arrive at the Port of Takoradi, and be transported to the logistics base in Takoradi, and then to the ORF land acquisition area as needed. Project vehicles will use local roads to transport personnel, heavy equipment and materials. The national road from Takoradi to the acquisition area is in poor condition suffering from severe erosion and narrowing in places and frequent collisions and road accidents were observed during the survey activity, particularly overturned trucks and haul transport. Traffic volume is already high and additional vehicle movements along these roads will contribute to the further degradation on the road.

At the peak of construction, much of the traffic will be restricted to the "Working Strip" along the onshore pipeline routes, however, it is estimated that up to 50 vehicle movements per day could occur on public roads between the Project Site and Takoradi.

Health Facilities

The presence of a national and expatriate workforce is likely to lead to increased pressure on the existing health care facilities in the DAoI and broader area. Despite the fact that the worker camp will have its own medical facility, increase in demand will arise if there is increased transmission of diseases, increased accidents and increased numbers of people accessing care for routine services. Considering the already limited health care capacity this increase in demand may further limit access to facilities and result in longer waiting times or patients not attended to and worsening health outcomes, such as uncontained spread of diseases/infection. This is a particular risk in the case of incidents involving multiple casualties or patients from both the workforce and community where hospital level care is required, or in the case of a disease epidemic. Of particular concern is the stretch on resources to deal with communicable diseases and sexually transmitted infections such as HIV/AIDS, and acute respiratory diseases like TB. The use of traditional medicine, which is also frequently used, may increase if access to public health services is restricted. This situation will be exacerbated by the increased presence of migrant workers and job seekers attracted by the oil and gas developments in the area (see section G.10on Cumulative Impacts).

Marine Infrastructure and Traffic

The Project activities will lead to an increase in vessel traffic on local offshore routes connecting the Project and the Takoradi Port, as described below:

- Traffic increase related to the pipelaying activities;
- Traffic increase related to supply vessels servicing the pipelaying barge and drilling rig with diesel, material, pipe, crew on site, and other necessities); and
- Traffic increase due to construction waste handling and waste water transportation.

Drilling material will arrive from abroad and be transferred to the Takoradi logistic base, when needed, it will be sent offshore using three supply vessels.

During the construction phase, there will be safety and security exclusion zones around Project vessels undertaking drilling and subsea infrastructure placement. Maritime traffic in the Offshore Project Footprint Area will continue, but will need to avoid these exclusion zones.

These increased vessel movements will result in an increased potential for interactions and possibly collisions with artisanal and commercial fishing vessels in the local offshore environment.

Mitigation Measures

Social Infrastructure and Services

Eni will build and operate Project support infrastructure, such as access roads, accommodation camps, and sewage systems and waste treatment facilities. In this way, eni will limit the pressure that the Project places on public infrastructure and services. eni is still investigating potential water sources at this stage, and will develop a Water Management Plan to ensure that the preferred source of water does not have a negative impact on the communities in the DAoI. All facilities and infrastructure specifically built for the project could be left in place after a mutual agreement with the authorities. It would then be handed over to local authorities/communities following a dedicated HSE assessment of the risks and potential impacts associated. As part of the handover a MoU would be signed and all responsibilities regarding maintainence will be transferred to receiving entity.

Additional mitigation measures are described below.

- In coordination with the Recruitment, Employment and Training Plan and Procurement plan, work with government and District Assemblies on regional scale, to manage expectations and detract work-seeking migration to the Project area through the communication of Project labour needs and clear Project policies and procedures for recruitment.

- Formalise and centralise local recruitment procedures through the CLO and the local traditional authorities (Chiefs) and publicise procedures in the immediately surrounding communities in order to manage local expectations and deter casual enquiries for employment at the site.

- Support government initiatives that address local capacity to meet increased pressure on schools in the area. An adequately educated population is of mutual benefit to the Project as it will facilitate local employment in the longer-term and foster a healthy social and economic environment in which the Project will operate.

- Support to strengthen public protective services through briefing and training private security personnel to cooperate with local police services in the DAoI through observation during patrols and reporting of misdemeanours or stakeholder interactions which indicate risk of community/social unrest.

- Promote the implementation of joint planning approaches with government and other key stakeholders for strategically important housing projects that will accommodate the influx jobseekers.

- Implement the Project Waste Management Plan (Annex F).

- Eni will develop and implement a Social and Environmental Investment Plan, which will include a community education/awareness campaign around responsible and safe disposal of waste, given the very poor levels of education in the communities in the DAoI around safe waste disposal and associated pests and disease. Synergies and coordination between these initiatives and the Project's broader Community Health and Safety awareness (See section G.7.7, health impact mitigations) activities will be maximised.

Photographically document the baseline and monitor population density and settlement changes at the boundary of the Project site, in the land acquisition area and in surrounding communities to record any influx. Regularly engage with local government to alert them to possible influx hotspots, where pressure on infrastructure and services may be becoming critical.

Road Infrastructure

- eni will develop and implement a Traffic Management Plan.

- Implement all mitigation measured defined in Section G.7.7regarding road traffic accidents.

Increased Pressure on Health Care Resources

The following mitigation measures will be implemented to minimise potential impacts on health infrastructure:

- eni will ensure that a capacity and needs assessment of equipment and personnel of hospitals in the project area is undertaken to determine if facilities have sufficient capacity to deal with health needs of workforce including contractors and subcontractors. Should it be determine that the hospital in Eikwe does not have the capacity to cope with the needs of the Project workforce, eni will develop a plan to support the hospital so that they are able to do so.

- eni will develop Emergency Response Plans (ERPs) for the Project taking into account access to health care, major incidences, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident.

- Workers will be provided with primary health care and basic first aid at construction camps / worksites. This will be done in line with the IFC/ EBRD guidelines on worker accommodation[1].

Marine Traffic and Infrastructure

(1) [1] IFC/ EBRD guidelines on worker accommodation August 2009

A Marine Traffic Transportation Plan will be developed for the Project to ensure appropriate protocol is followed during offshore vessel movements. This Plan will consider vessel movements associated with other oil and gas projects in the area, and commercial shipping traffic.

The following mitigation measures will be implemented:

- The vessels involved in dredging and other construction-related activities must be equipped with navigation equipment and suitable aids (such as buoys and lights) to minimise interference with other vessels and to maintain high visibility at all times.
- The Project will engage with the Maritime Authority and provide relevant information to maintain awareness of the Project and commercial fishing activities among relevant stakeholders.
- The Project will ensure that all its service and construction vessels are equipped with functional radar equipment, and that the radar system is continuously monitored.
- Where possible, safety exclusion zones shall be clearly noted and/or monitored, to enable vessels to be aware when they are close to the safety zones, and appropriate pilot vessels, coastguards and maritime support agreed between the Project and Maritime Authorities.
- eni will develop and implement a Security Management Plan

<u>Conclusion</u>

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on social infrastructure and marine traffic associated with the construction phase are summarized in Table G107.

Table G107 Residual Impacts on Infrastructure and Public Services during the Construction Phase

Impact	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Infrastructure and public services – Construction Phase					
Social Infrastructure	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	1	3	2	

Impact	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	*Impact Rank*
Road Infrastructure	Between 1 and 5 years	Regional scale: as determined by country's administrative boundaries	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	2	2	3	2	
Health Infrastructure	Between 1 and 5 years	Regional scale: as determined by country's administrative boundaries	High value/ sensitivity of receptors or resources, poorly able to adapt to changes with strong interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	2	2	3	2	
Marine Traffic and Infrastructure	Between 1 and 5 years	International Scale	Low value/ sensitivity of receptors or resources, able to recover or adapt to the change without interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**9-Medium**
Score	2	4	1	2	

G.7.5.4 Operation Phase

During operation phase the onshore workforce will be one tenth of the size of the construction workforce. The workforce will be accommodated in Sanzule, in a self-sufficient worker camp. Vehicle and offshore vessel traffic will also decrease during this phase.

Impact Identification and Assessment

Roads

During operations, vehicle movements will be limited to the movement of workers and goods/supplies being transported into and out of the accommodation camp, and on-site community liaison staff in and around the communities in the DAoI as well as routine inspections and maintenance of the onshore pipelines. Vehicle movements on the national road between the site and Takoradi will be significantly reduced and will consist mostly of movements of eni and contractor personnel with little or very infrequent movement of supplies, heavy equipment and materials. Impacts of increased pressure on the national and local road network and degrading of road surfaces will therefore be minimal during this phase.

Social Infrastructure and Services

The ORF ancillary facilities including worker accommodation will be largely self-sufficient during operation and place minimal strain on the existing social infrastructure and services. The influx of jobseekers into the area should also slow down or cease entirely during the operation phase given the limited employment opportunities, meaning those migrants who were not able to secure employment on the Project may return to their place of origin. The demand for social infrastructure and services will stabilise as in-migration into the area levels off.

Health facilities

The impact on health facilities will similarly be reduced during the operation phase as the influx of jobseekers into the area slows down and people return to their place of origin. The operations workforce will have access to health care through the onsite medical facilities.

<u>Marine Traffic</u>

During operations, vessel movement will be associated with the supply of the FPSO and Crew shift transportation. Routine maintenance and surveillance of the flowlines and gas export pipeline will generate vessel movement. Exclusion zones will be in place around fixed-position vessels (i.e the FPSO and drilling units), which will reduce the risk of collisions with other vessels.

Support vessel movement is not likely to interfere with international marine shipping, and over time, local sea users will become accustomed the routine movements of the Project vessels reducing the likelihood of vessel collisions and interactions.

<u>Mitigation Measures</u>

The mitigation measures defined in the construction phase will continue to be implemented during the operation phase.

<u>Conclusions</u>

Considering the mitigation measures described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on social infrastructure and marine traffic associated with the operation phase are summarized in Table G108.

Table G108 Residual Impacts on Infrastructure and Public Services during Operation Phase

Impact	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	***Impact Rank***
Infrastructure and public services – Operation Phase					
Social Infrastructure	Over 10 years / Irreversible	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 individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Road Infrastructure	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	4	1	2	1	
Health Infrastructure	Over 10 years / Irreversible	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 individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Marine Traffic and Infrastructure	Over 10 years / Irreversible	Regional scale: as determined by country's administrative boundaries	Low value/ sensitivity of receptors or resources, able to recover or adapt to the change without interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	4	2	1	1	

G.7.5.5 Decommissioning Phase

Impacts Identification and Assessment

At the end of Project lifespan (after 20 years), all Project infrastructure will be decommissioned. While much of the offshore infrastructure (with the exception of the FPSO) will be left in-situ, the onshore facilities will be removed as far as possible. The decommissioning impacts will be similar to that of the construction phase and will be completed in two years.

Mitigation Measures

Mitigation measures are expected to be similar to construction, with the benefit of being improved based on lessons learned during construction. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life.

Conclusions

The residual impacts are likely to be similar to construction, with the benefit of improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, the impacts have not been rated at this stage.

G.7.6 Workers management and rights, and workers health and safety

G.7.6.1 Overview

Workers' rights including occupational health and safety need to be considered to avoid accidents and injuries, loss of man-hours, labour abuses and to ensure fair treatment, remuneration and working and living conditions. These issues will be considered not only for workers who are directly employed by eni but also contractors (including sub-contractors) and workers within the supply chain. The main risks in relation to worker's management and rights are associated with the use of contractors and subcontractors.

During construction approximately 1300 personnel will be required, of which approximately 700 will be involved in the offshore component and approximately 600 for the onshore component. The project will be supervised and managed by 38 eni personnel (28 offshore and 10 onshore). It is estimated that just under half of the employment requirements will be filled by Ghanaian Nationals, with approximately 20 percent of employment opportunities being will be available to people from the DAoI (and EAoI). The highly skilled positions associated with the offshore works will be filled by people from elsewhere in Ghana, and internationally.

During construction between 400-600 eni and contractor workers engaged in the construction of the ORF and related infrastructures will be lodged in the temporary accommodation camp located near to the ORF while the workers engaged in the offshore component of the Project will be lodged in the FSPO.

During operations permanent employees on the FSPO will be about 65 people (8 locals, 49 expatriates and 8 eni expatriates). For the ORF, 45 people will be employed (80% locals and 20% expatriates). During operations, ORF workers will be lodged in a permanent camp and FSPO workers in the FSPO itself.

The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on worker management and rights.

Box G18 Key Sources of Impact, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Use of contractors and subcontractors. During construction approximately 1,300 workers will be employed by the project (700 onshore and 600 offshore). These numbers will be substantially lower during the operation. An estimated 110 workers will be directly employed by the project (45 onshore and 65 offshore).
- During decommissioning, worker numbers will approximate that of construction.

Potentially Impacted Resources and Receptors

- Workers directly engaged by the Project both from Ghana and overseas.
- Workers engaged through third parties from Ghana or overseas (contracted and sub-contracted workers).
- Workers engaged by primary suppliers of goods and services for the Project.

Baseline Conditions that are Potentially Influencing Impacts/Risks

- National Labour Laws and health and safety legislation in Ghana exist and are in line with international standards, including ILO, providing a framework for the protection of worker management and rights.
- The Ghana labour market is characterised by the dominance of the agricultural sector where economic activity is mostly organised on an informal basis. The informal sector where the majority of the workforce is self-employed is extensive, partly due to slow growth in employment in the formal sector.
- The formal sector of the labour market has high rates of unionisation particularly in the public sector that is the main source of formal employment in Ghana.
- For those employed in the formal sector, accounting for only 10 percent of the total workforce, collective agreements are common and define the conditions of employment including mandatory minimum wages and salaries, regulate cooperation, define rights and obligations of the contracting parties.
- In Ghana, 10.9% of children (ages 5-14) participate in the labour force and do not attend school. Approximately 70 percent of working children are employed in the agricultural sector (including fishing which is a likely contributor to why more children in rural areas are engaged in child labour, in comparison to urban areas. Some children in the area of influence only attend school three or four days a week, as they are fishing or assisting with the processing and selling of fish, or they are involved in agricultural activities. Critical sectors of Ghana's economy, such as the mining, agricultural and fishing sectors use the worst forms of child labour.
- The use of forced labour is illegal in Ghana but it is known to be occurring in many sectors of the economy yet this issue gains little attention. Equally, domestic human trafficking and slavery, which are prevalent in Ghana, have been given insufficient attention and resources[6].

Vulnerable Groups

- Children from poor families engaged in agricultural work.
- Migrant workers
- Women.

Project Influencing Factors

- Type and management of construction areas;
- Management of open camps;
- Non-resident workforce management;
- Security arrangements for onshore and offshore facilities; and
- Consultation with local communities.

(1) [6] Report of the Special Rapporteur on contemporary forms of slavery, including its causes and consequences, Gulnara Shahinian (UN Human Rights Council, August 2014)

The following table presents the key impacts of the Project on worker management and rights during key Project phases.

Table G109 Key Potential Impacts and Risks – Worker Management and Rights

Construction Phase	Operations Phase	Decommissioning Phase
• Worker Health and Safety	• Worker Health and Safety	• Worker Health and Safety
• Worker Rights	• Worker Rights	• Worker Rights
• Forced and child Labour		• Forced and child Labour

The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

G.7.6.2 Construction Phase

Impacts Identification and Assessment

Worker Health and Safety

Due to the nature of the activities being undertaken during construction, worker health and safety is a key risk with the potential for accidents that may result in injuries and fatalities as well as lost man-hours. Within Ghana, companies do not always meet national and international standards around worker health and safety. As such, many national companies, which may be contracted by the Project or be primary suppliers, may not currently meet the international safety requirements and standards required by eni. Employees working informally and those with limited or without awareness of their rights (for example, migrant workers, or those newly entering the labor market) are likely to be most at risk of working in unsafe conditions.

Workers may also be at risk of acquiring communicable diseases, vector borne diseases in particular malaria and sexually transmitted infections due to the existing baseline health conditions of communities in the Project area and the potential for worker community interactions described in Section G.7.7. Should workers becomes infected with such diseases this will have a negative impact on their health as well as their ability to work.

The greatest safety risks are associated with workers involved in the use of heavy equipment during construction and waste disposal. Solid waste and waste water generated by construction activities will be managed and stored at construction sites and basecamps in such a way as to minimise exposure to workers. Those involved in the handling and management of waste will be provided with appropriate personal protective equipment (PPE) and training in handling of waste materials. As such potential impacts to workers health and safety will be minimal.

Worker Rights

The labour laws in Ghana are in line with international labour laws and Ghana has ratified the eight core ILO conventions:

- Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87).
- Right to Organise and Collective Bargaining Convention, 1949 (No. 98);
- Forced Labour Convention, 1930 (No. 29);
- Abolition of Forced Labour Convention, 1957 (No. 105);
- Minimum Age Convention, 1973 (No. 138);
- Worst Forms of Child Labour Convention, 1999 (No. 182);
- Equal Remuneration Convention, 1951 (No. 100);
- Discrimination (Employment and Occupation) Convention, 1958 (No. 111).

However, there are issues in Ghana related to implementation that remain unresolved. Enforcement of labour laws is hampered by a lack of capacity within companies as well as within the labour inspectorate and judiciary. Furthermore, due to the employment situation in Ghana there is evidence that workers are willing to sacrifice their rights in order to find and maintain employment. As such, there is a risk that contractors and suppliers will not be operating in line with national or international best practice if suitable measures to manage such risks are not enforced through the adherence to management plans to prevent labour abuse.

Retrenchment

Retrenchment of workers is likely to be required at various points, especially in the transition from construction to operation. Furthermore, the majority of construction workers will be employed by contractors on short-term contracts and are not eligible for remuneration following completion of these contracts.

Workers Accommodation

The Project will build temporary accommodation for the 600 workers during the onshore construction phase. Accommodation will be built, run and maintained to a high standard and in line with appropriate national laws. The offshore construction personnel will be accommodated at the FPSO. The camps will be designed in accordance with eni's standards (Chapter 4).

Forced Labour in the Supply Chain

Article 16 of the Constitution prohibits all forms of forced labour. Section 116 of the Labour Act, 2003 also prohibits all forms of forced or bonded labour. The use of forced labour is therefore illegal in Ghana but it is known to be occurring in many sectors of the economy. The government of Ghana has taken the important step of recognizing the existence of slavery, of adopting legislative frameworks, and putting in place a number of institutional mechanisms and programs, such as in the area of child labour, and human trafficking, and ratified a number of international agreements, including key human rights and ILO Conventions (see Chapter 3). To date the emphasis has been on addressing child labour, rather than the exploitation of adults and slavery. Domestic human trafficking and slavery, which are prevalent in Ghana, have also been given insufficient attention and resources. As such there is a risk that suppliers, in particular of food (crops and fish) and mining where the use of forced labor is common, may use forced labor if appropriate measures to manage such risks are not enforced.

Child Labour in the Supply Chain

Despite improvements in recent years, child labour, especially in its worst forms remains a major concern for the Government of Ghana**.** The Government of Ghana continues to develop policies and social programs to address child labour. The Government has recently adopted the National Plan of Action (NPA) for the Elimination of the Worst forms of Child Labour, which aims to eradicate such practices by 2015. However, these programs have reached only a small fraction of the vulnerable children. Children are also engaged in child labour on farms, in mines, and in fishing as well as markets. Significant gaps remain in the enforcement of child labour laws and remediation through social programs[7]**.**

For the reasons outlined above, there is the potential that nationally based suppliers (who may form part of the supply chain) could be using child labour in their operations or are employing under 18's to undertake hazardous activities. Again, this is a particular risk in companies where the use of informal and day workers is more prevalent. The use of child labour is likely to be hazardous and have negative impacts on the health and wellbeing (mental health) of affected children including access to education and social development as well as the child's right not to work in certain circumstances.

Mitigation

Mitigation measures associated with worker management and rights are presented below, measures proposed under worker health and safety will also mitigate impacts associated with workers rights and retrenchment as well as reducing the risk of the use of child and forced labour however, these measures have only been presented once.

Worker Health and Safety

- eni will develop a health and safety management system in line with applicable national laws and regulations. This management system will be enforced throughout the Project including all contractors and sub-contractors. It will include aspects such as worker codes of conduct, identification and provision of Personal Protective Equipment (PPE), training and monitoring as well as ongoing safety checks and safety audits. The management system will communicated to all Project employees.
- eni will, as part of its Environmental and Social Management System; undertake socioeconomic compliance monitoring to inform its internal auditing and monitoring process. As such, KPIs will be developed around worker rights, discrimination and management, workforce grievance mechanism and monitoring of outcomes.

(1) [7] http://www.refworld.org/pdfid/4d4a68026.pdf

- As part of the contractor and supplier selection process eni will take into consideration performance with regard to worker management, worker rights, health and safety as outlined in Ghanian law, international standards and eni's policies.
- eni will provide support to contractors and subcontractors to ensure that labour and working conditions are in line with Ghanian law through gap analysis and capacity building.
- Workers will be provided with primary health care and basic first aid at construction camps /worksites. This will be done in line with the IFC/ EBRD guidelines on worker accommodation
- Facilities and operations will be developed, planned and maintained such that robust barriers are in place to prevent accidents. All employees have the duty to stop any works if adequate systems to control risks are not in place.
- In line with the worker code of conduct employees should not be under the influence of intoxicants which could adversely affect the ability of that employee to perform the work or adversely affect the health and safety of other employees, other persons or the environment.
- Surveillance programs for health status of workers shall be established and implemented.

Workers' Rights, Retrenchment and Accommodation

- In all contractor contracts the Project will make explicit reference to the need to abide by Ghanian law, international standards and eni's policies in relation to health and safety, labour and welfare standards including child and forced labour and retrenchment. No eni employee or job applicant will be discriminated against on the basis of his or her gender, marital status, nationality, age, religion or sexual orientation.
- All workers will, as part of their induction, receive training on national legislation around worker rights and international standards to ensure that positive benefits around understanding labour rights are enhanced.
- All workers (including those of contractors and subcontractors) will have contracts which clearly state the terms and conditions of their employment (which will be in line with national legislation, international standards and eni policies) and their legal rights. Contracts will be verbally explained to all workers where this is necessary to ensure that workers understand their rights. Contracts for workers coming from outside Ghana must be in place prior to workers leaving their home location.
- eni will require all contractors and sub-contractors to put in place a worker grievance mechanism that will be accessible to all workers, whether permanent or temporary, directly or indirectly employed. The eni worker grievance mechanism shall be open to the contractor and subcontractor workforce in the event that their grievance is not adequately resolved by their direct employer. eni will then have the authority to act to resolve this grievance.
- eni will develop a Human Resources Policy which will outline worker rights to be included in all contracts including the right of workers to join a union of their choice, restrictions on working hours in line with Ghanian and international law, compensation including consideration of overtime, holidays etc. eni will require its contractors and subcontractors to put in place policies in line with national legislation.

- Camps will be designed, constructed and managed in line with the eni General Design Criteria for Accommodation (INFR-DG-791-10) and the standards outlined in the WB/ EBRD Guidelines on Worker Accommodation (August 2009).
- eni will establish the right to audit on site contractors to ensure they are abiding with national legal requirements, international standards, eni policies or clauses in the contract through all contracts and subcontracts. Failure to meet these standards will result in consequences up to and including termination of contract, to be decided on a case by case basis.
- eni will review and monitor the outcomes of community engagement, media coverage and its workforce and community grievance mechanism for additional indications of labour related issues including child and forced labour that may be arising.

Child and Forced Labour in the Supply Chain

In addition to the above mitigation measures:

- eni will require all contractors and subcontractors to comply with Ghanaian laws for legal age for work and work hours for school age children as well as provide proof of age.

Conclusions

According to the methodology defined in section G.2, the residual impacts on worker management and rights associated with the construction phase are summarized in Table G110.

Table G110 Residual Impacts on Worker Management and Rights during Construction Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Worker health and Safety	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty which might require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	
Workers' Rights, retrenchment and accommodation	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty which might	Affecting small no. of individuals, households, individual enterprises	**6-Low**

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
			require interventions	and/or small no. of species	
Score	2	1	2	1	
Forced Labour	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty which might require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	
Child Labour	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty which might require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**6-Low**
Score	2	1	2	1	

G.7.6.3 Operation and Maintenance Phase

Impacts Identification and Assessment

During the operation and maintenance phase some of the impacts from the construction phase will continue to be of concern to eni. There is the potential for impacts to occur related to worker health and safety and worker rights, worker accommodation and to a much lesser extent retrenchment and child and forced labour (in the supply chain). However, due to the small size of the operation workforce estimated at around 140 workers, including onshore and offshore, and different structure of the workforce mainly composed by skilled specialised labour, reduced contractor hierarchy and the activities being undertaken the likelihood of impacts occurring is reduced when compared with the construction phase. These impacts have been already analysed in Section G.7.6.2.

Mitigation

Worker Health and Safety

The mitigation measures defined for the construction phase will be continued throughout the operation phase with consideration in the health and safety management system of the specific risks associated with operation and maintenance activities and the new size and structure of the workforce. In this regards mitigation measures outlined in Section G.7.6.2 above are applicable to the operation.

Worker's Rights, Retrenchment and Accommodation

The mitigation measures defined for the construction phase with regards to addressing respect for worker's rights, retrenchment and accommodation standards will be continued throughout the operation phase with consideration in the worker management system of the specific risks associated with the operation and maintenance activities and the new size and structure of the workforce. In this regards mitigation measures outlined in Section G.7.6.2 above are applicable to the operation.

Conclusions

Considering the mitigation described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on worker management and rights associated with the construction phase are summarized in Table G111.

Table G111 Residual Impacts on Worker Management and Rights during Operation Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Worker health and Safety	Over 10 years*	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Workers' Rights and accommodation	Over 10 years*	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	

**Although the impact will last for over 10 years in fact it may be intermittent over that time period.*

G.7.6.4 Decommissioning Phase

Impacts Identification and Assessment

Potential impacts will need to be reassessed given the period of time that will pass before decommissioning activities are expected to take place. Decommissioning activities performed will apply to the ORF and the pipeline as well as the offshore facilities. Thus potential impacts during Project decommissioning are likely to be similar to impacts during construction but less significant than during the construction phase due to the smaller affected area.

Mitigation Measures

Mitigation measures are expected to be similar to construction, with the benefit of being improved based on lessons learned during construction. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life.

Conclusions

The residual impacts are likely to be similar to construction, with the benefit of being improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, residual impacts could be rated differently approaching the time period of Project decommissioning.

G.7.7 Community Health, Safety and Security

G.7.7.1 Overview

The presence of the Project could affect the health, safety and security of the communities in the area of influence as a result of worker-community interactions, in-migration to the area, increase in diposbale incomes that may be used for drugs, alcohol and prostitution (see Section G.7.3, the risk of injury associated with construction activities, increased pressure on health care resources and changes to the environment. Any community concerns or perceptions with regard to reduced health and physical safety and security by the community also need to be addressed.

There are numerous ways in which the development of the Project could impact on community and individual levels of health. The term "health" can be used broadly to include physical and mental health and well-being. However, in this section it refers mainly to physical health. The section also discusses impacts on the security of local communities.

Box G19 shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on community health and safety.

Box G19 Key Sources of Impacts and Risks, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Presence of Project national and international onshore workforce in the area of influence of approximately 600 people sourced nationally and internationally- who through interactions with communities may lead to increased disease transmission. The 700 offshore personnel will be transferred directly to and from Takoradi and will not spend time onshore in the direct area of influence but in Takoradi.
- The provision of health care for workforce (both primary and secondary) has the potential to affect access to health care for communities due to competition for resources (see Section G.7.5 on Infrastructure and Public Services).
- Community members could be involved in accidents leading to injuries if they enter areas where construction works are being undertaken;
- Changes to the environment due to increased noise, decreased air quality and changes to the visual environment.
- Increased number of heavy vehicles in the area and traffic might lead to a higher number of road accidents and injuries.
- Presence of economic migrants, leading to increased pressure on health care resources, changes to the environment and increased risk of transmission of communicable diseases.
- Increased vessel movements offshore.
- Presence of Project security.

Potentially Impacted Resources and Receptors

- Communities living in Eikwe, Krisan, Sanzule, Bakanta and Atuabo villages.
- Fishermen operating the area of the Project and close to the pipeline shore landing.
- Road users along transportation routes between settlements in the area of influence and Takoradi.
- Local health care facilities.
- Residents of Takoradi due to transit of workers

Baseline Influencing Factors

- Poor health status for some within the project area, in particular high rates of malaria, HIV/AIDS, anaemia and diarrhoeal diseases. Incidence of TB in the Project area. Limited health services and infrastructure. The main hospital in the district serves a population of 100,000 and has 200 beds. Local access to public health services is inadequate (long waiting lists, few and inadequate infrastructure and staff).
- Poor sanitation and waste disposal facilities.
- Local stakeholders highlighted that policing of the offshore pipeline ROW and FPSO exclusion zones from encroachment from other uses could result in conflictual interactions.

Vulnerable Groups

- Children elderly and disabled– these groups are traditionally more vulnerable to ill health and environmental and socio-economic changes.
- People with existing poor health conditions, for example those that currently suffer from diseases such as HIV/AIDS, TB or respiratory diseases.
- Youth, in particular young girls who are traditionally associated with higher levels of interactions with new comers and are more likely to incur in related higher risks (teenage pregnancy and prostitution, transmission of communicable diseases, including of STD).

Project Influencing Factors

- Type and management of construction and operation areas.
- Workforce management.
- Numbers and movement of Project vehicles and vessels.
- Management of in-migration.
- Security arrangements for onshore and offshore facilities; and
- Consultation with local communities.

The following table presents the key impacts of the project on human health during the key project phases.

Table G112 Key Potential Impacts and Risks – Community Health, Safety and Security

Construction Phase	Operations Phase	Decommissioning Phase
• Increased prevalence of sexually transmitted infections including HIV/AIDS. • Increased prevalence of communicable diseases due to worker-community interaction. • Increased prevalence of malaria due to worker- and population influx. interaction with environment (potential increase of mosquitoes breeding sites) • Traffic accidents from increased traffic and presence of heavy vehicles in local roads. • Increased pressure on health care resources* • Environmental changes due to nuisance and air emissions. • Site trespass and injury. • Use of security forces.	• Increased prevalence of sexually transmitted infections including HIV/AIDS. • Increased prevalence of communicable diseases due to worker-community interaction. • Increased prevalence of malaria due to worker- and population influx interaction With environment (potential increase of mosquitoes breeding sites) • Traffic accidents from increased traffic and presence of heavy vehicles in local roads. • Increased pressure on health care resources* • Environmental changes due to nuisance and air emissions. • Use of security forces.	Potential impacts are expected to be similar to construction phase also if less impact is foreseen due to the fact that works will be performed on a limited area (ORF and pipeline route).

(*) the impacts on health care resources are assessed in Section G.7.5.

The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

G.7.7.2 Construction Phase

Impacts Identification and Assessment

Increased Prevalence of Sexually Transmitted Infections including HIV/AIDS

The presence of an external workforce living in a setting where interaction with nearby communities in the DAoI is possible along with increased population in the area due to economic migrants could lead to the increased transmission of STIs including HIV/AIDS within the communities.

According to the 2013 HIV sentinel survey report in Ghana,the HIV/AIDS prevalence rate is 1.3 percent. The prevalence rate in the area of influence is not known but according to accounts provided by health care personnel it is believed to be much higher than the national rate. The reason for this discrepancy is not clear although the proximity to Ivory Coast which has a higher prevalence could explain the current situation. Evidence indicates that the influx of workforce in the area of influence and in Takoradi as well as the establishment of transportation routes to supply the Project can contribute to an increase in transmission and prevalence of STIs and HIV/AIDS. The Project is has the potential to impact on transmission of STIs due to:

- A mainly male workforce with disposable incomes may engage in high risk sexual activities with commercial sex workers both in the surrounding population centres and on transit routes to / from site;
- In-migration resulting in the mixing of people with higher STI prevalence rates than the communities in the area of influence;
- Transport drivers, who typically have higher rates of STIs than the general population, may engage in casual high risk sexual activity along the transport route and at their end destination; and
- Offshore workers transiting through Takoradi, although the risk is lower due to the socioeconomic context of Takoradi and the limited amount of time that workers will be onshore in Takoradi.

As reported by women in communities in the DAoI, vulnerability of the communities in the will certainly be exacerbated by the development of the Project and the related influx of people. Access to treatment for STIs is limited in the communities in the DAoI and increased transmission of STIs could also impact on the long-term health of those who suffer infections. Stigma and taboos around STIs may also affect people's willingness to access treatment in a timely manner which may also affect health outcomes.

Transmission of Communicable Diseases

As a result of Project development, in particular during the construction phase when the workforce is likely to be greatest and when in-migration may peak, the rate of transmission of communicable diseases may increase. The profile of these diseases will be influenced by the existing health profile of communities within the DAoI of the project and that of the workers. This will be largely due to:

- Interactions between the Project workforce and local communities;
- Potential for overcrowding as a result of increased pressure on existing housing infrastructure, water and sanitation services; and
- In-migrants and the Project workforce bringing new diseases or varying disease profiles compared to the existing community.

Furthermore, transit of workers through Takoradi could also provide a transmission pathway for communicable diseases.

Diseases of particular concern, due to baseline conditions include TB (as well as its opportunistic relationship to HIV/AIDS), skin diseases and acute respiratory infections. Furthermore, poor quality housing is associated with poor quality sanitation which can facilitate the transmission of diarrhoeal diseases, especially in children. This is already reported to be a problem. Poorer sectors of the community will be more vulnerable to such impacts as they are more likely to live in overcrowded, poor quality houses.

The presence of the workforce could facilitate increased transmission of communicable diseases already prevalent within communities and introduce new diseases (e.g. pandemic influenza, Ebola and meningococcal meningitis, all of which have been subject to recent outbreaks) into the area. The risk of transmission of diseases will be greatest if some of the workforce is sourced from areas with a higher prevalence of communicable diseases. Taking account of the size of the onshore workforce, which will peak at approximately 700 workers, the duration of the onshore construction activities (28 months), the proximity of the workers camp to the settlements of Anwolakrom and the village of Sanzule and the fact that workers will be allowed outside the camp for recreational purposes, the opportunities for interaction will be high.

Finally, in-migration of people into the area from other parts of Ghana and the Ivory Coast also has the potential to introduce new diseases to communities or increase transmission of existing diseases such as Acute Respiratory Infections (ARIs) and TB. Again this risk will only be higher if these individuals migrate from places with a higher prevalence of such diseases.

Transmission of Malaria

The current malaria burden is high in the communities surrounding the proposed Project.

As malaria is endemic, the Project is unlikely to significantly change the existing disease burden of the community as there are existing areas suited to breeding of mosquitos. If Project activities modify the environment such that the presence of suitable breeding grounds (usually slow moving or standing water) extends into the dry season then impacts may occur. The risk of breeding grounds being created could occur both due to direct Project activities and indirectly if there is inadequate waste management or storage of water by the Project or communities and due to environmental change associated with the presence of temporary structures by in-migrants.

Traffic Accidents

Increased traffic and presence of heavy vehicles on local roads as a result of Project development increases the risk of road traffic accidents involving members of the community. During the construction of the ORF and associated facilities traffic movements are planned along public roads, to transport of materials, sand, excavated soil, waste and water to and from the construction site. Transportation on public roads will be mainly from Takoradi and it is estimated that there will be an average number of 50 vehicle movements per day during construction. Local traffic movements associated with construction workers moving between sites and accommodation will also occur to a lesser extent.

The construction of the pipeline will involve transportation of personnel, heavy equipment and materials along the pipe routes and the related working strip. An average number of 50 vehicle movements per day are estimated through the construction area during the pipeline construction activities, with a peak of 60 movements per day during the excavation and pipeline laying activities, due to the transfer of excavated soil to be disposed and of sand used to protect the pipeline. Helicopters will only be used for medical emergencies.

The predicted increase in road traffic will increase the risk of road traffic accidents occurring which could result in injuries or fatalities to drivers and passengers in non-project related vehicles, cyclists or pedestrians. Children are generally considered to be at a higher risk due to their general lack of awareness of risks associated with road traffic accidents.

Site Trespass and Accidents

There is a potential risk of site trespassing at work fronts for the duration of construction of the pipeline and all the facilities. Work fronts will not be fenced routinely although areas will be secured through temporary barriers and signage to be erected along the route. The risk of trespassing is highest when work fronts are located closest to isolated houses or communities. Site trespassing could result in accidents leading to injuries or even fatalities since the presence of large pieces of machinery and open trenches for the construction of the pipeline, pose a particular risk if they were to become part filled with water. Young people and children are at most risk of getting injured since they are most likely to trespass onto construction sites due to curiosity and lack of awareness of potential risks.

Environmental Health

The construction of the ORF, the pipeline routes and associated facilities will result in changes to the physical environment, which has the potential to affect the health and wellbeing of communities. Construction activities will result in pollutants released to the air. During construction this will include pollutants from engines, including greenhouse gases (GHG) (assessed in Section G.4.2) and dust (Section G.4.1).

The increase in dust will result in increased annoyance and decreased wellbeing especially for residences closest to construction site e.g., less than 200 m from the construction and close to the main working sites and roads.

Increased noise levels area likely to result in some annoyance and decreased wellbeing for those closest to the construction activities, especially during onshore hydro-testing activities. Hydro-testing activities are likely to be a source of major noise impact for approximately two days. Operations will run daily on a 24 hours basis.

In terms of decreased air quality, impacts are expected to be minor at the ORF and other construction sites and therefore are unlikely to result in a recordable increase in respiratory diseases in the population.

Furthermore, the construction of the pipelines is likely to result in some temporary increased of waste production. Workers contracted during the construction phase for onshore piping and ORF will be around 600 and will be housed at the work camp close to the ORF. The increased pressure on the waste management system can potentially increase the prevalence of contagious diseases such as diarrhoeal diseases. Waste production as a result of the construction activities is unlikely to impact on the health of communities along the route due as opportunities for communities to come into contact with waste will be minimal as it will be stored in fenced areas.

Public Security

Onshore security (facilities, construction sites, camp) will be assured by a private company with unarmed personnel.

The area around the FPSO will be established for safety and security reasons. Eni will provide an unarmed dedicated patrol vessel to monitor and patrol offshore buffer zones. Ghana Navy, if required, will support eni's patrol vessel to assure the buffer zones to be respected. Additional Ghana Navy representatives can be deployed on eni's patrol vessel for extra support (in this case, they will be unarmed).

During the ESHIA consultation, local stakeholders highlighted that policing, by the Ghana Navy, of the offshore pipeline ROW and FPSO exclusion zones against encroachment from other uses, in particular local fishermen, could cause conflict. Local fishermen complained about abuses by personnel from the Ghanaian Navy in charge of security of the existing oil and gas developments (i.e. thefts of nets and fishing equipment, detention, etc.).

Mitigation Measures

Increased Prevalence of Sexually Transmitted Infections including HIV/AIDS and Communicable Diseases

- Conduct pre-employment screening protocols for all employees (onshore and offshore) including contractors and subcontractors which will include testing for TB and other diseases appropriate to the individual's country of origin, vaccinations and voluntary testing for sexually transmitted diseases.
- Conduct regular health screening will be provided for all employees (onshore and offshore) including contractors and subcontractors. Adequate referral and support for ongoing treatment programmes for workers found to have treatable conditions will be provided. Subcontractors will be required to do the same through contractual specifications.
- Employees (onshore and offshore) contractors and subcontractors will be required to follow, and will be trained in, the Worker Code of Conduct which includes context specific guidelines on worker-community interactions, worker-worker interactions and alcohol and drug use.
- Employees (onshore and offshore) contractors and subcontractors will be trained and educated to improve awareness of transmission routes and methods of prevention of sexually transmitted infections, communicable diseases (such as TB) and vector borne diseases, notably malaria, as part of induction. Other diseases will be covered as appropriate.
- Develop and implement Emergency Response Plans (ERPs) for the Project taking into account access to health care, major incidences, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident.
- Develop and implement an Influx Management Plan.
- Continue to implement a programme of stakeholder engagement including a grievance mechanism in communities in the DAoI, in compliance with IFC PS1 and PS4.
- Disseminate the grievance mechanism within Takoradi in particular close to the Port and any accommodation used by the Project by advertising it in public places, such as health centres, community facilities and places of worship.
- Provide all workers (onshore and offshore) with primary health care and basic first aid at construction camps / worksites. This will be done in line with eni standard and the IFC/ EBRD guidelines on worker accommodation[8].
- Monitor health trends during Project construction (and operations) in order to be aware of and respond appropriately to any negative health trends that may be linked to the Project and its workers.
- Monitor the emergence of major pandemics/ epidemics through WHO alerts and in the event of a pandemic review mobilise and demobilisation of all Project personnel.

(2) [8] IFC/ EBRD guidelines on worker accommodation August 2009

- Work with relevant health authorities and NGOs to provide awareness training regarding the transmission of communicable diseases and STIs, preventative measures and the importance of seeking appropriate treatment.

- Provide access to free condoms at all worker sites and accommodation.

Malaria

- Take measures to reduce the presence of standing water during construction through environmental controls and source reduction to avoid the creation of new breeding grounds.
- Take measure such as the installation of screens or nets on windows and at doors, in worker accommodation, office space and other buildings to reduce the potential for mosquito-human interactions.
- Provide education and communication campaigns on malaria diseases with the workforce;
- Work with relevant partners in the community health sector (health authorities, NGOs, development agencies, etc) to implement awareness raising campaigns regarding the transmission of malaria and measures to prevent transmission within communities.
- Implement procedures to identify specific prophylaxis needs for Project personnel.
- Monitor the incidence of malaria in the workforce.

Traffic Accidents

- In order to reduce the risk of accidents journey management planning, driving codes of conduct and enhanced driver safety awareness will be implemented.
- Plan traffic routes to limit road use by the Project during high traffic periods (including pedestrian traffic) and in sensitive areas such as near schools in order to reduce interaction with public road use.
- Assess local road conditions and be responsible for road maintenance during Project construction to minimise traffic risks associated with roads deteriorated from Project activities.
- eni will provide driver training to promote safe and responsible driving behaviour. The training will also target contractors and subcontractors.
- Require mandatory training on safe driving, worker code of conduct and health awareness training for all Project drivers.
- Develop and implement a Traffic Management Plan to ensure compliance with procedures and rules.
- Engage with local communities and authorities to inform them about plans and procedures
- Implement awareness campaigns recording traffic and road safety in communities along the transport corridor.

Site Trespass and Accidents

- Develop and implement an education program for community members, particularly youth, prior to and during construction activity to promote awareness and understanding of personal safety risks associated with the Project construction.

- Undertake a programme of stakeholder engagement and consultation to educate local communities of the risks of trespassing, the meaning of signs, the dangers of playing on or near equipment or entering fenced areas.
- Erect signs around work fronts and construction sites warning of risks associated with trespassing. All signs will be in local language or in easily understandable form.
- Erect fencing around pipe yards and other similar facilities to minimise the risk of trespassing. Fencing will be checked daily to ensure that it is in good condition and to look for any signs of entry.
- When work areas are within 100 m of an inhabited building, all equipment will be parked overnight in a restricted area.

Environmental Change

- Eni undertake stakeholder engagement with affected communities and other stakeholders on a range of issues including changes to the visual environment, noise, waste management and social concerns including human trafficking. This engagement will take place during ESIA disclosure and prior to the commencement of construction activities. Engagement will also take place during construction and prior to the commencement of operations. The stakeholder engagements activities and requirements are described in detail in the Stakeholder Engagement Plan.
- Eni will implement a Grievance Mechanism to address stakeholder concerns related to the Project in a timely manner.
- Mitigation measures to minimise impacts to the environment will minimise the risk to health see Section G.4.1Air Quality and 10.4.3 Noise and Annex F for the Waste Management Plan for the Project.

Public Security

- A security management plant together with a specific patrolling procedure will be developed for both onshore and offshore installations.
- Project security systems will comply with Ghana laws and regulations as well as the requirements of the UN Voluntary Principles for Security and Human Rights. The security system will include, among other things, selection or personnel based on a careful background screening, training with regards to human rights requirements, and monitoring of performance.
- Given the ongoing complaints by local fishermen and the concerns raised by community members in the area of influence, eni and its contractors and subcontractors will need to be particularly attentive to ensuring that their security arrangements respect human rights, with constructive outreach to police and the navy through consultation, as well as training on human rights.

Conclusions

Considering the mitigation described in the previous section and the evaluation criteria defined by eni Standard requirements (Environmental, Social and Health Impact Assessment Standard - Doc n° 1.3.1.47), the residual impacts on community health, safety and security associated with the construction phase are summarized in Table G113.

Table G113 Residual Impacts on Health, Safety and Security during Construction Phase

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Increased prevalence of Sexually Transmitted Infections including HIV/AIDS	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 small number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	2	2	2	
Increased prevalence of Communicable diseases	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 small number of individuals, communities or administrative and/or higher no. of species and habitats	**8-Medium**
Score	2	2	2	2	
Increased prevalence of malaria	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	1	2	
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	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 small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	2	2	2	1	
Increased pressure on health care	Between 1 and 5 years	Local scale: the proposed operating site	Moderate value/sensitivity of receptors or	Affecting small number of individuals, communities or	**7-Medium**

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
resources.		and its immediate environs	resources, able to adapt with some difficulty and which may require interventions	administrative and/or higher no. of species and habitats	
Score	2	1	2	2	
Site trespass and injury	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	2	1	
Environmental health	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**6-Low**
Score	2	1	2	1	
Public security	Between 1 and 5 years	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**5-Low**
Score	2	1	1	1	

G.7.7.3 Operation and Maintenance Phase

Impacts Identification and Assessment

During the operation phase some of the impacts from the construction phase will continue to be of concern. These include impacts that have been already analysed in Section G.7.7.2(e.g. environmental health impacts, prevalence of communicable diseases, public security, etc.).

The potential for increased transmission of communicable diseases and STIs including HIV/AIDS and STIs is likely to continue and will be monitored and controlled. Similarly the use of public and private security forces to police the ORF, the FSPO, the pipelines RoW (onshore and offshore) to prevent encroachment from other uses will continue to raise concerns from a human rights perspective. Finally, increased traffic and vessel movements are likely to continue but at lower levels than during construction. The potential for increased transmission of malaria is likely to significantly reduce during the operations phase.

During the operational phase of the ORF will maintain low noise levels, and effects on the local air quality will be limited (See Section 10.4). Other sources of air pollutants will include marine vessels, vehicles, power generators, waste incineration and helicopters. However, the impacts to health from the emissions from these sources are likely to be not significant.

Communities in the area of influence of the Project have expressed concerns over safety issues associated with the pipeline once it is operational. Particular concerns included risk of explosion, pipeline rupture and gas leaks. The design of the pipeline, setback, operational controls and security (i.e. buried underground, restrictions along the working strip, safety measures and controls) mean that the pipeline will be made as safe as possible. Concerns around pipeline safety could affect community wellbeing and their perception of the safety of the area. Risks around pipeline safety are assessed in *Section G.9*on unplanned events.

Management of community-workforce interaction will continue to be important considering the fact that a camp with capacity for 66 people will be established and a number of contractor and subcontractor personnel will continue to be engaged with the Project.

<u>Mitigation Measures</u>

With regard to community health, safety and security, eni will undertake stakeholder engagement with affected communities and other stakeholders on a range of issues including, noise and emissions, safety of facilities and pipeline, use of security forces and community-workforce interaction. This engagement will take place during ESIA disclosure and prior to the commencement of construction activities. Engagement will also take place during construction and prior to the commencement of operations. The stakeholder engagements activities and requirements are described in detail in the Stakeholder Engagement Plan.

Mitigation measures developed for construction will continue to be implemented, in addition the following specific measures will be implemented:

- eni will undertake stakeholder engagement regarding the operation of the FPSO, the ORF and associated facilities, and the pipeline. This will be undertaken prior to the commencement of the operation phase.
- eni will maintain the grievance mechanism throughout the operation of the Project so stakeholders can report specific concerns.
- eni will undertake a community education programme on pipeline safety to alleviate concerns.
- eni will have the ORF and FSPO permanently guarded, while the pipeline routes will be regularly patrolled to deter deliberate damage or vandalism and assure the operational safety of the Project is not compromised

Conclusions

Considering the mitigation described in the previous section and the evaluation criteria defined in section G.2, the residual impacts on community health, safety and security associated with the operation phase are summarized Table G114.

Table G114 Residual Impacts on Health, Safety and Security during Operation Phase

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Increased prevalence of sexually transmitted infections, HIV/AIDS	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8 -Medium**
Score	4	1	2	1	
Increased prevalence of Communicable diseases	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**8-Medium**
Score	4	1	1	1	
Increased transmission of Malaria	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**
Score	4	1	1	1	
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small no. of individuals, households, individual enterprises and/or small no. of species	**7-Medium**

Impacts	**Duration**	**Extent**	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	**Impact Rank**
Score	4	1	1	1	
Public security	Over 10 years / Irreversible	Local scale: the proposed operating site and its immediate environs	Low value/sensitivity of receptors or resources able to recover or adapt to the changes without interventions.	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**7-Medium**
Score	4	1	1	1	

G.7.7.4 Decommissioning Phase

Impacts Identification and Assessment

Potential impacts will need to be reassessed given the period of time that will pass before decommissioning activities are expected to take place. Decommissioning activities performed will apply to the ORF and the pipelines. Thus potential impacts during Project decommissioning are likely to be similar to impacts during construction but less significant than during the construction phase due to the smaller affected area.

Mitigation Measures

Mitigation measures are expected to be similar to construction, with the benefit of being improved based on lessons learned during construction. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life.

Conclusions

The residual impacts are likely to be similar to construction, with the benefit of being improved mitigations based on lessons learned during construction. However, residual impacts depend on the outcome of potential impacts during construction and the effectiveness of mitigation measures. As such, residual impacts could be rated differently approaching the time period of Project decommissioning.

G.7.8 Offshore Security and Piracy

G.7.7.1 Overview

Acts of piracy, such as hijacking and armed attacks on Project vessels, pose a risk to Project assets including human capital. Attacks on Project vessels potentially place the Project workforce at risk, as such attacks are often violent in nature. Further, acts of piracy could halt the production of gas, particularly if Project infrastructure is damaged during an attack.

The Gulf of Guinea is a known piracy hotspot, and acts of piracy have been primarily targeted at oil and gas vessels.

Box G20 Key Sources of Impact, Potentially Impacted Resources and Receptors

Sources of Impacts and Risks

- Offshore project infrastructure and project vessels are at risk to acts of piracy.

Potentially Impacted Resources and Receptors

- Workers directly engaged by the Project both from Ghana and overseas, who are working on offshore infrastructure and installation and support vessels.
- Project assets such as the FPSO.

Baseline Conditions that are Potentially Influencing Impacts/Risks

- The Gulf of Guinea has been identified as the most dangerous maritime area in terms of the success rate of attacks and violence.
- Ghana has been largely exempt from this threat but in 2014 Ghana registered it's first significant hijackings (two were on oil tankers).
- There is a lack of legislation with respect to the crime of piracy in Ghana.

Vulnerable Groups

- The offshore workforce

Project Influencing Factors

- Security arrangements for offshore facilities.

The following table presents the key impacts of offshore security and piracy during key Project phases.

Table G115 Key Potential Impacts and Risks – Offshore Security and Piracy

Construction Phase	Operations Phase	Decommissioning Phase
• Risk of attacks on drilling vessels and supply vessels.	• Risk of attacks on FPSO, tankers and supply vessels.	

The potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

G.7.7.2 Construction Phase

Impact Identification and Assessment

The Gulf of Guinea has been identified as the most dangerous maritime area in terms of the success rate of attacks and violence. While in the past Ghana has been largely exempt from this threat, in 2014 Ghana registered it's first significant hijackings. The Gulf of Guinea has recorded the most attacks against FPSOs in the world, all of which have occurred off the coast of Nigeria (Ali Kamal-Deen, 2014). Oil tankers are at high risk of being targeted by pirates, as they transfer the oil onto smaller ships and then sell illegally at high prices.

During construction, Project vessels installing off-shore infrastructure as well as supply vessels may be perceived as potential targets by pirates. An attack would endanger the lives of the offshore Project workforce and could disrupt the drilling process.

Mitigation Measures

To increase off-shore security and reduce the risk of piracy eni will:

- Conduct regular security and anti-piracy exercises and drills on all Project related vessels
- Monitor advisories from the National Port Authority and when piracy risks are deemed high, initiate protocols such as additional lookout and increased situational awareness both day and night.
- eni will support the national government and other oil and gas companies in regional counter-piracy efforts;
- increase situational awareness both day and night;
- applyoperational planning suited to mitigate risk;
- increase lookouts.

Conclusions

Considering the mitigation described in the previous section and the evaluation criteria defined by eni Standard requirements (Environmental, Social and Health Impact Assessment Standard - Doc n° 1.3.1.47), the residual impacts on offshore security and piracy associated with the construction phase are summarized in Table G116.

Table G116 Residual Impacts on Offshore Security and Piracy

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank

Impacts	Duration	Extent	***Importance / Resilience of Receptor /Resource***	***No. of Elements Involved***	Impact Rank
Offshore Security and Piracy	Between 1 and 5 years	International scale: trans-boundary	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**10-High**
Score	2	4	2	2	

G.7.7.3 Operation and Maintenance Phase

Impact Identification and Assessment

During operation and maintenance, the FPSO, oil tankers as well as supply vessels may be perceived as potential targets by pirates, and will be at risk of attacks and hijackings. An attack would endanger the lives of the offshore Project workforce and could disrupt the gas production process.

Mitigation Measures

The mitigation measures suggested in the construction phase will be applicable to the operation phase.

Conclusions

Considering the mitigation described in the previous section and the evaluation criteria defined by eni Standard requirements (Environmental, Social and Health Impact Assessment Standard - Doc n° 1.3.1.47), the residual impacts on offshore security and piracy associated with the operation phase are summarized in Table G117.

Table G117 Residual Impacts on Offshore Security and Piracy

Impacts	Duration	Extent	*Importance / Resilience of Receptor /Resource*	*No. of Elements Involved*	Impact Rank
Offshore Security and Piracy	Project duration/ More than 5 years	International scale: trans-boundary	Moderate value/sensitivity of receptors or resources, able to adapt with some difficulty and which may require interventions	Affecting small number of individuals, communities or administrative and/or higher no. of species and habitats	**11-High**
Score	3	4	2	2	

G.7.7.4 Decommissioning Phase

At the end of Project lifespan (after 20 years), all Project infrastructure will be decommissioned. While much of the offshore infrastructure will be left in-situ, the FPSO will be towed away. Tankers and other Project associated vessels will no longer operate and therefore will not be at risk.

Impact Identification and Assessment

At the end of Project lifespan (after 20 years), all Project infrastructure will be decommissioned. While much of the offshore infrastructure will be left in-situ, the FPSO will be towed away. The FPSO may be a potential target while it is being towed away, and other Project associated infrastructure could able be seen as potential targets for attacks.

Mitigation Measures

Mitigation measures are expected to be similar to construction and operation, with the benefit of being improved based on lessons learned during operation. Additionally, eni will prepare a Preliminary Decommissioning Plan (which will be a 'living document') that will be developed further during field operations and fully defined in advance of the end of field life.

Conclusions

The residual impacts are likely to be similar to construction and operation., with the benefit of improved mitigations based on lessons learned during construction and operation. As such, the impacts have not been rated at this stage.

G.8 ECOSYSTEM SERVICES

The Ecosystem Services impacts identification has been performed applying the IPIECA Ecosystem Services Guidance (IPIECA, 2011). This guidance approach, it provides a set of checklists to help identify the main habitats involved in the AoI, ecosystem service dependencies and impacts of Oil and Gas developments.

According to the baseline data and the aforementioned guidance document, for the AoI described in Section 6 of the EIS, the following Ecosystem Services are here in after described and reported:

- Forest Habitats: represented by the primary rainy forests and the secondary forest formed by coconut/palm trees (including those in plantations) and thickets.
- Wetlands: represented by brackish and freshwater lagoons, as well as wetlands in the low lying coastal areas.
- Deep Water: represented by the offshore marine areas where project activities will take place.
- Near shore/transition zone (including mangroves): represented by beaches, rocky tidal zones and the mouths of Amansuri River. Further East of the Project area there is also a dead coral reef belt and mangroves along the Amansuri River.

This Section provide a set of matrices which identifies the interactions between Project activities, the ecosystem dependencies (ie how the ecosystem services will support the mitigation of these impacts) as well as the negative effects as a result of the impacts and risks on the functioning of the ecosystem services (provisioning, regulating and cultural).

G.8.1.1 Overview

This Section identifies and assesses the main impacts on ecosystem services proposes mitigation and management measures and then discusses the conclusion and impact ranking. The following box shows the key sources of impact, potentially impacted resources and receptors, baseline and project influencing factors associated to the impacts of the Project on seawater resources.

Box G21 Key sources of risks and impact, potentially impacted resources and receptors

Sources of Impact

- Installation/ Construction Phase: FPSO installation, wells drilling, re-entering and testing; onshore and offshore pipeline trenching and laying activities; pipeline's flooding, testing, dewatering, drying; vessels operations, Temporary land-take for Project construction activities (pipeline working strip; work sites, construction sites and temporary infrastructure and exclusion zones around work areas), ORF construction.
- Operations and maintenance phase: wells, ORF and FPSO operation; external inspections and routine maintenance works; consumption of water, improper waste and waste water discharge management, air emissions;.
- Decommissioning phase: FPSO, wells and ORF decommissioning; pipes remain on the seabed and buried onshore and are filled with a suitable material; movements of vessels at sea and trucks and machinery onshore for equipment and personnel transport, consumption of water; waste management.

Potentially Impacted Resources and Receptors

- Forest habitats and associated ecosystem services.
- Wetlands habitats and associated ecosystem services
- Nearshore habitats and associated ecosystem services
- Deep water habitats and associated ecosystem services

Baseline Influencing Factors

- Distribution and extent of the ecosystems providing each service-.

Project Influencing Factors

- Land take, specific techniques used for construction, presence of workforce; water management and waste management.

The following table presents the key impacts of the project on ecosystem services during the key Project phases.

Table G118 Key impacts and risks – ecosystem services

Installation/Construction Phase	Operations Phase	Decommissioning Phase
• Land take due to project footprint of facilities and camps and the associated loss of ecosystem services in the area. • Delimitation of exclusion zones restraining access to ecosystem services there provided • Contamination of marine water, freshwater, groundwater, seabed, and soils due to generation of wastes (solid and liquid). • Consumption of existing resources as water and food. • Impacts on flora and fauna due to increased noise, light and dust from construction works.	• Land take due to project footprint of facilities resulting in a loss of ecosystem services in the area. • Delimitation of exclusion zones restraining access to ecosystem services there provided • Contamination of marine water, freshwater, groundwater, seabed, and soils due to generation of wastes (solid and liquid). • Consumption of existing resources as water and food. • Impacts on flora and fauna due to increased noise, light and airborne emission from operation activities.	• Delimitation of exclusion zones restraining access to ecosystem services there provided • Contamination of marine water, freshwater, groundwater, seabed, and soils due to generation of wastes (solid and liquid). • Consumption of existing resources as water and food. • Impacts on flora and fauna due to increased noise, light and dust from decommissioning works.

The *sensitivity* of the ecosystem services component is reported in the following Sections. Then potential impacts relating to each of the three main project phases are described prior to presenting the mitigation measures that will be adopted by the Project.

G.8.1.2 Ecosystem Services Sensitivity

Sensitivity of the different ecosystem services relies on the specific sensitivity of the habitat, ecosystem or component that allows such a service to exists. Four main groupings of ecosystems and their sensitivity are considered as follows.

G.8.1.3 Forest Habitats (lowland)

The Project area generally lies within a Wet Evergreen forest type of Ghana, with the sand bar occupied by a narrow band of coastal strand vegetation. Coconut Plantations are common along the dune at numerous places in this zone. The whole extension of the proposed pipeline will run throughout: coastal strand and vegetation; Secondary forest/thicket (i.e. cocount/palm plantations); grasslands in the Wet Evergreen forest and freshwater swamp forests.

Provisioning services: forests have been exploited for different purposes. Especially during the last two decades they have been providing food and timber and they have further-more been converted in agricultural lands.

Regulating services: Forests offer important carbon sequestration, climate and nutrient regulation services and, in particular in this area, have a fundamental role in erosion and flood control. In addition, lowland forests help to regulate the water quality, pollution patterns, soil loss/erosion and provide a steady flow of clean water downstream.

Cultural services: Forests are also widely viewed as having heritage value for future generations. Tropical forests in particular provide cultural services in the form of extremely high levels of biodiversity, iconic species and genetic materials.

Forest habitats are particularly vulnerable to both direct and indirect habitat conversion relating to oil and gas activities, particularly related to the utilization of some resources during the construction phase and to the consequent degradation of some regulating services, such as altered surface and subsurface hydrological patterns, erosion and increased pollution. These situations can potentially lead to deforestation, species loss and potential conflicts with local communities. In the Area of Influence, existing waste management services may not be accessible and disposal of waste will involve storage and transportation in appropriate and approved containers. Upon site closure, the rehabilitation of forest habitats will require an understanding of landscape level trends, native species, and potential future ecosystem services of the area.

G.8.1.4 Wetlands

The Amansuri Lagoon is located about 4 km northwest of Atuabo and 15 km northwest of the concession area. The low lying grasslands located between the lagoon and the Project location are reportedly seasonally flooded during the wet season and are considered to be a seasonal wetland area, belonging to the main Amansuri Wetland system. These wetland areas drain to the north and into the Amansuri River (joining downnstream of the Amansuri lake) and flowing to the west and south and into the Amansuri coastal lagoon.

Provisioning services: the river/lagoon provides provisioning services in the form of water, food, fuel and materials for construction. It provides protein to many local communities through fish and shellfish as well as plant food, material for fuel and for construction.

Regulating services: the river/lagoon habitat supply vital regulating services such as groundwater recharge, water storage, flood control and water purification (waste assimilation).

Cultural services: Wetland areas are recognized for their populations of endemic or migratory bird species and protected species. River habitat can represent an important sites for recreation and are valued as historic waterways.

Oil and gas activities can potentially impact the river and lagoon area through changes in the surface water drainage around the ORF site. Accidental events may cause impacts with long lasting implications due to much lower dispersal and assimilation rates than in marine environments.

G.8.1.5 Deep Water

This ecosystem hosts a great variety and abundance of fishes and other marine organisms. Fish species harvested are generally semi-pelagic/demersal species such as porgie, seabreams, jacks, groupers, snappers, soles and flounders; as well as cuttlefishes and crustaceans.

Provisioning services: Commercial fishing is the most significant provisioning service provided by deep water habitats, with fishing for long-ranging species such as tuna and sardines prevalent. Artisanal fishing is less common at these depths. There is also considerable scope for genetic and pharmaceutical products from the diverse range of benthic species, many of which have yet to be discovered.

Regulating services: Deep water ecosystems provide important waste assimilation services both in the water column and in the benthic substrate. Plankton can play an important carbon sequestration function. In addition, predator species may play a key role in biological control against alien-invasive species introduced through ballast waters.

Cultural services: Marine tourism is less prevalent in deep water environments. However, these areas often include migration routes for marine mammals, birds and reptiles, including many culturally iconic species.

Oil and gas activities can potentially impact deep water habitat through the movement of seabed sediments. Impacts on Deep Water could be mostly related to suspension of nutrients and increase of turbidity near the pipeline, though it may not have a considerable effect on the quality of water. In case of existent presence of contaminants within the sandy seabed bottom, movement could affect the quality of waters and have serious health implications on all the food chain.

G.8.1.6 Nearshore/ transition zone

The near shore/transition zone in the AoI includes mangroves towards the mouth of the Amansuri River and potentially isolated coral individuals, though no coral reef has been recorded.

Mangroves are the formation of trees found on the muddy shores of the tidal zone, they are highly productive natural ecosystems and tend to have a higher 'litter' production (of leaves, twigs, fruit and flowers) than lowland rainforests (Jiminez et al. (1985). This litter is broken down by detritivores to enrich the surrounding waters, particularly with nitrogen and phosphorus. The influence of mangroves on the nutrient levels of other coastal ecosystems is also considered important as tides transport these nutrients to other coastal areas (Ong et al. 1980). Mangroves habitat include a number of plant and animal species that are tolerant of the salt water and mud environments.

Provisioning services: The mangroves vegetation provides food, through leaf fall and decay processes, as well as shelter to a unique and rich community of animals, particularly large crustaceans and molluscs. Mangroves are also important nurseries for prawns and many pelagic fish of commercial importance.

In mangrove areas, timber and non-timber forest products can also be present. Ornamental and pharmaceutical products are also often found in mangroves and coral reefs environment. Construction materials are often used (i.e. sand, shingle, rocks and coral rubble).

Regulating services: Mangroves play an important role in holding down the ground. The roots of mangroves help absorb the action from waves and help prevent shoreline erosion. They also perform a flood reduction function, help to prevent erosion of the riverbanks, and serve to dampen storm surges and to a minor extent high winds, both of which are associated with many tropical and subtropical storms. Mangroves also filter pollutants, absorb excess nutrients from runoff, and trap sediments, helping to increase the clarity and quality of waters.

Cultural services: The near shore environment is one of the most valuable habitats for recreation activities and as habitat for iconic species. A variety of marine mammals may be found near shore in certain periods. In addition, many coastal communities place cultural value on maintaining traditions of hunting and fishing in the near shore environment.

G.8.1.7 Construction Phase

The following sources of construction phase impacts have been identified. Without mitigation, the sources listed below have the potential to cause impacts on ecosystem services.

Table G119 Ecosystem impacts and risks - construction and pre-commissioning phase

Source of Potential Impact	Potential Impact
Land take for facilities, pipelines and temporary presence	Modification, fragmentation and loss of habitats and agricultural land.
Exclusion zones	Reduction in access to ecosystem services
Workforce presence, provisioning and waste generation	Consumption of resources and pollution of ecosystem derived from waste generation, both with an associated loss of ecosystems services
Construction activities	Disturbance to fauna and flora from dust, noise and light and depletion of natural resources (eg water, wood) for construction works.
Chemical handling	Potential pollution of soils and water with the associated loss on ecosystem services provided

Impacts identification and Assessment

The aim of this Section is to identify the possible impacts on ecosystem services during the installation/construction and pre-commissioning phase, including onshore and offshore activities.

As a given ecosystem provides multiple services of different categories (provisioning, regulating, cultural services), this section will assess the impacts organised per each ecosystem identified in the area, analysing how the different activities proposed by the Project may affect each of the cateogries of the ecosystem services they are providing.

As a result four tables are presented, each for one ecosytem (forest, wetlands, deepsea and nearshore), where the different sources of impacts and potential impacts on ecosystem services are identified and discussed as follows:

- Potential impacts to ecosystem services provided by forest habitats;
- Potential impacts to ecosystem services provided by wetlands habitats;
- Potential impacts to ecosystem services provided by deep sea habitats;
- Potential impacts to ecosystem services provided by nearshore habitats;

These are presented and assessed in the following tables.

Table G120 Identification of impacts and risks to ecosystem services (Forest habitat) during the construction phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Facility footprint: Construction of facility and pipelines; temporary presence	Modification, fragmentation and loss of habitats and agricultural land. Terrain modification.	Use of local natural materials (i.e. timber, aggregates) for foundations, concrete, etc.	Natural flood, erosion and storm controls at site.	n/a	Hunting is still a source of supporting livelihoods for some vulnerable group of people, so the reduction of the habitat could reduce the ability to hunt and gather wild foods **(i.e. meat, fruit, nuts)**, and to harvest timber and agricultural outputs.	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation.	Reduction of species.
Exclusion zones: Temporary exclusion of people from a defined area	Reduced human access to an area.	n/a	n/a	n/a	Temporary reduction in local people's ability to gather wild products (firewood from mangroves, fish, shellfish, etc.). Potential increase in key species due to protection from overuse.	n/a	Temporary loss of access to cultural, livelihood and recreation features. Protection of habitats and species from misuse and overuse by people.

Sub-activity Issue	**Potential Impact**	**Dependencies on Ecosystem Services**			**Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning**		
		Provisioning	**Regulating**	**Cultural**	**Provisioning**	**Regulating**	**Cultural**
Workforce and ancillary camps: Construction, operation, closure	Disposal and pollution from wastes and wastewater, having visual, physical, biological and chemical impacts. Vegetation clearance. Potential introduction of alien-invasive species.	Use of local natural materials for building camps.	Assimilation service of rivers, soils, etc. disposing of liquid and solid wastes. Water filtration service to provide clean water	Possible pollution of water supply. Potential changes to supply of wild foods through introduction of alien species (typically negative impacts).	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation. Reduction of availability of resources due to increased procurement for the Project.	Loss of carbon sequestration services from clearing trees and vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	
Site preparation: Vegetation clearance, excavation, dewatering, trenching	Modification, fragmentation and removal of habitats. Modification to drainage and hydrology regimes (groundwater, surface water, soil). Soil erosion. Water runoff and sedimentation.	n/a	n/a	n/a	Hunting is still a source of supporting livelihoods for some vulnerable group of people, so the reduction of the habitat could reduce the ability to hunt and gather wild foods **(i.e. meat, fruit, nuts)**, and to	Loss of carbon sequestration services from clearing trees and vegetation. Reduction in flood and erosion control and water purification by clearing vegetation.	Loss of access to recreation features

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
					harvest timber and agricultural outputs.		
Provisioning workforce: providing food and water, etc.	Depletion of water and local food resources. Reduction in flora and fauna.	Use of local crops, livestock, medicinal plants, water, firewood, etc.	n/a	n/a	New local market but increased pressure on use of water and wild meat, fruit, etc. hunted and gathered as a result of increased procurement.	n/a	Possible reduction in species from increased hunting.
Construction work: Digging, building, etc.	Noise, light, vibrations and dust from construction works affecting flora and fauna. Depletion of natural resources for buildings, i.e. cutting forests, excavating sand, etc.	Use of aggregates (sand, gravel, rocks, etc.). Timber from trees. Water, etc.	Water filtration services to provide clean water.	n/a	Disturbance and loss of animals	Interference with natural water supplies downstream (surface and groundwater).	n/a
Landscape alteration: from presence of the facility and construction work	Visual impacts to the local landscape. Import of non-local species.	Visual and aesthetic impact on enjoyment of locals and visitors.	n/a	n/a	n/a	n/a	Visual and aesthetic impact on enjoyment of locals and, in case, visitors. See impact on change in sense of place.

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**	**Provisioning**	**Regulating**	**Cultural**
Accidental events: Risk of blow outs, chemical spills, pollution, fires, explosions, etc.	Water, soil and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Use of water to control fires or other natural resources to reduce the impacts.	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Reduction in provisioning foods and water through contamination by chemicals (actual and perceived). Development of a Emergency Response Plan.	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through chemical contamination (actual and perceived).

Table G121 Identification of impacts and risks to ecosystem services (wetlands) during the construction phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and risks on Ecosystem Services		
		Provisioning	**Regulating**	**Cultural**	**Provisioning**	**Regulating**	**Cultural**
Chemical handling and use: including pre-commissioning chemicals	Possible water quality contamination associated with permitted releases.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Possible reduction in artisanal or commercial fisheries (especially perceived impacts).	n/a	n/a
Accidental events: Risk of blow outs, chemical spills, pollution, fires, explosions and ship groundings.	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Reduction in provisioning foods through contamination by chemicals (actual and perceived).	n/a	Reduction in local livelihoods and species through oil and chemical contamination (actual and perceived).

Table G122 Identification of impacts and risks to ecosystem services (deepwater habitats) during the construction phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Vessels: Mobilisation, operation and general presence	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Possible reduction in commercial fisheries. Possible impacts on fisheries due to disturbance.	n/a	Disturbance (visual, auditory and physical) of species.
Exclusion zones: Temporary exclusion of boats from a defined area	Reduced human access to an area. Protection of habitats and species (i.e. reduced fishing effort).	n/a	n/a	n/a	Temporary reduction in artisanal or commercial fishing (restricted access to fishing grounds); perceived impacts in particular. Potential local increase in key species due to protection from overuse.	n/a	n/a
Seabed interaction: (trenching, piling, anchoring, etc.)	Turbidity, noise and direct physical impacts to seabed habitats, species, spawning areas and fishing grounds.	n/a	n/a	n/a	Loss of habitat could result in loss of associated provisioning services such as fisheries.	Loss of habitat could result in loss of associated regulating services such as assimilative services.	Loss of habitat could result in loss of associated cultural services such as aesthetic and non-use values.
Chemical handling and	Possible water quality contamination	n/a	Assimilation services (i.e.	n/a	Possible reduction in commercial or	n/a	n/a

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**	**Provisioning**	**Regulating**	**Cultural**
use: including pre-commissioning chemicals	associated with permitted releases.		dilution and microbial action) to help break down and disperse oil and chemicals.		artisanal fisheries (especially perceived impacts).		
Accidental events: Risk of blow outs, oil spills, chemical spills, pollution, fires, explosions and ship groundings.	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Reduction in provisioning foods and fisheries through contamination by chemicals (actual and perceived). Both large scale commercial and artisanal fishing could be impacted depending on the size and extent of the spill.	n/a	n/a
Facility / equipment footprint: Construction of subsea equipment, pipelines, etc.	Potential artificial reef effect (positive impacts for various species, fish and fisheries)	n/a	n/a	n/a	Possible for subsea structures to increase commercial or artisanal fisheries in the immediate area. In deep water, commercial fishing may be relevant rather than artisanal.	n/a	n/a

Table G123 Identification of impacts and risks to ecosystem services (nearshore, transition zone) during the construction phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Offshore							
Vessels: Mobilisation, operation and general presence	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Possible reduction in artisanal or commercial fisheries and fish or shellfish for consumption. Possible impacts on fisheries due to disturbance.	n/a	Disturbance (visual, auditory and physical) of species
Exclusion zones: Temporary exclusion of boats from a defined area	Reduced human access to an area. Protection of habitats and species (i.e. reduced fishing effort).	n/a	n/a	n/a	Temporary reduction in local people's ability to fish (restricted access to fishing grounds and/or landing sites); perceived impacts in particular. See table "Deep Water". Potential increase in key species due to protection from overuse.	n/a	Temporary loss of access to cultural, livelihood. Protection of habitats and species from misuse and overuse by people.

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Seabed interaction: (trenching, piling, anchoring, etc.)	Turbidity, noise and direct physical impacts to seabed habitats, species, spawning areas and fishing grounds.	n/a	n/a	n/a	Loss of habitat could result in a reduction in fish or shellfish for consumption.	Loss of habitat could result in loss of associated regulating services such as assimilative services.	Loss of habitat could result in loss of associated cultural services such as aesthetic and non-use values.
Chemical handling and use: including pre-commissioning chemicals	Possible water quality contamination associated with permitted releases.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Possible reduction in commercial or artisanal fisheries (especially perceived impacts)	n/a	Possible negative impacts for marine recreation
Accidental events: Risk of blow outs, chemical spills, pollution, fires, explosions and ship groundings.	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Reduction in provisioning foods through contamination by chemicals (actual and perceived).	n/a	Reduction in local livelihoods, recreation and species through oil and chemical contamination (actual and perceived).
Facility / equipment footprint: Construction of subsea equipment,	Potential artificial reef effect (positive impacts for various species, fish and fisheries)	n/a	n/a	n/a	Possible for subsea structures to increase commercial or artisanal fisheries. Alternatively,	n/a	n/a

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
pipelines, etc.					possible reduction in fish or shellfish due to disturbance.		
Onshore							
Facility footprint: Construction of facility and pipelines; temporary or permanent presence	Modification, fragmentation and loss of habitats and agricultural land. Terrain modification.	Use of local natural materials (i.e. aggregates) for foundations, concrete, etc.	Natural flood, erosion and storm controls at site.	n/a	Hunting is still a source of supporting livelihoods for some vulnerable group of people, so the reduction of the habitat could reduce the ability to hunt and gather wild foods **(i.e. meat, fruit)**, and to harvest timber and agricultural outputs.	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation.	Reduction in access to cultural or recreation features
Exclusion zones: Temporary exclusion of people from a defined area	Reduced human access to an area. Protection and maintenance of habitats and species (i.e. reduced logging, land conversion and hunting).	n/a	n/a	n/a	Temporary reduction in local people's ability to gather wild **products (firewood from mangroves, fish, shellfish, etc.)**. Potential increase in key species due to protection from	n/a	Temporary loss of access to cultural, livelihood and recreation features. Protection of habitats and species from misuse and overuse by

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
					overuse.		people.
Site preparation: Vegetation clearance, excavation, dewatering, trenching	Modification, fragmentation and removal of habitats. Modification to drainage and hydrology regimes (groundwater, surface water, soil). Soil erosion. Water runoff and sedimentation.	n/a	n/a	n/a	Possible reduction in local people's ability to gather wild products (firewood from mangroves, shellfish, etc.).	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation.	Loss of access to cultural and recreation features
Construction work: Digging, building, etc.	Noise, light, vibrations and dust from construction works affecting flora and fauna. Depletion of natural resources for buildings, i.e. cutting forests, excavating sand, etc.	Use of aggregates (sand, gravel, rocks, etc.). Timber from trees. Water, etc.	Water filtration services to provide clean water.	n/a	Disturbance and loss of animals	Interference with natural water supplies downstream (surface and groundwater).	n/a
Landscape alteration: from presence of the facility and construction work	Visual impacts to the local landscape. Import of non-local species.	Use of aggregates, soil, etc. Potential use of local species for landscaping.	n/a	n/a	n/a	n/a	Visual and aesthetic impact on enjoyment of locals.

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Accidental events: Risk of blow outs, chemical spills, pollution, fires, explosions, etc.	Water, soil and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Use of water to control fires. Use of natural products to absorb oil. Use of sand in bags to block oil.	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Reduction in provisioning foods and water through contamination by oil and chemicals (actual and perceived).	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through chemical contamination (actual and perceived).

Mitigation Measures

The Ecosystem Services Table presented in Section G.8.1.1 resumes the potential Impacts of the Construction phase for the four identified priority habitats. Accordingly, a set of mitigations measures has been considered.

The mitigation measures are in line with each of the impacts identified for the Physical, Biological and Social environmental components identified in the Project baseline, nonetheless, for Ecosystem services, the main mitigation measures will be associated to the nature of the service.

- Provisioning services: those identified are related to hunting/fishing and gathering of local flora/fauna, thus mitigation measures applicable will be mostly related to those identified for Terrestrial/Aquatic Flora and Fauna and Habitats.
- Regulating services: main services identified are those of carbon sequestration, assimilation of contaminants (purification) and flood/erosion control, all of which are to a great extent produced by the loss of habitat through the clearing of trees and vegetation. Mitigation measures identified are those related to terrestrial flora, such as flora monitoring and re-vegetation.
- Cultural services: the main services that may be affected correspond to those of a loss of access to cultural-recreational sites by part of the local inhabitants, reduced landscape aesthetic values and disturbance of species in the area. No mitigation measures are in place for landscape considering the timespan of the construction phase, nonetheless mitigation measures for fauna consider the restoration of vegetative cover and limits to project emissions which may limit disturbance, and at the same time have an effect on the surrounding landscape. Loss of access by part of the locals may have in fact a positive outcome in regards that there would be a limit in hunting/fishing practices in specific areas, which may in turn benefit prey species that inhabit it.

In addition a pre-construction survey (either in the disclosure of the ESHIA Report or prior to construction) to consult with the affected communities, with special focus on Sanzule community, will be carried out in order to confirm the ecosystem services listed here, that the local population considers as priority. This will allow particular attention to be paid to them during the construction (and operation) phases of the project.

G.8.1.8 Operational phase impacts

Impacts identification and Assessment

The aim of this Section is to identify the possible impacts on ecosystem services during the operation phase, including onshore and offshore activities.

The following sources of operation impacts have been identified. Without mitigation, the sources listed below have the potentiality to cause impacts on ecosysteem services.

Table G124 Ecosystem impacts and risks - operation phase

Source of Potential Impact	Potential Impact
Project footprint of operating facilities	Modification, fragmentation and loss of habitats and agricultural land and the associated services
Exclusion zones	Reduction in access to ecosystem services
Operation activities and workforce presence	Disturbance to fauna and flora from air emissions, noise and light and depletion of natural resources (eg water, wood) for operation activities resulting in a reduction or loss of associated ecosystem services.
Chemical handling and waste generation (solid and liquid) and management	Potential pollution of soils and water with the associated loss on ecosystem services provided

As in the case of the construction/ installation phase, given the complexity and diversity of the services offered by each ecosystem and the multiple activities that may affect each of them this section asesses the impacts by each main habitat or ecosystem identified in the area, analyzing how the different operation activities proposed by the Project may affect each of the cateogries of the ecosystem services they are providing.

As a result, four tables are presented, each for one ecosytem, where the different sources of impacts and potential impacts on ecosystem services provided are identified and discussed.

Therefore, key potential impacts on ecosystem services during operation activities are presented as follows:

- Potential impacts to ecosystem services provided by forest habitats;
- Potential impacts to ecosystem services provided by wetlands habitats;
- Potential impacts to ecosystem services provided by deep sea habitats;
- Potential impacts to ecosystem services provided by nearshore habitats;

These are presented and assessed in the following tables.

Table G125 Identification of impacts and risks to ecosystem services (forest habitat) during the operational phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Facility footprint: Operation of facility, presence	Fragmentation of habitats. Noise. Light. Atmospheric emissions.	Use of local natural materials (i.e. aggregates) for foundations, concrete, etc.	Natural flood, erosion and storm controls at site.	n/a	Hunting is still a source of supporting livelihoods for some vulnerable group of people, so the reduction of the habitat could reduce the ability to hunt and gather wild foods **(i.e. meat, fruit, nuts)**, and to harvest timber and agricultural outputs.	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation.	n/a
Workforce and work camps: Construction, operation, closure	Disposal and pollution from wastes and wastewater, having visual, physical, biological and chemical impacts. Cutting down of trees. Potential introduction of alien-invasive species.	Use of local natural materials for building camps.	Assimilation service of rivers, soils, etc. disposing of liquid and solid wastes. Water filtration service to provide clean water	n/a	Possible pollution of water supply. Potential changes to supply of wild foods through introduction of alien species (typically negative impacts).	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in water purification by clearing vegetation.	Visual and aesthetic impact of camp and waste.
Provisioning workforce: providing food and water, etc.	Depletion of water and local food resources. Reduction in flora and fauna.	Use of local crops, livestock, medicinal plants, water, firewood, etc.	n/a	n/a	New local market but increased pressure on use of water and wild meat, fruit, nuts, etc. gathered due to increased procurement. (see construction phase	n/a	Possible reduction in species from increased hunting.

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
					mitigations).		
General operation: Resource requirements in operation (water, electricity)	Depletion of water resources. Support of local economies. Depletion of fuel, aggregates and timber, etc.	Water supply and energy supply	n/a	n/a	Reduction of water supply. Possible restriction in energy supply	n/a	n/a
Disposal of waste materials: General, hazardous	Contamination of air, soil, water and groundwater resources if not disposed and managed appropriately potentially causing smothering and poisoning of flora and fauna.	n/a	Assimilation services of receiving soil and vegetation.	n/a	Possible pollution of water supplies	n/a	Visual and aesthetic impact to locals. Impacts on species for degradation of environment.
Wastewater management	Contamination of soil, water, groundwater resources if not disposed and managed appropriately, potentially poisoning flora and fauna.	n/a	Assimilation services of receiving waters.	n/a	Pollution of water supplies and impacts to fisheries (if it reaches main water bodies). Possible useful products in the waste materials.	n/a	Visual and aesthetic impact to locals. Threats to species for degradation of environment.
Visual presence:	Impacts to local landscape. Visual	n/a	n/a	n/a	Possible pollution of water supply (and fisheries if it	n/a	Visual and aesthetic impact

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**	**Provisioning**	**Regulating**	**Cultural**
from permanent presence of the facility / traffic movements.	impacts to local communities and amenity users.				reaches main water bodies).		on enjoyment of locals.
Accidental events: Risk of chemical spills, pollution, fires, explosions.	Water, soil and air contamination. Mortality and morbidity to flora and fauna. Noise.	Use of water to control fires. Use of natural products (i.e. vegetation) to absorb oil. Use of sand in bags to block oil.	Assimilation services (i.e. dilution and microbial action) to help break down and disperse chemicals.	n/a	Reduction in provisioning foods and water through contamination by chemicals (actual and perceived).	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through chemical contamination (actual and perceived).

TableG126 Identification of impacts and risks to ecosystem services (wetlands) during the operational phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
Chemical handling and use: including pre-commissioning chemicals	Possible water quality contamination associated with permitted releases.		Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.		Possible reduction in artisanal or commercial fisheries (especially perceived impacts).		
Accidental events: Risk of chemical spills, pollution, fires and explosions.	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.		Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.		Reduction in provisioning foods through contamination by chemicals (actual and perceived).		Reduction in local livelihoods and species through chemical contamination (actual and perceived).

TableG127 Identification of impacts and risks to ecosystem services (deepwater habitat) during the operational phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
FPSO and vessels: Operation and general presence (FPSO, support vessels)	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence. Alien-invasive species associated with water and sediment ballast.		Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.		Possible increase in commercial fisheries resulting from the rig acting as habitat; impacts would have to accrue outside of any exclusion zones. Possible impacts on fisheries due to disturbance and alien-invasive species.		Disturbance (visual, auditory and physical) of species
Buffer zones: Permanent exclusion of boats from a defined area	Reduced human access to an area. Protection of habitats and species (i.e. reduced fishing effort).				Reduction in commercial or artisanal fisheries (restricted access to fishing grounds). Potential local increase in key species due to protection from overuse.		
Footprint / physical presence of equipment: FPSO, subsea equipment, pipelines, etc.	Potential artificial reef effect (positive impacts for various species, fish and fisheries). Noise from subsea valves leading to disturbance of fauna.				Possible for subsea structures to increase commercial or artisanal fisheries in the immediate area.		

Chemical handling and use: including hazardous waste, biofouling and corrosion protection	Possible water quality contamination associated with permitted releases.		Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.		Possible reduction in commercial or artisanal fisheries.		
Accidental events: Risk of blow outs, chemical spills, pollution, fires, explosions and ship groundings.	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.		Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.		Reduction in provisioning foods and fisheries through contamination by chemicals (actual and perceived). Both large scale commercial and artisanal fishing could be impacted depending on the size and extent of the spill		Reduction in local livelihoods, recreation and species through chemical contamination (actual and perceived).

Table G128 Identification of impacts and risks to ecosystem services (nearshore/ transition zone habitat) during the operational phase

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	Regulating	Cultural	Provisioning	Regulating	Cultural
FPSO and vessels: Operation and general presence (rigs, support vessels)	Noise and light. Physical presence of ships leading to disturbance to fauna. Visual presence. Alien-invasive species associated with water and sediment ballast.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse chemicals.	n/a	Possible increase in commercial or artisanal fisheries resulting from the rig acting as habitat; impacts would have to accrue outside of any exclusion zones. Possible impacts on fisheries due to disturbance and alien-invasive species.	n/a	Possible disturbance of species. Possible impacts on marine recreation (visual presence).
Buffer zones: Permanent exclusion of boats from a defined area	Reduced human access to an area. Protection of habitats and species (i.e. reduced fishing effort).	n/a	n/a	n/a	Possible reduction in local people's ability to fish (restricted access to fishing grounds and/or landing sites); perceived impacts in particular. Potential increase in key species due to protection from overuse.	n/a	Loss of access to cultural, livelihood and recreation features. Protection of habitats and species from misuse and overuse by people.

Sub-activity Issue	Potential Impact	Dependencies on Ecosystem Services			Impacts and Risks on other Receptors and Resources due to changes in Ecosystem Service Functioning		
		Provisioning	**Regulating**	**Cultural**	**Provisioning**	**Regulating**	**Cultural**
Footprint / physical presence of equipment: Offshore pipeline.	Potential artificial reef effect (positive impacts for various species, fish and fisheries). Noise from subsea valves leading to disturbance of fauna	n/a	n/a	n/a	Possible for subsea structures to increase commercial or artisanal fisheries. Alternatively, possible reduction in fish or shellfish due to disturbance.	n/a	n/a
Chemical handling and use: including hazardous waste, biofouling and corrosion protection	Possible water quality contamination associated with permitted releases.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Possible reduction in commercial or artisanal fisheries (especially perceived impacts)	n/a	Possible negative impacts for marine **recreation.**
Accidental events: Risk of blow outs, chemical spills, pollution, fires, explosions and ship groundings.	Water and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	n/a	Assimilation services (i.e. dilution and microbial action) to help break down and disperse chemicals.	n/a	Reduction in provisioning foods through contamination by chemicals (actual and perceived).	n/a	Reduction in local livelihoods, recreation and species through chemical contamination (actual and perceived).

Onshore							
Facility footprint: Operation of facility, presence of workforce	Fragmentation of habitats. Noise. Light. Atmospheric emissions.	Use of local natural materials (i.e. aggregates) for foundations, concrete, etc.	Natural flood, erosion and storm controls at site.	n/a	Possible reduction in local people's ability to gather wild products (firewood from mangroves, etc.).	**Loss of carbon sequestration services from clearing trees and vegetation.** Reduction in flood and erosion control and water purification by clearing vegetation.	Reduction in access to cultural or recreation features. Disturb tranquility of area for local communities and species, including potential disturbance of sea turtle nesting in beaches.
Disposal of waste materials: General, hazardous	Contamination of air, soil, water and groundwater resources if not disposed and managed appropriately potentially causing smothering and poisoning of flora and fauna.	n/a	Assimilation services of receiving soil and vegetation.	n/a	Possible pollution of water supplies and impacts to fisheries (if it reaches main water bodies) **and possible damage to mangroves habitats.** Potentially useful products in the waste materials.	n/a	Visual and aesthetic impact to locals and visitors. Impacts on species, including sea turtles nesting.
Wastewater management	Contamination of soil, water, groundwater resources if not disposed and managed appropriately, potentially poisoning flora and fauna.	n/a	Assimilation services of receiving waters.	n/a	Pollution of water supplies and impacts to fisheries (if it reaches main water bodies). Possible useful products in the waste materials.	n/a	Visual and aesthetic impact of camp and waste to locals. Threats to species **due to environmental degradation.**
Visual presence: from	Impacts to local landscape. Visual impacts to local communities and	n/a	n/a	n/a	Possible pollution of water supply (and fisheries if it reaches	n/a	Visual and aesthetic impact on enjoyment of

permanent presence of the facility / traffic movements, etc.	amenity users.				main water bodies).		locals.
Accidental events: Risk of blow outs, chemical spills, pollution, fires, explosions, etc.	Water, soil and air contamination. Mortality and morbidity to flora and fauna. Noise, fire and smoke.	Use of water to control fires. Use of natural products to absorb oil. Use of sand in bags to block oil.	Assimilation services (i.e. dilution and microbial action) to help break down and disperse oil and chemicals.	n/a	Reduction in provisioning foods and water through contamination by oil and chemicals (actual and perceived).	Reduction of regulating services from loss of habitat extent and quality.	Reduction in local livelihoods, recreation and species through chemical contamination (actual and perceived).

Mitigation Measures

The Ecosystem Services Table presented in G.8.1.1 resumes the potential Impacts of the operation phase for the four identified main habitats identified in the Project AoI.

The mitigation measures required to minimise impacts on ecosystem services are in line with each of the impacts identified for the Physical, Biological and Social environmental components identified in the Project baseline, nonetheless, for Ecosystem services, the main mitigation measures will be associated to the nature of the service. As such, mitigation measures included for the operation phase on its different components will also apply for the ecosystem services.

In general terms, the impacts identified for the operating phases are less significant than those of the construction phase, as the level of impact on ecosystem services is corrolated with the land take which occurs during construction, larger workforce presence (and secondary impacts on demand for local goods and services) and movement of vehicles and machinery during the construction phase. During operation, it is expected that there will be a reduction in the demand of the local goods and materials (water, food, etc), a reduction in the activity associated to workforce presence and machinery movement. Mitigation measures during operation consist of the continuation of those already set forth during the construction phases (i.e. maintenance of revegetated areas).

In any case, priority ecosystem services will be identified in consultation with the affected communities during the livelihood restoration baseline data collection. Results of these consultations will be reflected in the Livelihoods Restoration Plan, so as to ensure efficiency of the mitigation measures in those key ecosystem services for the local populations.

G.8.1.9 Decommissioning phase impacts

Impacts identification and Assessment

Potential impacts during Project decommissioning are likely to be similar to impacts during construction but less significant than during the Construction Phase due to the smaller affected area.

Mitigation Measures

Potential impacts and related mitigation measures for the offshore decommissioning phase of the Project, will be similar to those expected for the Construction Phase. Appropriate mitigation, both for onshore and offshore section of the Project will be addressed by a Preliminary Decommissioning Plan.

G.9 UNPLANNED EVENTS

Several types of unplanned events with potential consequences to humans and the environment could occur during the different phases of the project. In this early stage of engineering and design, the Project has performed preliminary assessments of risks. More detailed assessments will be conducted at later stages of the Project design including studies to identify risks (e.g., HAZID, ENVID) and methods to assess and mitigate risks (e.g., HAZOP, QRA). These studies would be carried out to in order to refine design and identify additonal prevention and mitigation (if relevant) to minimize risks to ALARP (as low as reasonable practical) according to internationally accepted good practice.

In order to keep as much coherence as possible with the routine operations impacts, impacts from unplanned events will also be distributed between the onshore and offshore components of the project.

G.9.1 Assessment Approach and Criteria

For unplanned events the methodological approach to impact assessment differs from the routine events. Evaluating impacts requires consideration of two factors, namely the probability of an event occurring, and the consequences (considering sensitivity/value of receptor and magnitude of consequence). Probability is determined by using historical data and referring to eni Ghana's probability and consequence definitions as summarised in Table G129 and Table G130.

Table G129 Probability definitions

Rating	Probability
0	Practically non-credible occurrence (could not happen in E&P industry)
A	Rare occurrence (heard of in E&P industry)
B	Unlikely occurrence (occurred at least once in Company)
C	Credible occurrence (occurred several times in the Company)
D	Probable occurrence (occurred once in this location)/(occurred several times in the Company)
E	Likely/ Frequent occurrence (occurred several times in one location)

Table G130 Consequence definitions

Severity		Environment Consequence
1	Slight Effect	Slight environmental damage – contained within the premises.
2	Minor Effect	Minor environmental damage, but no lasting effect.
3	Local Effect	Limited environmental damage that will persist or require cleaning up.
4	Major Effect	Severe environmental damage that will require extensive measures to restore beneficial uses of the environment.
5	Extensive Effect	Persistent severe environmental damage that will lead to loss of commercial, recreational use or loss of natural resources over a wide area.

Based on the above criteria a risk matrix can be elaborated in order to assess the unplanned events. This matrix is presented in Table G131.

Table G131 Environmental risk matrix

Severity	Consequence	Probability					
		0	A	B	C	D	E
1	Slight Effect						
2	Minor Effect						
3	Local Effect						
4	Major Effect						
5	Extensive Effect						

Key Colour

Low Risk   Medium Risk   High Risk

G.9.2 Offshore component

Preliminary assessments undertaken allow an identification and asessment of the events with the most significant consequences. These events in the case of the OCT project are:

- Well blow out;
- Rupture/failure of pipes/flow lines at different sections:
- Spills of hazardous materials (including oil spill and diesel spill from FPSO).

The risk associated to these events, with their associated fire/explosion/pollution secondary consequences, is analysed in the following sections.

G.9.2.1 Well blow out

The following studies related to this potential event have been undertaken by eni:

- Phase II Gas Development- Blow-Out and Dinamic Killing Study
- Ghana OCTP block - Hazard Identification for Oil Spill Analysis

The latter document is specific to the Phase 1 wells (oil phase), as it analyses the risk of an oil spill associated to well blow-out. The risk of an oil spill is discussed independently in section G.9.2.3.

For a blow out with gas and condensate as releases, the first study aims were:

- Assess a blowout (underwater and atmospheric) maximum condensate and gas flow rate evaluation in order to identify and characterize the Worst Case Discharge (WCD);
- Underwater plume modelling and water density profile evaluation for the subsea WCD;
- Flammable gas dispersion;
- Dynamic killing mitigation assessment and characterization (underwater and atmospheric scenarios) in order to identify the worst case in terms of mud rate, pump head, required total mud volume and killing time;

The study does not include a probabilistic assessment of a gas blow with the worst case scenario, but presents the potential consequences of such a scenario. The definition of the WCD is in compliance with the NTL No. 2010-N06 delivered by US BOEM[1] after the Macondo event and detailed in a Guidance for Complying delivered by a dedicated SPE Committee. For the assessment methodology a probability type B Unlikely occurrence (occurred at least once in Company), will be used, for conservative purposes.

The main conclusions of the mentioned study in terms of consequences are:

- The fluid released from the blowout generates a plume that raises towards the surface. When the plume is exhausted, the gas is dispersed in the water sea as bubbles that will reach the sea surface. The presence of gas bubbles in the water column modifies the density of the water near the blowout source and this effect could be dangerous in terms of stability of the vessels present in the area. The subsea WCD scenario (SANKOFA-D casing) has been considered in order to evaluate the water density profile variation and the amount of gas that reach the sea surface in case of a subsea blowout. From the simulations, it results that the gas phase released during the blowout forms hydrates due to the specific ambient conditions (high pressure and low temperature). For this reason the water density profile variation, due to the presence of gas bubble, can be neglected.
- The flammable concentration has been evaluated at different heights above the sea level. For the atmospheric blowout the gas jet reaches a height of about 57 m above the sea level. The flammable gas concentrations are lower than the reference thresholds for each meteorological condition. For a subsea blowout the gas released does not reach the sea surface due to hydrate formation. For this reason, the flammable gas dispersion originating from the volatile phase released from the condensate reaching the sea surface has been modelled. The flammable thresholds are not reached after the dilution of gases due to diffusion phenomena
- The times and volumes of mud required to kill the well and displace oil and gas completely from the blow-out well is in the orders of magnitude of 30 minutes, with a total mud volume of 2000 m^3.

[1] NTL N. 2010-N06, "NATIONAL NOTICE TO LESSEES AND OPERATORS OF FEDERAL OIL AND GAS LEASES, OUTER CONTINENTAL SHELF (OCS)", UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF OCEAN ENERGY MANAGEMENT, REGULATION, AND ENFORCEMENT, June 18, 2010

Using the methodology above mentioned, the consequences of the worst case scenario, could be considered minor (category 2) for the effects on navigation or the FPSO itself (no buoyancy problems nor fire/explosion risk).

From the purely biological standpoint, it is likely that a significant gas or condensate release from the pipeline would result in fatal impacts on fish life or marine mammals located in the immediate vicinity of the plume of gas, primarily as a result of pressure released and a local reduction in oxygen. This is likely to be very limited in extent however, as the vast majority of pelagic marine species would immediately vacate the area. Therefore in the worst case it could be considered local (category 3).

The overall environmental risk rating is thus ***Medium*** according to the matrix risk (Table G131), before the implementation of any mitigation measures, thus consideration to further mitigation in order to reduce the risk to ALARP is necessary.

Mitigation for accidental events can be of two different main types, those that decrease the probablity of the event happening and those that mitigate the consequences of the event (x and y axes of Table 130, Risk Matrix, respectively)

With respect to the measures which decrease the probability of the events, a well blow out can be caused by a range of trigger events taking place during drilling, completion and operation phases.

Design measures have also been introduced to reduce the risk of blow-out. A summary of the mitigation measures to be implemented during the drilling program is provided below:

- adoption of industry standard formal and systematic hazard identification, drilling, operational and maintenance practices and procedures;
- detailed understanding of the nature of hydrocarbon reservoirs being drilled and the adoption of proven industry standard well design and drilling technology;
- use of appropriate drilling fluids for hydrostatic control in the event of sudden or unexpected changes in well bore pressure;
- installation and regular testing of industry standard safety valves (blowout preventers) on the subsea well head;
- preventive maintenance on all rig equipment;
- use of only competent crews with Engineers, Drillers and Drilling Supervisors trained and certified in well management and well control procedures;
- ongoing checks of facility and equipment integrity;
- standard procedures of well monitoring and control, including development of a peer-reviewed / independent expert reviewed well control plan for each well, before drilling.

The Project will incorporate an Integrated Control and Safety System (ICSS) that will provide an integrated monitoring, control, protection and safety system for the entire drilling, production, topsides, marine, and subsea facilities. The safety systems shall be separate from the Process Control System (PCS):

- Routine operator inspections, maintenance inspections and internal and external audits;

- Emergency Shut Down (ESD) valves at every well head and platform;
- Secondary and emergency controls systems installed and tested;
- Procedures followed on all occasions and not circumvented;
- Regular emergency drills scheduled and performed.

With regards to the measures aimed at reducing the consequences of a potential gas blow out, the main ones are the following:

- inclusion in the well procedures of the kill option identified in the study, and
- implementation of the Emergency Plan in case of a blow out.

G.9.2.2 Rupture/failure of pipes/flow lines at different sections

For this risk, eni has undertaken a study of a SSIV (Sub Sea Isolation Valve) systems as a semi-quantitative risk assessment. The study includes all the risk assessment techniques in order to assess the benefits of installing such a SSIV system to decrease identified risks related to the mentioned initiating events. The study is comprehensive in terms of types of pipes/flow lines included in the assessment, identification of release causes (ship impact on riser, drifting vessels, sinking ships, dropped TEU, interaction with fishing activities, dropped object from FPSO crane) accidental scenarios, frequency and consequence assessment, risk assessment, ranking, identification and recommendation of ALARP measures.

Effects from a gas release from a pipe would be similar to those of a gas release from a blow out. Results from the simulations of the density profile variation and subsequent effect on buoyancy of passing vessels, show that the gas phase released during the blowout forms hydrates due to the specific ambient conditions (high pressure and low temperature). For this reason the water density profile variation, due to the presence of gas bubble, can be neglected.

The study makes a detailed risk assessment related to fire and explosion consequences from the different scenarios, Based on the classification for frequency and consequences described in the study, and consistent with the method described in previous sections, the risk level associated to all the scenarios able to give consequences belonging to the same severity class risk is assessed by the intersection of the frequency column with the severity row in the eni Risk Matrix , similar to Table 130 in concept. The general results show that in case of risk to people, the number of scenarios in “Medium” area is always significantly higher than the number of scenarios classified as “Low”. These results are caused by the severity classification of fire scenarios, due to the nearness from the release points to manned areas of the FPSO. This would require the implementation of ALARP measures.

From the purely biological standpoint, the involved volumes of gas and condensate release from pipelines ruptures are much lower than from a blow-out scenario. Therefore, it is less likely that they would result in fatal impacts on fish life or marine mammals located in the immediate vicinity of the plume of gas as a result of pressure released and a local reduction in oxygen. This is likely to be even more limited in extent, as the vast majority of pelagic marine species would immediately vacate the area.Therefore, in the worst case it could be considered minor (category 2), and consequently minor risk, not needing further mitigation.

In terms of mitigation which decrease the probability of the events, the causes of the rupture/leak (ship impact on riser, drifting vessels, sinking ships, dropped TEU, interaction with fishing activities, dropped object from FPSO crane), these are difficult to decrease beyond current design and planned mitigation measures (such as preventative maintenance, pigging, ROV surveillance), however they could be investigated in further engineering phases.

For mitigation with the aim and lowering the consequences of a rupture/leak, those will be focused in the risk to people at the FPSO scenarios. The mentioned SSIV study identifies the following mitigation options:

- SSIV: the implementation of Subsea Safety Isolation Valve is required on long lines, since in case of rupture the release could last for long periods, and strongly reccomended for the gas injection line. Such solution has already been implemented, as described in Section 4.5.1 of this ESHIA
- Electro-hydraulic activation on wellhead: for short lines (with length between 3 and 4 km) theimplementation of electro-hydraulic activation on wellhead to close wellhead valves is resulted to be a sufficient protection measure
- Fire (Flame) detection system: flame detection system (UV/IR) on each balcony is recommended in order to have quick leak detection times
- Water inside the hull: it is common practice, in case of FPSO, to fill the external hull with water; this solution will not significantly affect the floating of the vessel due to its large dimensions and it will protect the bulkhead in case of flame impingement,
- Automatic / remotely operated monitors: the installation of remotely operated firewater monitors in the corners of the balcony, directed on the bulkhead, could assure a longer resistance of the hull to flame impingement if combined with some of the other measures

The implementation the SSIV measure is possibly enough to decrease the risk to ALARP LEVEL, whether this is so or other complementary meadures are needed will be be determined at further stages of engineering design, once the final QRA is available.

G.9.2.3 Spills of Hazardous Materials

Oil Spills

The risk of an oil spill into the marine environment is inherent in all offshore oil and gas developments and represents the largest potential environmental impact.

Although there will be no oil production as part of the Project (OCTP Block Phase 2) , there will be shared infrastructures between both Phases of the project (Phase 1, OCTP Block Phase 1 oil drilling and production and Phase 2 gas and condensate well drilling and production) such as the FPSO. In this situation it has been decided to identify and, the potential impacts related to large-scale unplanned events i.e. major oil spills of any and all of the common and associated structures of both Phases of the Project, as part of this EIS.

During the drilling and completion phase there is also the potential for spills of fuels and oils during drilling operations, well head installations, fuelling, handling and storage of chemical and fuels including repair, fabrication and maintenance of machinery, as well as from support vessels.

During FPSO installations and operations (offloading), accidental spills may occur from a loss of well integrity, leaks in subsea manifolds, flowlines, riser through which crude oil is pumped into the FPSO. Also the water/oil separation operation in the FPSO has potential to spill produced water and oil. Offloading operations, ship to ship transfers as well as tanker vessels colliding are also key sources of spills of oil into the marine environment.

Evaluating oil spill risks, as mentioned in the general approach to accidental events section, requires consideration of two factors, namely the probability of a spill occurring, and the consequences (considering sensitivity/value of receptor and size of spill). The probability was determined by using historical data and referring to eni Ghana's probability and consequence definitions as summarised in Table G129 and Table G130.

Assessing the environmental risk of oil spills begins by firstly describing the characteristics of the oil. This will be a key factor in determining the oil's behaviour in the environment and the associated response. Potential oil spill scenarios are then defined based on a comprehensive risk assessment.

Potential oil spill scenarios identified in the risk assessment are then selected for spill modelling taking into account the site weather and sea conditions, including any seasonal variations. The results of the modelling not only give an indication of the size and dispersion of oil spill events, but also identify the likely zone of effect.

Modelling Overview

Oil spill modelling was done at Eni using SINTEF's Oil Spill Contingency And Response (OSCAR) software. Oil spill computer modelling predicts the fate and effect of oil in the environment. In this risk assessment two types of modelling using the OSCAR model have been utilised.

Deterministic modelling is used to predict the route of a hydrocarbon slick over time, and to estimate the oil weathering profile under specific meteorological conditions. It investigates potential beaching under a constant (worst case) wind speed and direction.

Stochastic modelling is used to estimate the likelihood of particular trajectories occurring, based on historical wind speed and direction data. This is then calculated to provide a probability range of oiling representative of the prevailing conditions.

Project Release Scenarios

The term "scenario", as used in this report, refers to the conditions that describe a specific spill event including the type of oil spilled, as well as the volume, duration, location, and depth of the release. To identify these scnearios eni undertook a Hazard Identification for Oil Spill Analysis, from which the following scanrios have been selected.

For the purpose of this EIS, the most probable (i.e. highest frequency, but relative to the identified scenarios, not raw frequency which is extremely low for any scenario), the most severe (i.e. largest volume spill), and a diesel spill have been considered as worst cases, corresponding all to a Tier 3 response (that is the most severe cases) :

- **Most severe case**: blowout through the main bore and atmospheric discharge from the OP-Camp1 well. This is not only due to the total volume of oil that could be released (due to lack of backpressure of the water-column), but also from the point of view of the potential slick, since the oil does not disperse into the water, while rising from the seabed to the sea surface.
- **Most probable case**: blowout through the main bore and atmospheric release from the OP5-Cenom well. Again, the lack of water backpressure and dispersion into seawater maximise the volume spilt.
- **Diesel spill from FPSO**: diesel release from FPSO fuel tank due to collision with another vessel.

Table G132 summarises the assumptions for each scenario such as type of event, volume released for each scenario, and the spill duration. All the events considered are extremely improbable as such, and the released quantity used for the model is considered conservative. Additional scenarios and the technical details of the modelling approach are presented in the oil Spill Contingency Plan (OSCP) attached to this EIS.

Table G132 Oil spill scenarios

Case	Release site	Phase	°API	Release Depth	Release duration	Simulation duration (days)	Volume spilt (m^3)
Most severe	OP-Camp1	Drilling	31.7	Sea level	95 days	120	819,175
Most probable	OP5	Completion	31.7	Sea level	95 days	120	121,311
Diesel spill	FPSO	Production	36.4	Sea level	2 hours	45	8,304

Blowout scenarios have been simulated, both in the stochastic and in the deterministic approach, assuming a release duration of 95 days (the maximum period considered necessary to bring the well under control, a hybrid between relief well drilling and capping), and for a further 25 days after the source had stopped discharging in order to examine the full extent of the fate of the oil in the marine environment. In the case of the fuel release of 2 hour duration, the model includes the fate of the spill for 45 days.

Modelling has been carried out with the assumption that no intervention measures have been implemented on the spill after the release. Under normal conditions, oil recovery would be attempted and/or dispersants used which would reduce the impact from that predicted by the model.

Modelling Results

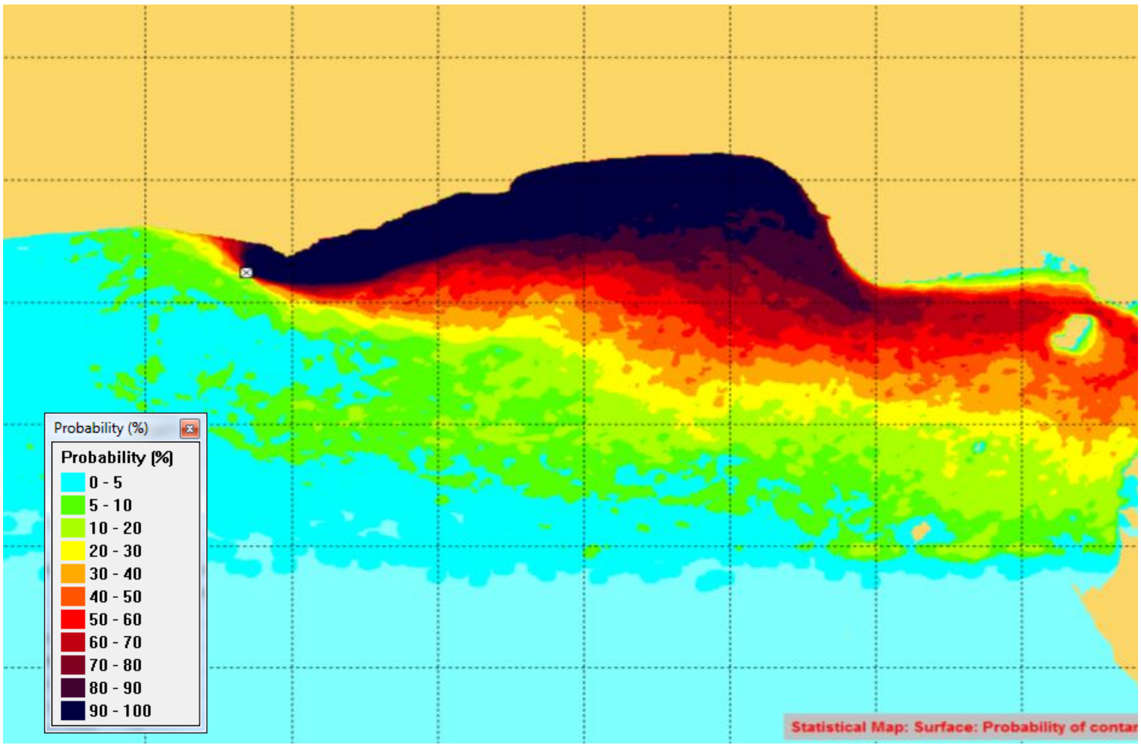
Most Severe Case

In this first scenario, an accident results in the continuous discharge (95 days) of crude oil at sea level at OP-Camp1 location.

The results of the stochastic model reveal the probability of contamination from oil on the sea surface (Figure G5) and from oil stranded ashore (Figure G6). The probability of contamination is more than 90% from 3° W (West of Cape Three Points) to 5° E, in offshore Nigeria, and then decreases. The simulation indicates that the oil on the surface may travel over 900 km to the east. These results present a marine environment area theoretically at risk (probalistic area) as a result of the summary of several single spills with different metocean conditions. In reality the surface area affected would be much smaller and would be determined by the actual metocean conditions prevailing at the time of a spill. Similar considerations apply to the actual location affected.

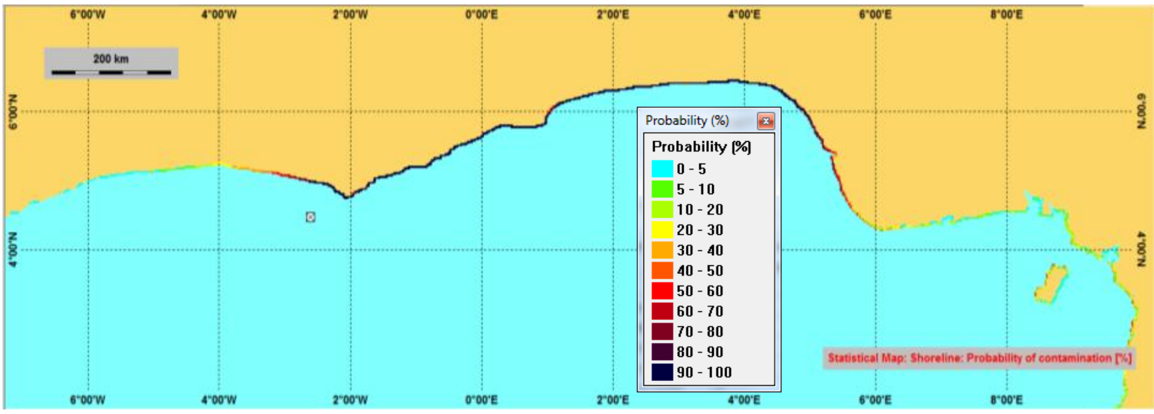
The maximum thickness of the emulsion of oil expected in this length of shore is approximately 10-11 cm. The same pattern in shown also by stranded oil.

Figure G5 Probability of contamination offshore- most severe case



Source: eni, 2015

Figure G6 Probability of contamination ashore- most severe case



Source: eni, 2015

The results of the trajectory (deterministic) modelling indicate that the maximum amount of oil ashore after 120 days, in the worst metocean conditions would be 63,960 tons, as while 35.2% of the oil released evaporates, 33.2% remains on the surface of the ocean and the remaining oil is in the water column or is biodegraded.

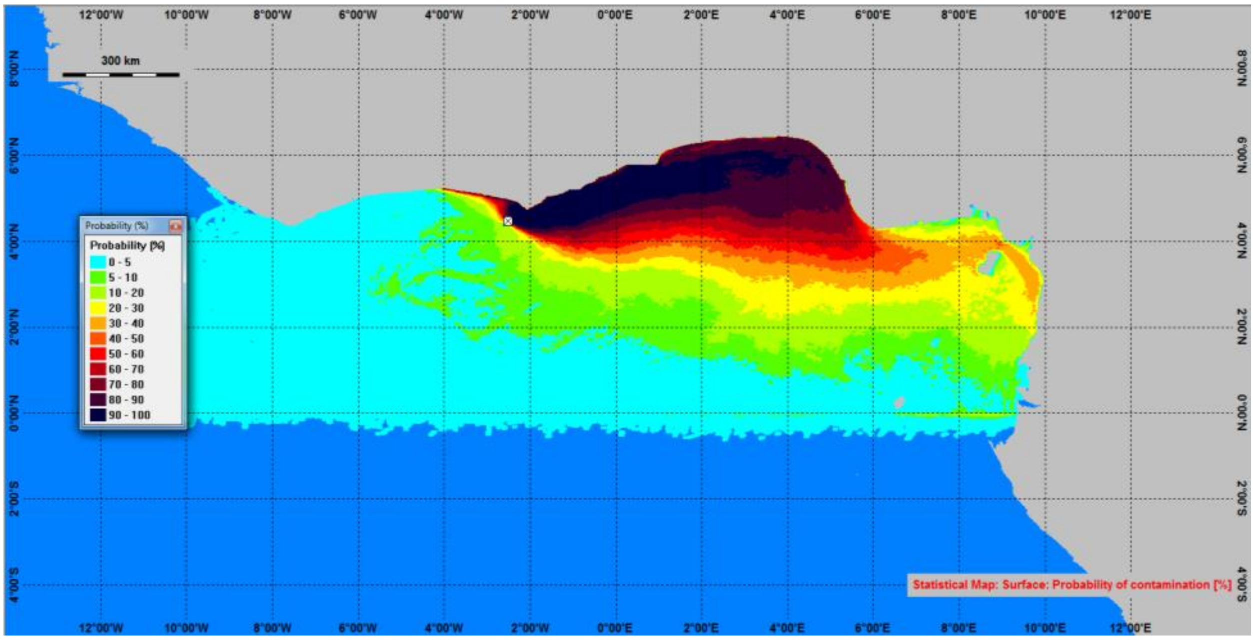
The minimum time of arrival ashore would be 1 day and 12 hours according to the model considering the worst metocean conditions pushing the spill northwards towards the coast, which would initially affect the coastline facing the wells locations.

Most Probable (relative) Case

In this scenario, an accident results in the continuous discharge (95 days) of crude oil at sea level from oil well OP5 during the completion phase.

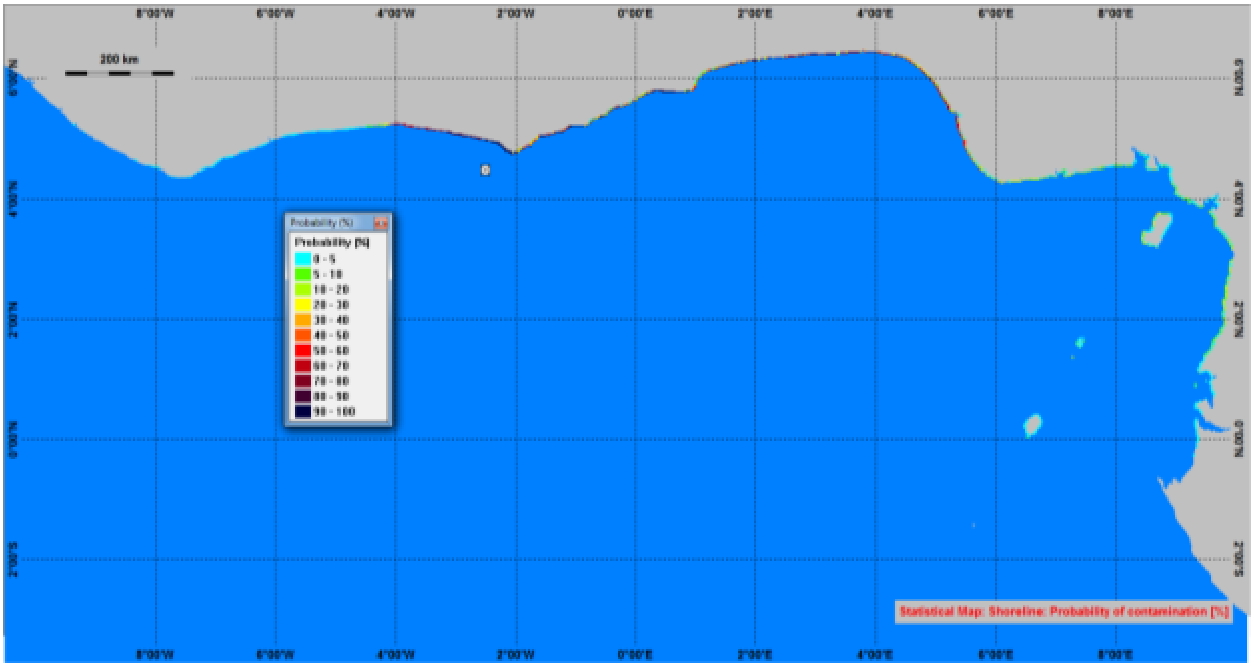
Results are similar to those for previous scenario, with the location with the greatest likelihood of being affected being north off the well in the Axim and Cape Three points coasts. The released oil, driven by wind and marine currents, drifts mainly eastwards, giving an area in which the probability of contamination is over 90 % off the coasts of Ghana, Togo, Bénin and Nigeria.

Figure G7 Probability of contamination offshore- most probable (relative) case



Source: eni, 2015

Figure G8 Probability of contamination ashore- most probable case



Source: eni, 2015

The results of the trajectory (deterministic) modelling indicate that the maximum mass of oil ashore, after 120 days for this scenario would be 27,132 tons, provided the specific metocean conditions take place. Among the total oil released, after 120 days, 40.5 % evaporates, 25.9% remains on the surface of the ocean and the remaining oil is in the water column or biodegraded.

The minimum time for the oil to reach the shore in the most unfavourable metocean conditions is 1 day and 15 hours, reaching the Cape Three Points coast.

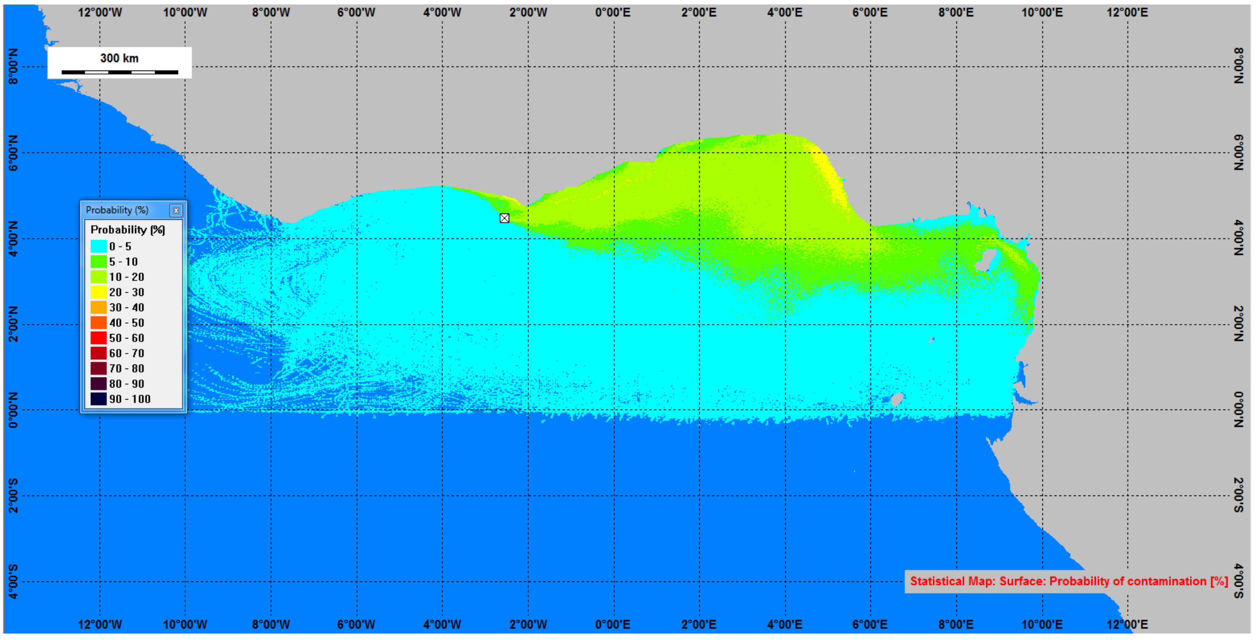
Diesel Spill from FPSO

In this scenario, a collision results in breakage of fuel tank in the FPSO and the associated release of diesel during 2 hours. The modelling encompasses the fate of the diesel during 45 days.

Results are similar to those for previous scenarios in term of potential area affected, as released oil, driven by wind and marine currents, drifts mainly eastwards. However, given the lower quantities and the more volatile nature of the diesel fuel, probabilities are much lower, reaching a maximum probability of contamination of 30 % for a given point considering multiple simulations of different metocean conditions.

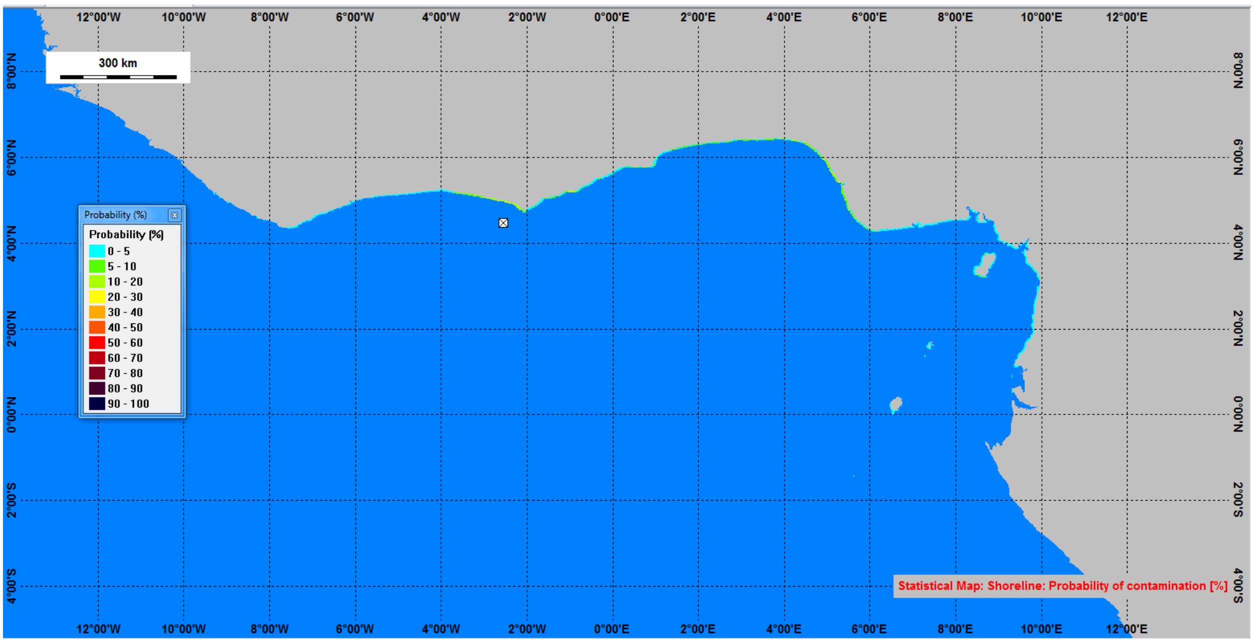
Graphical results of the probability for shoreline oiling and offshore contamination are presented in Figure G9 and Figure G10. Note that these figures do not represent the area contaminated in a given case but just the probability of a given point of being polluted, as the final output in case of an spill will depend in actual metocean conditions.

Figure G9 Probability of contamination offshore- diesel spill case



Source: eni, 2015

Figure G10 Probability of contamination ashore- diesel spill case



Source: eni, 2015

The maximum mass of oil that would reach the shore, after 45 days, is 2,532 tons, that is 36.2 % of the whole spill, while 27.2 % evaporates and 36.3 % is biodegraded. No diesel is left in the water column after that period of time.

The minimum time for the diesel spill to reach the shore in the worst metocean conditions would be 1 day and 18 hours arriving to the Cape Three Points.

Evaluation of Potential Impacts

The severity of potential environmental effects will depend on a range of factors, such as the size and duration of the spill, the duration of exposure, the time of year, weather and sea conditions and the extent of weathering of the oil. These factors affect the toxicity of the oil and how amenable it is to natural and chemical dispersion, and to clean-up once on shore. In addition, the general condition and life stages of individuals potentially affected at the time will influence the resilience they exhibit to possible oiling, and the speed and extent of recovery.

The following assessment is based on a general understanding of known oil spill effects on the types of habitats, communities and species that occur in the region.

In the event of a well blowout, the marine environment offshore and coastal shoreline of Ghana would be impacted. Offshore, there will be impacts to water quality, however, the more significant impacts would be to marine biodiversity, and in particular those species that frequent the sea surface, including seabirds, marine mammals and turtles. Fish species and larger invertebrates in deeper water will tend to avoid the sea surface or leave the impacted area in the event of a spill.

Onshore, impacts could include contamination of sensitive habitats such as mangroves, wetlands, lagoons and turtle nesting beaches and impacts on species that frequent such habitats such as coastal birds, fish and turtles.

These impacts are described further in the following Sections.

Seabirds and Coastal Birds

Direct mortality of birds in the event of an oil spill is often the most widely perceived risk. While impacts to birds can occur offshore in the marine environment, the more pronounced impacts are often experienced if oil reaches coastal waters. Spills affecting coastal waters near major bird colonies during the breeding season can be particularly severe since birds are feeding intensively and often dive through the surface oil to feed on fish.

Birds are affected by oil pollution in the following three key ways.

- Stains of oil on the plumage may destroy the insulating and water repelling properties which may ultimately cause the death of the bird.
- 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.

Main bird areas potentially affected by the spills according to the model are the coastal Important Bird Areas as designated by Birdlife international, namely the Amasuri wetland, Densu Delta (also designated as Ramsar Site), Keta Lagoon Complex (Ramsar Site), Muni-Pomadze (Ramsar Site), Sakumo (Ramsar Site) and Songor (Ramsar Site). Main affected species would be both seabirds (15 species recorded in Ghana) and water birds (up to 120 species recorded in Ghana), including black tern, white winged black tern, royal tern, common tern, sandwich tern, great black-back gull, lesser blackback gull, pomarine skua and great skua. According to the model, these areas would be affected with more than the 90% probability in the most severe and most probable scenarios derived from oil wells, while in the scenario of the diesel spill the probability of each area to be affected would be less than 30%.

Marine Mammals

The marine environment in offshore Ghana is known to support significant marine mammal populations, as discussed in Section G.5.5of this report, including the sperm whale (*Physeter macrocephalus*), assessed as vulnerable by the IUCN and the Clymene dolphin (*Stenella clymene*) included in Appendix II in the 2008 Conference of the Parties of the Convention for the Conservation of Migratory Species (CMS/UNEP), the latter beign probably the most common cetacean species in Ghanaian waters. The humpback whale (*Megaptera novaeangliae*) is known to breed in the area (between August and December).

Marine mammals are generally less sensitive to oil spills than seabirds as they will tend to avoid and move away from affected areas and avoid any breaching or feeding behaviors, thus reducing direct physiological impacts, and returning as the environment recovers. However, marine mammals are still sensitive to impacts from oil spills, and in particular from the hydrocarbons and chemicals that evaporate from the oil, particularly in the first few days following a spill event.

In this context, most of the area affected by the spill in the most probable and most severe scenarios is expected to present dissolved aromatic hydrocarbons (DAH) concentrations above the acute toxicological threshold (5 ppb), and therefore beign indicative of potential damages to marine mammals. Ingestion or contact with tiny liquid droplets may cause additional stress or mortality upon the organisms in this region. Dilution and biodegradation will typically reduce these concentrations to sub-lethal levels within days to weeks. However, even at sub-lethal levels, impacts may occur due to chronic impacts from prolonged exposure to these dissolved concentrations. In summary, an oil spill as those modelled would result in avoidance of the area by the marine mammals and an increase in mortality and probably a reduction in reproduction success due to potential chronic problems for the individuals affected.

Marine turtles

Marine turtles spend most of their life at sea, but during the breeding season they go ashore and lay their eggs on sandy beaches. Green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*) and Leatherback (*Dermochelys coriacea*) turtles nest on the isolated beaches found along the entire Western Region of Ghana and in most of the beaches along the country.

The area with higher probability of shoreline oiling, with more than 90 % probability covers the whole Ghanaian coastline eastwards from the release site in the most probable and most severe scenarios, and therefore includes critical habitats for the reproduction of marine turtles as it hosts many known nesting beaches.

Turtles are sensitive to the effects of oil spills at all life stages: eggs, post hatchlings, juveniles and adults. Several aspects of sea turtle biology place them at particular risk. These include a lack of avoidance behaviour, indiscriminate feeding around the sea surface and large pre-dive inhalations at the sea surface. Potential direct impacts from oil spills to sea turtles include:

- increased egg mortality and developmental defects;
- direct mortality due to oiling in hatchlings, juveniles and adults; and
- negative impacts to skin, blood, immune systems and salt glands.

In addition, sea turtles are sensitive to potential secondary and longer term impacts, which are generally less obvious than the short term impacts immediately following a spill. These impacts include:

- behavioral effects (eg disorientation) resulting from loss of smell sensors;
- contamination of food supply and reduction in available food levels; and
- influence on sea turtle development and behaviour caused by subtle changes in sand temperature colour and when spills impact the shoreline (eg because sex determination in

turtles is temperature dependent, shifts in sand temperature caused by oiling could potentially change hatchlings sex ratios).

Fish Stocks

The offshore and coastal waters in Ghana support a significant diversity of fish species, many of which are targeted by the artisanal and commercial fisheries. Most fishing activities occur from the coast to the edge of the continental shelf. Fish nursery areas that exist along the coastline are vital at sustaining fish stocks in coastal areas, as is the case of the mangrove areas close to the Amansuri river mouth.

Typically, adult fish are not considered highly sensitive to impacts from oil spills. Adults are mobile and generally able to detect heavily contaminated areas or areas of low water quality. In open waters, fish have the ability to move away from an area of pollution, and are therefore either unaffected by oil or affected only briefly. As such, it is unlikely that fish are significantly affected by oil in open water.

Fish kills may occur, however, as a result of high exposure to emulsified oil / freshly spilled diesel in shallow waters (such as in lagoons) and oil pollution may clog fish gills causing asphyxiation. In all the oil spill scenarios modelled, the top few meters of the water column beneath the slick in the first days after release, before many hydrocarbon compounds evaporate or degrade, are likely to present high levels of aromatic compounds which may cause acute toxicological effects due to narcosis.

Fish exposed to elevated concentrations of hydrocarbons absorb contaminants through their gills, accumulating it within their internal organs which can lead also to long-term, sub-lethal effects. In addition, spilled oil reaching confined and shallow waters, such as lagoons or mangrove areas, poses a threat to fish eggs and larvae which cannot actively avoid oil. Fish eggs and larvae are mostly in the upper planktonic layers (also in open waters), and hence are affected and heavy mortalities often result. Lethal effects on the population as a whole are rare but can be long-term, sub-lethal effects are possible, particularly if a major spawning area is affected.

Fisheries

The fishing activities along the coast of Ghana are important from a socio-economic perspective (employment and source of food). Artisanal fishing activities are scattered along the coast with more than 11,000 vessels in the artisanal fleet operating mainly from the beaches.

In the event of an oil spill reaching either coastal waters, fisheries are usually temporarily banned by the regulatory authorities to avoid contamination of fish being lifted through the slick on the surface waters, to prevent gear contamination, and more important to prevent the introduction of polluted fish into markets. Fishing therefore becomes difficult or impossible in areas directly affected by an oil spill as gear will be smeared in oil and the catch might be spoiled. The fishermen might for a period be forced to stop or temporarily move to other fishing grounds free of oil slicks. Fishing communities along the coastline will therefore be affected on their livelihood during the closure, resulting in a reduction in both food and economic resources.

In addition, tainting of fish will reduce the quality of the fish landed and sold to traders, leading to a reduction in prices or is associated with potential health risks if these are consumed.

Given the importance of artisanal fishing along the Ghanaian coast, fisheries are considered highly sensitive to impacts resulting from an oil spill that reaches coastal waters.

Coastal Habitats

According to the model performed there are more than 1,000 km of coastal areas at risk of being directly affected by oiling as a result of an oil spill. The probability of oiling however varies depending on the site, and even in a worst case scenario it is unlikely that all of these areas are finally affected at the same time.

The model shows therefore that the four major habitat types found along the shores of Ghana are at risk:

- **Sandy marine shore ecosystem and beaches**: Usually having low species diversity they may serve as important nesting sites for sea turtles and in some cases are important sites for coastal bird species. This habitat corresponds to the majority of Ghana's coastline.

- **Rocky marine shores**: occur as rocky out-cropping alternating with sandy bays. The rocks are substrate for a wide variety of species of macro algae, barnacles and snails. Ecologically, algae mats on rocky shores serve as important micro-habitats for epifauna (i.e. crustacean, macro-invertebrates) and fishes. This habitat corresponds to areas such as the Cape Three Points.

- **Coastal lagoons**: these are important nursery sites for many fish species and also support significant numbers of waterfowl species and can be found in several sites in Ghana, many of them protected as Ramsar sites.

- **Mangrove/ tidal forests**: Usually found associated with coastal lagoons, river mouths and estuarine wetlands, is used as nursery for many fish species and also hosts significant populations of fish, shrimps, crabs and mollusc species.

Each type of coastal habitat is considered sensitive to oil spills, however, lagoons and mangrove habitats are considered particularly sensitive as they tend to support higher levels of biodiversity, and be the place of fish nurseries that allow the stocks to be replaced. They are also usually bird feeding areas.

If an oil spill reaches the shore in these areas toxic concentrations of oil may develop in the shallow water and given the long persistence time of the oil, effects may be encountered for a long period.

In mangrove stands, such as those found in mouth of the Amansuri River oil slicks may enter the mangroves when the tide is high and be deposited on the aerial roots and sediment surface as the tide recedes. The oil covers the pores in the aerial roots and if many roots are oiled, the respiratory system collapses and the trees die.

Risk level assessment

Most Severe and Most Probable (relative) Cases

The frequency of a crude oil spill due to a blow out during drilling or during well completion are events that have happened at least once in the company (and also to some other companies) and are therefore assigned a probability rating of "B".

The two larger oil spill scenarios (namely 819,000 m^3 and 121,000 m^3 of crude release) have the potential to result in widespread coastal oiling (assuming a 'no intervention' scenario). The results of the stochastic modelling (of multiple metocean scenarios) shows that in the worst case, more than 1,000 km of Ghanaian, Togo, Benin, Nigeria, Cameroon and Equatorial Guinea coastline is theoretically at risk, including several internationally and nationally protected areas, fishing grounds and all the recorded existing habitats. In reality (i.e. outside of the more severe and most probable case) the length of coastline that would be affected would be much smaller and would be determined by the actual metocean conditions prevailing at the time of a spill. Similar considerations apply to the actual location affected.

The areas affected include, therefore sites considered as highly sensitive to impacts given the ecological sensitivities considered and fishing activities along that affected area of coastline. If oil reaches these sensitive receptors, they will be exposed to adverse impacts that will be difficult to mitigate effectively and will have long-term consequences.

The surface of offshore areas theoretically at risk includes most of the Gulf of Guinea, where marine birds will not be able to feed and marine mammals and sea turtles (which are know to occur, including breeding activities within these areas) could also be harmed. This area also encompasses artisanal and industrial fishing grounds, and therefore the oil spill will interfere with normal fishing activities. The consequence category is considered Extensive (consequence rank of 5).

The overall environmental risk rating is thus High according to the matrix risk (Table G131), before the implementation of any mitigation measures.

Diesel Spill from FPSO

The frequency of a large diesel spill from a collision of a vessel has also happened at least once in the company and therefore the probability category assigned is "B".

The consequence of oiling of such a scenario could include impacts to areas of national and international conservation importance along the coast (Ramsar sites). The results of the stochastic modelling (of multiple metocean scenarios) shows that again most of the Gulf of Guinea is at risk of being affected, though with a relatively low probability. In reality the surface area affected would be much smaller and would be determined by the actual metocean conditions prevailing at the time of a spill. Similar considerations apply to the actual location affected.

Despite the evaporation rates exhibited by diesel fuel, it is expected that such an spill would affect sea birds as well as potentially harming marine mammals and sea turtles. Fishing activities would be temporarily banned.

Given the sensitivity of the resources affected and the nature of the fuel, the consequence rating can be considered as 4 ('Major Effects').

The overall environmental risk rating is thus Medium according to the matrix risk (Table G131), before the implementation of any mitigation measures.

Mitigation Measures

Mitigation for accidental events can be of two different main types, those that decrease the probablity of the event happening and those that mitigate the consequences of the event (x and y axes of Table G131, Risk Matrix, respectively)

With respect to the measures which decrease the probability of the events, oil spills can be caused by a range of trigger events taking place during drilling, completion and operation phases.

A number of design measures have been introduced to reduce the risk of spill from operations such as leaks from on-board the drillship, releases of hydrocarbons from vessel collision and refuelling etc. Design measures have also been introduced to reduce the risk of blow-out. A summary of the mitigation measures to be implemented during the drilling program is provided below:

- adoption of industry standard formal and systematic hazard identification, drilling, operational and maintenance practices and procedures;
- detailed understanding of the nature of hydrocarbon reservoirs being drilled and the adoption of proven industry standard well design and drilling technology;
- use of appropriate drilling fluids for hydrostatic control in the event of sudden or unexpected changes in well bore pressure;
- installation and regular testing of industry standard safety valves (blowout preventers) on the subsea well head;
- preventive maintenance on all rig equipment;
- use of only competent crews with Engineers, Drillers and Drilling Supervisors trained and certified in well management and well control procedures;
- ongoing checks of facility and equipment integrity
- standard procedures of well monitoring and control, including development of a peer-reviewed / independent expert reviewed well control plan for each well, before drilling.

The Project will incorporate an Integrated Control and Safety System (ICSS) that shall provide an integrated monitoring, control, protection and safety system for the entire drilling, production, topsides, marine, and subsea facilities. The safety systems shall be separate from the Process Control System (PCS):

- Routine operator inspections, maintenance inspections and internal and external audits
- Emergency Shut Down (ESD) valves at every well head and platform;
- Secondary and emergency controls systems installed and tested;
- Procedures followed on all occasions and not circumvented;
- Regular emergency drills scheduled and performed;
- Procedures for bunker transfer to minimise the risk of spillage;
- Use of bulk handling methods and non-return valves for diesel transfer to reduce the risk of spillage;

With regards to the measures aimed at reducing the consequences of a potential oil spill, and complementary to the comprehensive prevention measures in place, in order to reduce the consequences of the residual risk of an oil spill, an approved Oil Spill Contingency Plan (OSCP), briefly described in Section 4.12.1 and attached to this EIS (Annex F), is in place for the proposed drilling operations, including access to subsea containment solutions and to Tier 1, 2 and 3 spill management resources.

Considering the mitigation measures and the evaluation criteria, the residual risk derived from unplanned events resulting in an oil spill is reduced as either the probability of the event happening diminishes to an equivalent of type A due to the prevention measures taken, or the consequences of the three scenarios analysed are reduced in all cases to major effects (consequence rank of 4), due to the activities planned in the OSCP. The overall risk of these spills is therefore assessed as Medium risk.

G.9.2.4 Onshore Component

Due to the recent changes in the design philosophy of the onshore compoents of the project, a formal risk assessment report is not yet available for the ORF at this stage of engineering design. These processes and documents are planned to be developed for the next stage of engineering design, in the form of HAZID, HAZOPS and QRAs for the different components of the onshore facilities. The objective of these will be to guarantee the safety of the facility in terms of risks to the nearest human habitation, which in case of the ORF will be the permanent accommodation camp located immediately south-west of the ORF facility. The methodologies which will be followed for these processes is included in Annex E.

A preliminary safety assessment has been performed for the existing 20” GNGC sales line, for the assessment of alternatives related to the location of the permanent accommodation camp and ORF. Ths study (20” Gas Pipeline Release Scenario Consequence Analysis) was performed for the scenarios of jet fire and explosion from a leak or accident to the sales line. It was calculated at the nominal maximum pressure to be provided by the compressor station (100 bar) at the ORF and a maximum flow of 405 MMSCFD. The main result of this study is that the safety distance to keep a 0.021 bar pressure from an explosion scenario (95% of no serious damage beyond that distance, 10% of window glass broken, 0% fatality and very low probability of injury from overpressure) is 185 m. This distance to the sales line has been kept with a great margin with the current lay out of the permanent accommodation camp and ORF.

With regards to the onshore section of the export pipeline from the landfall to the ORF, a similar preliminary safety assessment has not yet been undertaken. However, an order of magnitude comparison can be made.

- Safety distances depend on pressure and diameter.
    - In this case, the diameter of the GNGC sales line and of the export pipeline is expected to be the same.
    - Needed pressure, with equal diameters, and flow. The preliminary pressure expected from the FPSO is 80 bar, and the flow from the FPSO at the maximum overdesign capacity is 300 MMSCFD, both flow and pressure 80% of that of the GNGC pipeline (100 bar, 405 MMSCFD). If these parameters are 80% of the maximum calculated pressure for the GNGC sales line, the safety distances will also be in those orders of magnitude of 80% of the calculated one for the GNGC line (aprox. 140 m).
- The route of the export pipeline is not yet defined. However, it is expected to be within the limits of the concession area and to run between the settlements of Sanzule and Awonakrom. The minimum distance of the western limit of the concession area to the nearest building at Awonakrom settlement is approximately 120 m.

In summary, at this stage of the project design and with very preliminary calculations, the need for potential further mitigation measures to guarantee the safety of the nearest buildings at Awonakrom cannot be discarded. Theset specific mitigations (if necessary) shall be designed when further steps of engineering and more formal risk assessment processes are developed. At this stage, they could take the form of one or a combination of the following measures:

- Engineering design measures to decrease probability and/or consequences of an accident at the sensitive segment of pipeline (increase pipe thickness, burial depth, install concrete slab atop pipeline, etc).
- Shift landfall and pipeline route 70 m westwards, to keep safe distances both to Awonakrom and Sanzule settlements.
- Increase the service/safety corridor to 180 m (or whichever final safety distance after implementation of engineering design measures) during operation, and agree with Government on efficient measures to keep that pipeline safety corridor width to prevent encroachment, and similarly with the determined safety radius around the ORF.

In any case, and for any final design of pipeline and ORF, the following mitigation measure will be implemented.

- Preparation of an Emergency Plan for dealing with potential accidents.

G.10 CUMULATIVE IMPACTS

The im of this Section is to assess the Cumulative Impacts following the guidance of the IFC document Good Practice Handbook (GPH) on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, published in 2013.

G.10.1 Background

The use of the guideline for the private sector is assisting companies to identify their contribution to cumulative impacts and guide them in the effective design and implementation of measures to manage such cumulative effects.

Government plays an important role in establishing the development framework and for evaluating and managing cumulative effects. These frameworks are sometimes not available, and more often it is left to the private developer to try and take into consideration not only its own contribution to cumulative impacts, but also other projects and external factors that may place their developments at risk.

Overall there are many challenges associated with conducting an Cumulative Impact Assessment (CIA) process including lack of basic baseline data, uncertainty associated with anticipated developments, limited government capacity, and absence of strategic regional, sectoral, or integrated resource planning schemes. Thus in the absence of an Strategic Impact Assessment framework, or an agreed Cumulative Impact Assessment mechanism amongst different public and private sector parties a project by project led mechanism is the only available one.

What the guideline recommends, and it is adopted in this ESHIA, is a useful preliminary approach for developers in emerging markets to conduct a rapid cumulative impact assessment (RCIA). The RCIA can be an integral component of the ESHIA or a separate process: in this specific case it has been included as a component of the ESHIA study. RCIA entails a desk review enables the developer to determine whether its activities are likely to significantly affect the viability or sustainability of selected Valued Environmental and social Components (VECs).

Depending on the scenario, the RCIA may evolve into a more robust and comprehensive CIA, which requires the participation of many parties and is best led by local governments or regional planners.

G.10.2 Defining Cumulative Impacts

IFC Performance Standard 1 provides a definition for cumulative impacts, as impacts that:

> *"result from 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."*

Cumulative impacts are generally considered to be impacts that act with impacts from other projects such that:

- the sum of the impacts is greater than the parts; or
- the sum of the impacts reaches a threshold level such that the impact becomes significant.

The types of cumulative impacts that may be relevance are the following:

- **Accumulative:** the overall effect of different types of impacts at the same location. An example would be fugitive dust emissions, construction noise and construction traffic all impacting the three local communities as a nuisance/ disturbance.
- **Interactive**: where two different types of impacts (which may not singly be important) react with each other to create a new impact (that might be important) (eg water abstraction from a watercourse might exacerbate the impacts caused by increased sediment loading).
- **Additive or In-combination:** where impacts from the primary activity (ie the construction and operation of the Project) are added to impacts from third party activities e.g. other major projects in the vicinity of the Project which are already occurring, planned or may happen in the foreseeable future).

G.10.3 Objectives and Overview of the Approach to the CIA

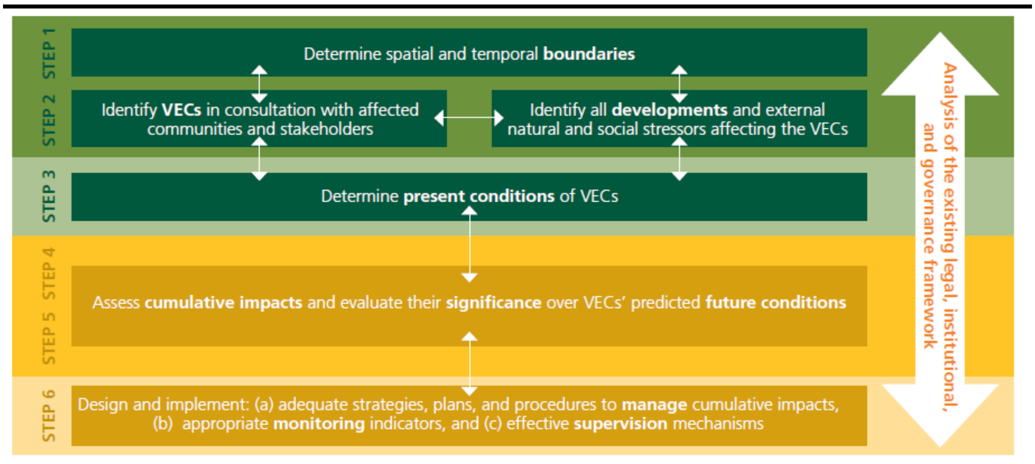
The overarching objectives of the identification and assessment of cumulative impacts are the following:

(a) recognition by each party that their actions, activities, and projects may contribute to cumulative impacts on Valued Environmental and social Components (VECs) on which other existing or future developments may also have detrimental effects; and

(b) avoid and/or minimise these impacts to the greatest extent possible. Furthermore, their developments may be at risk because of an increase in cumulative effects over ecosystem services they may depend on.

In order to accomplish these objectives, the RCIA logical framework includes a six-step process (as shown in the following Figure): **Scoping** (Steps 1 and 2), **VEC baseline determination** (Step 3), **assessment of the contribution of the development under evaluation to the predicted cumulative impacts** (Step 4), **evaluation of the significance of predicted cumulative impacts to the viability or sustainability of the affected VECs** (Step 5), and **design and implementation of mitigation measures to manage the development's contribution to the cumulative impacts and risks** (Step 6). The following Paragraphs briefly describe how this six step approach has been implemented in this ESHIA, including the objectives of each step and how they have been accomplished in the assessment.

Figure G11 CIA – Six-step process



Source: IFC document Good Practice Handbook (GPH) on Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, 2013

G.10.3.1 Step 1: Scoping Phase I – VECs, Spatial and Temporal Boundaries

Identify and Agree on VECs in Consultation with Stakeholders.

This has been done using both the technical identification and approach in the different sections of the ESHIA (physical-biological, ecosystem services, socio-economic, cultural heritage) giving priority to those VECs that are likely to be at the greatest risk from the development's contribution to cumulative impacts. On the other hand it has taken in account the results of several stakeholder engagement processes, which main concerns related to cumulative impacts have been:

- Effects on fishing due to the exclusion zones
- Disturbances to population
- Air emissions
- Biodiversity disruption
- Land take
- General Cumulative impacts

Determine the Time Frame for the Analysis.

In this case the time frame expected for the complete life cycle of the proposed development (and to the extent known of predictable future developments) has been the default option, especially from implementation of Project related management measures standpoint. However it is rather evident that the time frame of some potential effects of the proposed development can extend beyond that life cycle, after project decommissioning, specially socio-economic effects related to the disappearance of this and other similar projects.

In this case the time frame of the analysis need to go, and does go, beyond project life cycle. However in general the certainty related to effect generally decrease with time, some of the effects will decrease in magnitude with time (ie effects related to disturbance to sea bed) and finally the most significant effects will appear and need to be managed at a relatively early stage.

All these circumstances render the exercise of extending the time frame beyond the project life cycle in many other effects an academic exercise for project mitigation, albeit the assessment points to potential long lasting effects (further than the mentioned exit socio-economic effect) to aid public planning. This cumulative impact assessment follows a condensed approach to provide some indication and assessment of the impacts.

Establish the geographic scope of the analysis.

The boundaries for the analysis need to encompass the geographic extent of impacts (from other past, present, and predictable future developments) that influence VEC condition throughout the time period during which project impacts will occur. This scope is likely to extend beyond a Project's direct area of influence (DAoI) as typically defined in ESHIA. However the different areas of influence (AoIs) for each VEC in the ESHIA itself may extend also beyond the direct area of influences and is different for each VEC. Thus there are different levels of overlap between the different AoIs of each assessed past, present or predictable future development. The theoretical maximum common denominator of all AoIs of all projects would finally be the whole country and the whole planet possibly for different effects and VECs (e.g socio-economic, climate change, etc), whereas the level of geographical overlap and AoI for other effects and VECs is much more localised (e.g. drill cuttings discharge effects on seabed) Thus boundaries are set VEC and effect specifically, and expanded to the point at which the VEC is no longer affected significantly or the effects are no longer of scientific concern or of interest to the affected communities.

G.10.3.2 Step 1: Scoping Phase II Other Activities and Environmental Drivers

Identify other past, existing, or planned activities within the analytical boundaries.

The activities which will have both similar effects and affected VECs are to start with and obviously similar O&G developments, overlapping at different temporal and geographical areas, out of which the most important by many standpoints is OCTP Block Phase 1, proposed by eni. This Phase already has an ESHIA submitted to Ghanaian authorities and lenders. As mentioned this Phase is the most directly assessed for cumulative impacts with the current Project, and in some instances, such as the unplanned events impact assessment, in the corresponding section of this ESHIA both Phases have been assessed together as a single project, without the need to further analyse them in the cumulative impact section.

With regards to past projects, the Jubilee field development is already in place. Already existing or past projects effects are often incorporated within the baseline, as their effects are in some cases already evident, and such has been the approach of the assessment in this case. In fact some of the potential or predictable effects of the OCTP Project are derived from the already evident effects of the Jubilee project, especially in the socio-economic domain.

With regards to the planned activities, these are logically less evident, except the TEN Project from Tullow which ESIA is actually under evaluation. According to different sources, the other projects relate mainly to developments to take place mostly onshore, such as plans under consideration for an LNG receiving and regasification facility along the coast in Western Province (GNGC Gas Plant at Atuabo) and pipelines to connect it to WAGP and to potential consumers(phase 1 in operation, phase 2 under construction) There is also the Lornho Oil

Service Port at Atuabo which EIS is approved. All these projects have been included in the assessment at the level of availability and comprehensiveness of information.

Assess the potential presence of natural and social external influences and stressors (e.g., droughts, other extreme climatic etc)

There are no specific significant natural risks predicted for the long term, apart from the general climatic change which will most likely decrease water availability for the area, but which could actually be counter-measured by technological and management measures at the local level. On the other hand the social external influences on the area are very weak beyond and un-related to the proposed development, in a context of a mainly subsistence or low level of development economy, with little capacity to, for instance, overexploit natural resources such as fisheries.

G.10.3.3 Step 3: Establish Information on Baseline Status of VECs

Define the existing condition of VEC

Understand its potential reaction to stress, its resilience, and its recovery time and assess trends. These objectives have been accomplished within the Baseline and the Impact Assessment sections of the ESHIA.

G.10.3.4 Step 4: Assess Cumulative Impacts on VECs & Step 5: Assess Significance of Predicted Cumulative Impacts

These two steps have been undertaken together actually, consistently with the general methodology of the ESIAs (ESHIA, ESIA, EIS). Their objectives are:

- identify potential additive, countervailing, masking, and/or synergistic effects amongst projects and natural/social risks;
- define appropriate thresholds and indicators,
- determine impact and risk magnitude and significance in the context of past, present, and future actions, identify trade-offs.

The first part of the objectives has been accomplished VEC by VEC, following the same scheme as the ESHIA itself, in terms of the different types of VECs (physical-biological, ecosystem services, socio-economic, cultural heritage) and their main location (onshore, offshore, mixed). Once the effects were identified, the same thresholds and indicators have been used to determine impact and risk magnitude and significance as for the other sections of the ESHIA, for obvious coherence of assessment reasons.

It must be noted that given the uncertainty inherent to some of the future developments characteristics the level of certainty of the cumulative effects being above the thresholds and indicators of significance is generally low, being the assessment in many cases based on risk of these effects being significant, this risk based on professional judgement and assessment of comparable situations

G.10.3.5 Step 6: Management of Cumulative Impacts – Design and Implementation

Use the mitigation hierarchy, design management strategies to address significant cumulative impacts on selected VECs, engage other parties needed for effective collaboration or coordination, propose mitigation and monitoring programs, manage uncertainties with informed adaptive management.

All of these objectives have been accomplished to different levels in the assessment. It must be highlighted that the engagement of other parties needed for effective collaboration or coordination has been accomplished to the level possible at this stage, that is identifying which impacts need this collaboration and coordination most, and propose which parties should be included, as part of management strategies proposed. The mitigation and monitoring programs for the cumulative impacts responsibility of eni are, obviously, included in the general ESHMP, which also include the eni ESMS, upon which relies the informed adaptive management objective.

On the other hand, and as a conclusion and summary of the process, and in order to help governments manage future processes, the initial screening results of the RCIA can provide several potential scenarios for each project (according to IFC Handbook used as a reference for the assessment):

- **Significant risk for cumulative - impacts/significant leverage:** The development under consideration represents a significant contributor to the expected cumulative impacts or will be the first of several future reasonably anticipated developments that will use the same resource and/or potentially affect the same VECs. In these cases, the private developer can use Step 6 to design a strategy to appropriately manage cumulative impacts and provide advice to the government on the appropriate governance structure to ensure other developers will follow suit.

- **Significant risk for cumulative impacts/limited leverage:** The development under consideration is immersed in an environment where the cumulative impacts are evident but the issues are complex, many actors are already involved, and the solution is clearly beyond any individual project sponsor. In this case, the RCIA will help the developer (a) determine the significance of the overall cumulative impacts and its contribution to these cumulative impacts, and (b) design environmental and social management plans and procedures to appropriately mitigate those contributions. In this case, the developer will be accountable only for the design and implementation of mitigation measures commensurate with the magnitude and significance of its contribution to the cumulative impacts. However, individual sponsors will use their best efforts to engage other developers, governments, and other stakeholders in acknowledging the cumulative impacts and risks and in designing coherent management strategies to mitigate them.

- **Limited to no contribution to cumulative impacts**: The RCIA determines that even though there are clear cumulative impacts, the development's contribution to the cumulative impacts over the affected VECs are negligible or nil. In this case, no measures other than the ones resulting from the ESIA process would be necessary. In this situation, however, if there are cumulative impacts from other sources that are not being addressed, the developer may consider it pertinent to draw this to the attention of the government or other stakeholders, and assess whether its project may be at risk from the unmanaged cumulative effect.

In this case, and given the circumstances, the eni OCTP Phase II project would fall under category C, whereas the whole Phase I-Phase II could perhaps fall under Category B. In both cases, eni will be accountable only for the design and implementation of mitigation measures commensurate with the magnitude and significance of its contribution to the cumulative impacts, which is what this ESHIA does.

Although the ESHIA focuses on addressing Project level impacts and risks, part of the ESHIA conclusion and added value is as well to help eni to use their best efforts to engage other developers, governments, and other stakeholders, by acknowledging the cumulative impacts and risks and suggesting coherent management strategies to mitigate them. Eni will consider the establishment of a technical and management committee involving the operators, the national and local government and financiers. Participative monitoring of the affected communities and adequate stakeholder engagement on cumulative effects will also be considered.

G.10.4 Identifying of Relevant Development (s)

The proposed Project is a 'greenfield' development in that it will be located on a site that has not been developed. It will also be located in an area where there is limited other industrial activity. Cumulative impacts would thus be primarily related to the in-combination effects of the Project with potential future development in the immediate area around the Project site.

How the cumulative impacts are assessed here depends on the status of other Projects and the level of data available to characterise the magnitude of the impacts. The assessment that follows is necessarily of a broad nature and focuses on key issues and sensitivities for this Project and how these might be influenced by cumulative impacts with other developments.

Relevant and significant developments were identified through searches of relevant documents (ie regional planning documents) and consultations with local and state authorities. The Project is being developed in a coastal region already affected by a number of existing projects as well as a number of planned projects.

The cumulative effects of the Project have been evaluated considering the following which are known to be in development or that could reasonably be expected to be developed:

- Eni Ghana Oil Development (Phase 1, under evaluation);
- TEN Development (proposed, ESHIA under evaluation);
- GNGC Gas Plant at Atuabo and Pipeline (Phase 2 under construction); and
- Lornho Oil Service Port at Atuabo (proposed, ESHIA under evaluation).

The Jubilee Field Development (in operation since 2014), Phase 1 of the GNG Gas Plant at Atuabo and the road construction project along the GNGC pipeline ROW do contribute to the cumulative effects of changes in the AoI. However, the Jubillee Field Development has been in operation for a number of years and and has already an effect on the existing enviromental and social conditions. These conditions are described in the existing baseline and therefore already considered in the impact assessment. Similarly the changes due to the road construction are already noted within the baseline description (particualrly with regard to air quality levels).

The cumulative impacts are considered for the terrestrial and marine biophysical environment as well as the socio-economic and health environments. The impacts identified are described and assessed in the following Section and classified as impact during the construction and the operation phase.

Apart from a specific section describing the potential cumulative impacts related to livelihoods after decommissioning (Section G.10.7.2), the cumulative impacts related to decommissioning activities have not been assessed with the following Section. The decommissioning activities are not sufficiently understood and defined for the range of projects so that robust conclusions on the significance of these cumulative impacts are not able to be provided at this stage.

G.10.5 Cumulative Onshore Environmental Impacts

G.10.5.1 Air Quality

Cumulative air quality impacts would be related to the in-combination effects of the Project air emissions with existing emission sources in the immediate area around the Project site which could result in an elevation of ground level concentrations of pollutants and have an impact on the health of workers, local communities and habitats. This would be particularly significant for dust levels generated from earthworks and vehicles' movement during the construction phase, with cumulative impacts of low significance, however the scheduling of the construction phases is not expected to be concurrent for the projects assessed and therefore this will not occur.

During operations, cumulative impacts could be expected in the close proximity of emission sources. It should be noted that for SO2, considering the VEC (high background values monitored at villages), although the Project is not expected to generate significant additional SO2 emissions (data, the gaseous fuel is sulphur-free and consists mainly of natural gas, thus SO_X emissions will not be released), additional cumulative impacts due to future developments could have an increased magnitudes. During the operational phase, the proposed Project will not generate high levels of point source emissions and significant cumulative impacts for CO and NOx are however not expected.

In summary, the cumulative impact on Air Quality for the construction phase are identified as **Not significant** unless construction phases are concurrent when these would be **Low**; and for operation as **Not significant**.

G.10.5.2 GHG Emissions

The accumulated increase in greenhouse gas emissions could be considered as a significant risk, considering the simultaneous operation of all the projects planned during their expected lifetime of at least 20 years, and especially if residual gas associated with oil extraction is burnt. Measures to promote residual gas inclusion into the commercial circuit are absolutely necessary in this respect, both within the Project operations and in liaison with other project developers and Government.

In summary, the cumulative impacts on GHG identified as **Not significant** construction phase are and as **High** for the operational phase in relation to the lifetime of impacts.

G.10.5.3 Noise and Vibration

The cumulative emissions of noise from the Project could cause ambient noise levels to be raised above the current noise levels and also cause an additional nuisance to local community receptors. Noise effects are of particular concern especially during the night, as sleep disturbance among community members close to the fence lines could occur. This in turn could lead to a rise in stress levels, depression and behavioral problems as well as a further change in the sense of place. The sensitive receptors to noise are within the local communities.

In relation to the physical propagation of noise related to project activities and due to the location of the projects (which are separated by several kilometers, allowing noise to dissipate), the cumulative impacts on noise and vibration are expected to be **Not significant** during both construction and operation phases.

G.10.5.4 Surface Water

The physical presence of the gas plant will cause only incremental effects to surface water resources and drainage patterns. Cumulative impacts on surface water related to the additive effects of changes to the surface water flow and unplanned spills in the area which could affect the greater Amansuri River system. This River system is regarded as sensitive as it provide habitat for numerous migratory avian species and includes an Important Bird Area within the area.

In summary, the cumulative impacts, taking the most conservative approach for the purpose of the impact assessment, on the surface water system are considered to be **Medium** during both construction and operation phases in relation to the sensitivity of the receptors.

G.10.5.5 Groundwater

Water requirements for the other developments are not great and will likely install deep boreholes to extract freshwater water for routine use and presumably not for gas processing or for cooling. There may also be impacts of the seawater intrusion effects due to the construction of the Lonrho port which could further threaten the water quality of the shallow sandy aquifer in the area. Cumulative impacts could also result from additive effects of unplanned spills and improper waste management in the area which could affect the greater shallow aquifer.

In summary, taking the most conservative approach for the purpose of the impact assessment, the cumulative impacts on the groundwater are considered to be **medium** during both construction and operation phases.

G.10.5.6 Terrestrial Soils, Geology and Geomorphology

The implementation of the Project will result in the removal of vegetation and soil of a 240,000 m^2 area during the construction phase, changes in drainage regime and increased erosion potential offsite and increased runoff and siltation during construction, operation and decommissioning. The other onshore developments will also require clearing of land and in the context of potential further clearing for replacement agricultural land in the area.

In summary, the cumulative impacts on soils and geology are considered to be **Low** during construction (if the construction phases are concurrent) and **Not significant** during operation phase.

G.10.5.7 Terrestrial Flora

The Project site as well as the surrounding area consists of secondary forest, functional subsistence agriculture, seasonal wetland areas but limited natural vegetation or habitat. Although the Project site is considered to contain Modified habitats, faunal and floral species of ecological significance were identified and the other developments contribute to the conversion of the land from modified and natural/semi-natural to industrial use. This will further reduce habitat and contribute to more habitat fragmentation.

Construction phase of the several projects assessed for the CIA has the potential to facilitate alien / pioneer species intrusion in the ecosystem and expose to risk of loss valuable species and habitats. Accordingly, the cumulative impacts on terrestrial flora is considered to be **Medium** during construction phase, whilst has been assessed as **Not significant** during operation phase since the described risk is not related to this phase.

G.10.5.8 Terrestrial Fauna

A result of additional development around the Project area would be a cumulative increase in the general level of disturbance to species that are present in the terrestrial habitats within the general area. The main sources of disturbance would include the habitat loss, increased noise levels, visual intrusion from traffic or people, potentially increased levels of air pollution and possibly an increase in hunting of certain species. .

In summary, due to the largely Modified habitat present over the planned development sites the cumulative impacts on terrestrial flora are considered to be **Low** during construction phase and **Not significant** during operation phase.

G.10.5.9 Landscape

The proposed further industrialisation of the area would result in increased visual impact to the same sensitive receptors over a similar geographical area. There would be a concomitant landscape impacts as a result of further buildings and equipment laydown areas, industrial facilities and equipment and lighting installed for the gas plant. Any requirement for additional housing related to the gas plant would also have an impact on the visual character due to the additional buildings. Although there are a number of sensitive receptors, the change in the sense of place as a result of the port Project may reduce the sensitivity of receptors. Significance of further changes to the landscape and visual impacts would be less as the sensitivity also decreases over time.

In summary, the cumulative impacts on Landscape are considered to be **low** both during construction and operation phase.

G.10.6 Cumulative Offshore Environmental Impacts

The expected development of several projects in the coasts of the Western Region of Ghana, including ENI Phase 1 oil development, TEN development and the Lornho Oil Service Port at Atuabo may result in a confluence of factors contributing altogether to the reduction in the environmental quality of the seawater and seabed sediments as well as in the air quality and freshwater quality. These are described in further detail in the following Section.

G.10.6.1 Seawater Quality

In terms of liquid discharges, the main impact associated is marine water pollution and the associated effects on marine ecosystems and economic activities based on those. The liquid discharges expected include drainage, sewage and other vessel discharges, produced water and hydrostatic test fluid dischargeshe impacts of these discharges have been discussed in detail in the corresponding Sections. In terms of cumulative impacts of the components, the same liquid discharges can be generated by the same sources for the different components (i.e. vessel discharges, drainage) which can be coincidental in time and or geographical location in some instances, or different in nature by different sources (i.e produced water by platforms, hydrostatic test fluid discharges by pipelines) which can be coincidental in geographical location, but not in time. The planned Phases will include similar construction and operational discharges.

In this context, discharges from the planned projects, due to compliance of relevant agreements and regulations (Marpol and Ghana's legislation) suggest a non-significant additional source. Potentially contaminated drainage from platforms will be treated, and the expected very low quantities will not significantly increase the general pollutant load. Hydrostatic test water discharge is not considered a major source of pollution to the general load, given its expected chemical nature. However final effect on marine water quality depends on dilution/dispersion capacity of the surrounding marine environment. Potential cumulative impacts in this respect would only be expected when dispersion plumes from sources could overlap, due to temporal and geographical coincidence of discharges from these sources. The effluents form Atuabo Port, whereas also treated to relevant standards, would not overlap in space with other discharges (15 km distance as a minimum), albeit they would be coincidental in time during operations with all offshore developments. As such, considering the distances from the other existing or planned/potential point sources, and the low probability of temporal and geographical coincidence of point and moving sources discharges, the probability of cumulative impacts of the OCTP Phase II project with other sources of marine pollution in this respect is low. With regards to long term accumulation of still residual contaminants from liquid discharges, as with the drilling fluids, it is not expected to become a significant risk with the planned projects, but could be if more projects accumulate.

In terms of turbidity, Project will generate minor increases in the main sources of increase in turbidity are the drilling material discharged to the sea, pipeline construction and installation of the pipelines and other subsea structures or anchoring on the seabed. The characteristic of this impact in terms of accumulation of effects is that it is temporary in nature, both in the activity that generates it (construction, drilling) as well as the effect itself (the turbidity plume will settle in time). Only when there is simultaneous construction/installation of pipelines and platforms and/or drilling of wells, in an area where the turbidity plumes can overlap, there is the possibility of temporary accumulation of impacts. The distances between the developments planned in the coasts of Ghana are high enough to ensure that if any overlap of turbidity plume occurs, it will be associated to very low values of suspended solids, even with the nearest wells to be drilled for the OCTP Project Phase I (approximately 2 km) Additionally, these cumulative effects would occur only if there is an overlap in the drilling period within adjacent platforms, which is improbable. All the previous considerations lead to the conclusion that the cumulative impact produced by the existing and planned activities taking place in the marine area of influence of the OCTP Phase II in terms of increased turbidity and associated and consequential effects are probably not higher than any of the single projects impacts.

In summary, the cumulative impacts on seawater quality (discharges and small-scale spills) is considered to be **Low** during construction and operation, and cumulative impacts of increased turbidity are considered **Not significant** for construction or operation

Deterioration in marine water quality could impact biodiversity, fisheries and local communities. Contaminants within the water column are likely to settle out and accumulate within the marine sediments, and negatively affect the benthic habitat and fauna as described in the following Sections.

G.10.6.2 Seabed

The cumulative impacts of the existing and future developments on the offshore seabed habitats and sediment composition will greatly depend on what kind of drilling fluids will be used. Use of drilling fluids with oil or heavy metal components could potentially have a significant cumulative effect on seabed (and general marine) habitats and organisms due to acute and/or chronic toxicity and bio-accumulation. If water based drilling fluids the cumulative impact will only depend on the physical effect of these drilling materials on the seabed. Considering the restrictions imposed by the Authorities of Ghana (a maximum of 2 % of NADF adhered to cuttings discharged, pre-approval of additives to be used in the muds) it is expected that biochemical effects will be limited.

In addition, and similarly to the effects due to turbidity, expected effects on seabed sediments and habitats due to deposition of cuttings will be restricted to the immediate vicinity of each well drilled. In this context biochemical effects from drill cuttings are not expected to extend beyond 1 km from each well, and physical effects are expected to cover a smaller surface. This accounts for approximately 3 km^2 of maximum physically disturbed area per well, with no overlapping among them. Considering the total number of wells existing (24 Wells on TEN Jubilee) development Project) and planned in the western coasts of Ghana (18 wells for the OCTP Project Phase I, up to and 5 wells on OCTP Project Phase II) the final seabed surface potentially affected, 141 km^2, is not significant in relation to the total area of seabed covered by the different permits involved.

Smothering effects on benthic communities are expected to occur similarly around each well. In terms of offshore seabed habitats sensitivity the already existing information suggest that these are not particularly sensitive. Therefore, it is unlikely that there will be cumulative impacts from cuttings discharge on the marine environment. Only if there is an accumulation of projects beyond the mentioned in time and space, this issue could become relevant, as increasing quantities of residual oil and metals with cuttings could accumulate on the seabed.

In summary, the cumulative impacts during construction and operation phases on seabed are considered **Not significant**.

G.10.6.3 Air Quality and GHG

Regarding the cumulative impacts due to emissions to atmosphere from the various projects planned in the area, they are not considered to affect significantly the local air quality given the dispersion capacity of the surrounding atmosphere. Cumulative impacts in this respect would only be expected when atmospheric dispersion plumes from sources could overlap, due to temporal and geographical coincidence of emissions from these sources. The potential for temporal and geographical coincidence of the different sources within the OCTP Phase II project is very small. If the sources emit simultaneously in time (i.e vessels during construction or FPSO and ORF during operation) they will be geographically sufficiently separated so that their dispersion plumes would not significantly overlap. Thus the cumulative impact on the local air quality, and associated impacts on receptors, will be similar to the highest of the impacts from any of the components.

In summary, the cumulative impacts on air quality during construction and operation are considered **Not significant**.

Cumulative impacts are expected to occur due to the potential GHG emissions from the various projects planned in the area. Unlike air pollutant emissions, in fact, greenhouse gases impacts are not limited to the proximity of the sources and are not subjected to dispersion in the surrounding atmosphere. GHG impacts occur, and need to be evaluated, at a global scale. Thus, cumulative GHG impacts are foreseen to occur and will increase the national emissions currently projected in Ghana's National GHG Inventory. To limit the significance of cumulative impacts, all Projects planned to be developed in the area shall implement feasible mitigation measures and design control pocedures to allow to keep Project GHG emissions as low as possible.

G.10.6.4 Underwater Noise

With regards to noise, there will be several sources of underwater noise generated by the project components. Noise can be generated by the same sources for the different components (i.e vessel) which can be coincidental in time and or geographical location in some instances, or by different sources (i.e drilling rig, well testing, power generation during operation) which can also be coincidental in time and geographical location with other sources. In terms of other projects in the area, the existing platforms/rigs/FPSO do generate some noise, whereas the planned Phases will include similar construction and operational noise sources. The potential of cumulative noise impacts between project components would mostly come from cases where the noise output from different project components could coincide in time and location, so that a local cumulative effect could take place (superimposition of either or both power and frequency, affecting to a wider range of organisms). In terms of location it has to be considered that underwater noise can travel long distances from the source.

The noise impacts from each of the planned developments would be similar in nature and general magnitude as the ones assessed for the OCTP Phase II project but the potential for cumulative effects will depend somewhat on the level of simultaneity between the developments during drilling and construction. For operational noise sources, these are mostly related to service vessel and maintenance activities, resulting in a lower intensity and frequency of noise. The most relevant cumulative effect with regards to noise could arise from the increased traffic related to the Atuabo Port, but the proportion of vessel traffic related to the port operation itself is much higher than the activities of the offshore field operators, and as such not manageable by those. This circumstance, jointly with the cumulative impacts on marine safety and traffic associated issues determines the need of a Marine Traffic Management Plan for the area to be designed by the appropriate Ghanaian Authority in conjunction with the different operators

In any case the underwater noise generated by the different activities will potentially affect marine fauna and specially mammal species. Potential disturbances to breeding animals are foreseen by a reduction of suitable habitats for breeding and feeding given the general increase in background noise levels expected. This will also result in behavioral changes, mainly in the form of avoidance of the area. However, it is expected that both turtles and marine mammals get habituated to these noise levels and return to normal activities and behavior after a given period of time as has been observed in other seas around the world where mammals are periodically recorded in noisy marine areas.

The cumulative impact from noise is therefore assessed as of **Low** significance during construction and operation phases.

G.10.6.5 Marine Fauna and Flora

The presence of simultaneous projects along the coast of the Western Region of Ghana may result in cumulative impacts on marine mammals and sea turtles, mainly derived from the increased underwater noise levels and the presence of infrastructures, vessels traffic and human activity along the beaches. As such there is the possibility of simultaneous traffic for all drilling, platform construction and pipeline installation, depending on the detailed schedule of works of each project.

Regarding the potential simultaneous activity of the vessels and the drilling rigs, it is considered that it will not be significant in terms of increased probability of collision with marine fauna, given the relative areas of influence of each vessel or rig, and the low speed of all vessel types . In any case this simultaneous disturbance is likely to be temporary and localised at significant distances.

Another potential cumulative impact expected on marine fauna is due to the increase in human presence and land take along the beaches (construction of pipelines of TEN and OCTP projects, new Lornho oil service port, ORF facilities construction and operation). This is expected to result in a loss of suitable nesting habitats and especially in a reduction of reproduction success by an increased poaching on the already laid eggs, due to the increased human presence along the coast. In this context it is considered necessary to implement a biodiversity action plan (BAP) where this impact is addressed in collaboration with local entities. Currently there exist some examples of turtle protection in the area as is the case of the program run by Benyin Beach Resort that would contribute to protect the eggs already laid by turtles.

In summary, given the extension of suitable nesting habitats , the cumulative impacts on marine fauna and flora during construction and operation are considered **Low**.

G.10.6.6 Coastal Processes

The expected development of several projects in the coasts of the Western Region of Ghana that include interventions in the nearshore area in the form of trenching for pipeline installation or in the construction of breakwaters as is the case of the Lornho Port Project, may result in a cumulative affection of the sediment transport along the coast and the associated accretion and erosion patterns. The alteration of this pattern could result therefore in the loss of sections of the beaches, with the associated loss of critical habitats for turtles for instance, and on the creation of new sediment deposits on the location of the new infrastructure.

The construction and installation of offshore pipelines is, however, a temporary intervention that would only alter the sediment flux during the construction phase, and with limited effects. Main interruption is therefore due to the construction, and further operation of the port, as the breakwater will have an impact in sediment transport during the time the structures are in place. According to the Lornho Port ESHIA, this breakwater will affect the sediment transport for 5 km along the coastline.

The cumulative impact will in principle increase as more structures are built. The geographical extent of this impact is limited to the immediate vicinity of the structures, thus the cumulative effects would be relevant in areas where there is overlap of structures. In this respect the proposed structures do not overlap.

In summary, it is considered that there will be **Not significant** cumulative impact on coastal processes derived from the presence of such structures and nearshore works during operation and construction.

G.10.6.7 Unplanned Events

In terms of cumulative impacts from offshore facilities unplanned events, the ones related to fire and explosions, and environmental effects related to gas blow outs and pipeline ruptures depend heavily on the safety measures undertaken by other operators. An export as pipeline to shore is however expected to be built to convey gas from both projects to shore. Such safety measures re not known at this stage, but expected to be of the same level than the ones implemented for OSCP, and given the distances of between the different gas bearing faciltiies and infastructures it is not expected to have cumulative impacts (such as knock on escalation or domino, effects from an accident at one location) from unplanned events from this source.

The most significant unplanned event from an offshore facility with environmental consequences is a hydrocarbon spill. In this respect the cumulative effects of OCTP Phases I and II have in fact been analysed jointly in this ESIA already, as well as the necessary mitigation measures.

With regards to other projects, the most important and similar are Jubilee (already in place) and TEN, from the same operator (Tullow). In TEN ESIA there is already an assessment of cumulative impacts related to oil oil spills for both Jubilee and TEN, in that ESIA the probability of any individual major (affecting the coast) spill occurring is 1 in 2000 years (5x 10^{-4}). The probability of any spill occurring in any of the wells of any of the 3 projects (Jubilee, TEN and OSCP) is of similar orders of magnitude. These data relate to the phase of drilling, and is consistent with OGP statistical data (OGP Risk Assessment Data Directory, Blow Out frequencies, Report 434-2, March 2010), in the world which mention orders of magnitude of 10^{-4} , probabilities which have in fact not changed significantly with the BP GoM, Macondo spill

s, The probability of a spill occurring in any one well increases arithmetically and additionally with the number of wells drilled simultaneously. However within each project no wells are expected to be drilled simultaneoulsy, and in fact Jubilee has already drilled all its wells. The probability of TEN and OSCP wells being drilled simultaneously is low.

The estimated probabilities of blow outs or significant leaks from production wells according to OGP data is in the level of 10^{-6} level per well year for oil wells and one order of magnitude higher for gas wells. Leaks and accidents in these wells relate mostly to prodution areas designed a number of years ago with less sophisticated technologies and materials, and due to ageing of the latter.

The total of well years of Jubilee, TEN and OSCP for oil wells is approximately 420 well/years (with 20 years field life as an average, nine oil production wells Jubilee, five oil production well TEN, seven oil production wells at OSCP Phase 1) of which 280 well years belong to Tullow Jubilee and TEN, and 140 to eni OSCP Phase 1. The total associated risk during operation is thus 4×10^{-4} or expressed differently one in 2380 years, similar to the idnetified risk of having any one blow out with a major oil spill during drilling. On the other hand the probability of more than one well suffering a blow-out or significant leak simultaneously decreases exponentially to the number of wells involved.

The risk of collision and accidents related to vessel traffic may increase with the traffic increases related to Lornho Port, and that will be managed with the already mentioned Marine Traffic Management Plan.

In terms of managing the consequences of an eventual spill, each project, and the Port, do or will have each Oil Spill Contingency Plan.. In fact the organisation contracted to deal with Tier III spills for the Tullow projects is the same, Oil Spill Risk Ltd.

Although collaboration amongst oil operators sharing oil spill management and equipment is not yet guaranteed offshore Ghana, there are several examples in the world of joint efforts amongst the oil operators and the public authorities with the objective of designing and implementing national or regional OSCP, which would ideally include the port. If such was collaboration could crystallize, all parties could benefit from coordinated plans and actions to manage any accidents. Eni will work together with other oil operators and with the public authorities, as possible, with the objective of designing a national or regional OSCP, including the port, which could benefit from coordinated plans and actions to manage any accidents

G.10.7 Cumulative Impacts of the Socio-economic Environment

G.10.7.1 Economy and Employment

The emergence of the oil and gas (O&G) industry in the Western Region will lead to an increase in the number of people who are able to secure permanent employment in the area. The income earned will increase average household incomes and levels of disposable income. This will increase local spending power, the demand for goods and services, and attract stimulate further economic activity. In turn, it will also increase income stability in the area.

In summary, the significance of this positive cumulative impact is considered to be **Low** during operation and construction given the low levels of literacy, available skills and lack of technical training of the local population, which limit the extent to which they are able to access and benefit employment opportunities available, particularly during the operation phase of the O&G projects. If implemented effectively, the training provided by other oil & gas companies operating in the area and as a result of the Lonrho Project would work to support this positive impact.

Inflation and Exacerbation of Economic Vulnerability

The larger population and worker presence both from the Project and other possible developments in the area could increase the demand for goods and services. Although this has positive economic benefits for secondary business development, this may in turn exacerbate price increases for accommodation, food and other retail goods within the surrounding area which can negatively affect the ability of vulnerable persons within the communities to access and afford these goods and services. In response to this, however, there may be an increase in secondary businesses exploiting new local markets by bringing in larger quantities of goods at lower prices.

In summary, although this is expected to temper the inflationary action, the overall cumulative impact on price inflation is considered to be **Medium** during construction and operation.

Tourism

The tourism sector in the Western Region has been highlighted as an area for potential growth. While the Project will have a positive impact on tourism by increasing the demand for accommodation and tourism facilities, there is potential conflict between the tourism sector and the increase in industrial land-use associated with O&G projects. Multiple projects may alter the sense of place of the area and detract tourists who visit the area to experience the rural and natural beauty of the destination.

Mitigation measures for this impact include the development of a tourism development framework, which must be owned by the Regional government. eni and other developers will partner with local government to develop such a framework.

In summary, and after mitigation, the significance of this cumulative impact is considered to be **Low** during construction and operation**.**

G.10.7.2 Lands and Livelihoods

The accelerated influx of people to the area as a result of other O&G developments in the will be associated increased pressure on land, natural resources and ecosystem services. Economic migrants entering the area may also want to pursue fishing and farming activities. This, together with additional exclusion zones and land take from other projects, could have a impact on the livelihoods of the host communities. The exclusion zone associated with one project may not have an adverse impact of fishing activities, and is not anticipated to result in reduced fish catches. If, however, there are multiple exclusion zones within a certain fishing area, these restrictions could result in reduced catches. This concern was noted by fishermen during consultation.

Considering this effect within a baseline context of already historically declining fish catch, the cumulative impact on fisheries based livelihoods is considered to be of **High** significance during construction and operations.

In terms of pressure on farming activity, it is recognised that the land take for the ORF is relatively small. However, multiple projects in the area, all with their own land requirements could lead to a significant loss of agricultural land and associated economic displacement and loss of livelihoods. Farmers are particularly vulnerable to this impact given the lack of suitable replacement land for agriculture. Further infrastructure developments such as roads and additional pipelines will also result in a change of land use, placing further pressure on land available for agriculture.

In summary, the cumulative impact on farming is considered to be of **High** significance during construction and operation.

The increased human pressure on natural resources and development of new transportation infrastructures may lead people accessing previously undisturbed land and therefore an increase of the potential for habitat degradation / land use change. An increase in population in the area will also lead to an increase in demand for natural resources such as wood for building houses and for fuel, which in turn will lead to further environmental degradation.

In summary, this impact is considered to be of **Medium** significance during construction and operation.

Mitigation for the impacts on livelihoods and ecosystem services will include working with local and regional governments to develop effective measures and procedures to encourage sustainable resource management, spatial planning and land development as well as efficient land administration by relevant authorities. Mitigation measures within the Livelihoods Restoration Plan and Fisheries Management Plan will also be focused on the management of this impact.

Post Decommissioning and Livelihoods

The combined effect of all the anticipated O&G and infrastructure projects within the area over similar time periods may lead to a transformation of the economy and livelihood strategies of local communities from largely subsistence agriculture and faming to wage labour over the construction period, for example. If this transition does not occur in a sustainable way, this could result in economic dependency of locally impacted communities on the O&G sector.

The result of post-decommissioning job losses could have a negative economic and psychological impact on members of the local population, in particular those who have come to rely solely on the O&G sector for their source of livelihood. Local communities may also come to depend on or expect supplementary livelihood support from social investment projects from foreign companies as part of their social investment strategies in the area.. The poorly managed exit by companied from such projects can impact upon communities further.

Mitigation will include working with local, regional and national government as well as other Operators in developing a sustainable social investment and exit strategy, focused on addressing how social investments can benefits project affected people and project employees in a sustainable manner. The exit strategy will also define actions to mitigate the potential residual impact of withdrawing these benefits post-decomissioning.

In summary, the significance of this cumulative impact is considered as **Medium** during decommissioning.

G.10.7.3 Socio-cultural Changes

The introduction of large scale developments in relatively remote and rural environments can bring about substantial social and cultural change as a result of the increasing number of project workers and job-seekers from outside the area or the country, that move into the area. Whilst one Project may not result in a noticeable change, the rapid population increase which could be associated with multiple simultaneous or consecutive developments could result in the erosion of social-cohesion in impacted communities, through irreversible changes to cultural practices and breakdown of traditional social networks and norms. This can increase the local community's vulnerability and susceptibility to an increase in anti-social behaviours. These could include drug and alcohol abuse, increased incidence of sex workers, teenage pregnancies, and domestic violence and other crimes. A potential increase in anti-social behaviour can also be linked an increase in disposal income within the area [(1)].

These changes to socio-cultural norms, together with physical presence of multiple projects will have an impact on the sense of place of the area. The area is currently characterised by small coastal villages with very little industrial development and with very high levels of social cohesion and respect for traditional practices and authority binding communities and families. The presence of new industrial infrastructure and a growing migrant population will alter the sense of place (both physically and socially) for local residents who may value the rural nature of the area, feel security in the current stability of social networks, norms and low crime incidence, or attach religious or cultural significance to aspects of the natural environment.

In summary, the cumulative impacts are assessed to be of **Medium** significance.

G.10.7.4 Social Infrastructure and Public Services

Project tenants and other developments in the area will increase labour requirements over and above those of the Project. This will enhance skills transfer in the economy, however the increased labour requirements could also draw public sector employees into the private sector creating pressure on Government institutions and the provision of essential services, infrastructure and utilities. In summary, the significance of this cumulative impact is considered to be **Low** during construction and operation

It is accepted that large scale projects can lead to an increase in population of the area in which they occur. This is due to the influx of both the project workforce and economic migrants entering the area with the intention of securing employment with the Project. It is anticipated that the oil and gas projects and other large infrastructure projects in the coastal districts of the Western Region will draw people to the area. Although most projects will be

(1) It is generally accepted, and previous experiences confirm that an increase in disposable income is associated with an increase in anti-social behaviour.

at least partially self-sufficient, the project cannot be responsible for the likely increase in pressure on social infrastructure and demand for services from jobseekers who have settled in the vicinity of their project. As more projects are permitted in region, it is likely that in-migration into the area will further increase, placing additional pressure on already strained or inadequate social infrastructure and services such as health and education, waste and sanitation facilities.

On the other hand, the existing coastal villages are small and do not qualify for extensive services and infrastructure from local governments. An increase in population in these villages could have the positive effect of increasing their eligibility for more or improved services from local government such as clinics, schools, and waste removal. However given the lack of capacity within local government to deliver on services, and the possible lag time between the population growth and the delivery of infrastructure and services, this impact is still considered an overall negative impact on the communities in the area.

In order to mitigate the negative impacts of increased pressure on social infrastructure and service delivery, the Project will, in conjunction with other projects in the area and local government, develop an influx management plan.

In summary, the effective implementation of such a plan will mean significance of this cumulative impact is considered to be **Medium** during construction and operation**.**

G.10.7.5 Community Health, Safety and Security

Increase in traffic on local and national roads, air emissions as a result of the Project and other potential developments as well as additional risks of industrial accidents and explosions will result in cumulative impacts on community health and safety. These increases put additional pressure on existing infrastructure and pose risks to health and safety of general road users, traders and of pedestrians (school children whose schools are also close to the roads along transport routes). Increased traffic also increases levels of noise and dust generated in the area.

The influx and the potential increase of social pathologies could result also in the increase in the spread of diseases such as HIV/AIDS and diseases related to the densification of settlement patterns and unhygienic living conditions (eg water-borne diseases). Additionally the rate of transmission of communicable diseases may also increase. The profile of these diseases will be influenced by the existing health profile of communities within the area of influence of the project and that of the workers

In summary, appropriate maintenance of roads by relevant parties (projects and government) and mitigation such as development of project health and safety plans and support of government and NHO programmes would ensure that the impacts would remain **Medium** during construction and operation.

G.11 TRANS-BOUNDARY IMPACTS

The OCTP project is located in the southwest of Ghana, approximately 37 km east of Ivory Coast (minimum onshore distance measured from the ORF). In line with best practices, particular attention is paid in this EIS to potential trans-boundary impacts, which are those that may affect receptors in different countries.

This Section presents a summary of the impacts identified through the ESHIA impact assessment where the "extent" (as defined by the eni ESHIA methodology) of the impact has been judged to extend outside of the borders of Ghana if needed. Please refer to the full impact assessment description contained within Section G.2.

G.11.1 Economy and Employment

During the construction phase, the Project will require the purchase of equipment and other goods and services, generating business for suppliers. The majority of these contracts will be for highly specialised and technical work/ equipment and will therefore be provided by specialist suppliers internationally.

However, due to the small size of the project when considering an international scale, the transboundary impact on the economy and employment (positive impact) is considered **Low** during construction and operation.

Project construction activities will also lead to an increase in vessel traffic on offshore routes connecting the Project, the Takoradi Port and the countries from where the supplies will come from (eg. pipes, drilling rig, diesel, etc.). Due the reduced number of project vessels/trips involved internationally, the potential transboundary impact has been also considered as **Low** during construction and operation

G.11.2 Unplanned Events (Major Spills)

No significant transboundary impacts are expected to occur as a result of normal operations. However, modelling simulations of a large oil spill into the marine environment (blow out worst case scenario) showed oil being transported throughout the Gulf of Guinea, with oil making landfall in Ghana, Côte d'Ivoire, Togo, Benin, Nigeria, Cameroon, Equatorial Guinea and Gabon. Dealing with transboundary oil spill incidents is not within eni Ghana remit and the response to any such spills will be by the Government of Ghana. However, a number of mitigation measures aiming to decrease the probability of such events have been included in Section G.9 Unplanned Events. Moreover, in order to reduce the consequences of the residual risk, eni Ghana has developed an Oil Spill Contingency Plan which is included in Annex F of this EIS.

The Government of Ghana is currently working closely with the other contracting parties of the Abidjan Convention to seek and finalise formal arrangements for dealing with transboundary oil spill incidents.

Due to the high sensitivity of resources, the probability of a crude oil spill due to a blow out and receptors and the prevention measures defined the impact is assessed as being of **Medium** significance during operations. Please Refer to Section G.9 Unplanned Events for further details.

G.12 SUMMARY TABLES

Table G133, Table G134 and Table G135 below provide a summary of the impact assessment discussed above so as to facilitate the understanding of the overall impacts expected to the reader.

Table G133 Summary table of Impacts - Construction phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Onshore Air Quality					
Increased dust emissions from earth movement, excavation works, stockpiles, vehicle movement on unpaved surfaces and increased atmospheric pollutant concentrations (CO, NOx) due to exhaust emissions from vehicles involved in construction activities, engine-driven machinery and power generators.	*2*	*1*	*2*	*1*	**6 - Low**
Increased atmospheric pollutant concentrations during hydrostatic testing.	*1*	*1*	*2*	*1*	**5 - Low**
Onshore Ambient Acoustic Conditions					
Increased noise emissions from equipment involved in the construction of the ORF and pipeline installation.	*2*	*1*	*2*	*1*	**6 - Low**
Increased noise emissions from equipment involved in the hydrostatic testing	*1*	*1*	*2*	*1*	**5 - Low**
Surface Water Resources					
Removal of ephemeral within the Project site	*4*	*1*	*3*	*1*	**9 - Medium**
Degradation of surface water quality due to increased sediment load	*2*	*1*	*2*	*1*	**6 - Low**
Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste	*2*	*1*	*2*	*1*	**6 - Low**
Degradation of surface water quality due to spillages of the fuels and chemicals used during construction	*2*	*2*	*3*	*1*	**8- Medium**
Changes in hydrology and/or the hydrological regime caused by reduced flows and/or changes in flow direction caused by projected related work (ie site clearance, earthworks and constructions)	*4*	*1*	*2*	*1*	**8- Medium**
Groundwater Resources					

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Reduction in Groundwater Resources due to Water Consumption	*2*	*1*	*2*	*2*	**7 - Medium**
Surface Sealing and Infilling Leading to Lowering of Groundwater Levels and Drawdown	*2*	*1*	*2*	*1*	**6 - Low**
Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling	*2*	*1*	*2*	*1*	**6 - Low**
Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals	*4*	*1*	*2*	*1*	**8 - Medium**
Geology, Geomorphology and Soil					
Potential contamination of the Soil	*2*	*1*	*2*	*1*	**6 - Low**
Potential Disturbance and Degradation During Construction	*2*	*1*	*2*	*1*	**6 - Low**
Soil Removal/ Land Take	*2*	*1*	*2*	*1*	**8 - Medium**
Flora					
Loss of natural vegetation	*4*	*1*	*2*	*2*	**9 - Medium**
Loss of habitat/ habitat fragmentation	*4*	*1*	*2*	*1*	**9 - Medium**
Impacts on flora due to degradation of abiotic components of ecosystems	*2*	*1*	*2*	*1*	**7 - Medium**
Introduction of alien species	*2*	*1*	*2*	*1*	**6 - Low**
Fauna					
Habitat Reduction/ Fragmentation and Isolation	*4*	*1*	*2*	*1*	**8 - Medium**
Disturbance and/or Displacement of Fauna due to Pollution	*2*	*1*	*2*	*1*	**6 - Low**
Increased Mortality of Wildlife	*2*	*1*	*2*	*1*	**6 - Low**
Landscape and Visual					
Landscape changes and visual impacts due to installation of the pipeline	*1*	*1*	*2*	*1*	**5 - Low**
Landscape changes and visual impacts due to construction of ORF and associated	*4*	*1*	*2*	*1*	**8-Medium**

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
infrastructure					
Visual impacts due to well installations, presence of the FPSO and vessel movement	*1*	*1*	*2*	*1*	**5 - Low**
Seawater Resources					
Increase in Turbidity	*2*	*1*	*2*	*1*	**6- Low**
Release of Contaminants and Nutrients	*2*	*1*	*2*	*1*	**6 - Low**
Potential Contamination from routine discharges of Vessel Operations and occasional spills	*2*	*1*	*2*	*1*	**6 - Low**
Drilling waste (mud and cuttings) and cement discharges	*2*	*1*	*2*	*1*	**6 - Low**
Use and discharge of Treated Seawater Resources	*1*	*1*	*2*	*1*	**5 - Low**
Seabed Quality					
Physical alterations to the seabed (including smothering of habitat)	*2*	*1*	*3*	*1*	**7 -Medium**
Sediment contamination due to use of cementing/ drilling chemicals	*2*	*1*	*3*	*1*	**7 -Medium**
Air Quality–Offshore Construction Phase					
Drill rig and vessels exhausts for production wells drilling	*2*	*1*	*1*	*1*	**5 - Low**
Vessels exhausts for pipeline installation	*1*	*1*	*1*	*1*	**4 - Low**
Underwater Noise					
Increased underwater noise emissions as a result of pipeline laying, trench excavation and general shipping activities	*2*	*1*	*2*	*1*	**6 - Low**
Increased underwater noise emissions as a result of drilling activities	*2*	*1*	*2*	*1*	**6 – Low**
Marine Fauna					
Potential disturbance of marine fauna due to increased underwater noise emissions	*2*	*1*	*2*	*1*	**6 - Low**

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Potential disturbance of marine fauna including seabirds, cetaceans and turtles due to physical presence (collision risk, light emissions, physical presence)	*2*	*1*	*2*	*1*	**6 - Low**
Potential disturbance of marine fauna including benthos and nekton community due to cuttings deposition on seabed, decreased marine water quality and increase of suspended solids	*2*	*1*	*2*	*1*	**6 - Low**
Potential disturbance to ecosystem due to the introduction of alien species due to the discharge of ballast water	*2*	*1*	*2*	*1*	**6 - Low**
Marine Fauna					
Impacts due to the Installation of the Pipeline in the Nearshore	*1*	*1*	*1*	*1*	**4 - Low**
Fisheries					
Impact derived from FPSO, drilling rig and vessel discharges.	*2*	*1*	*1*	*1*	**5-Low**
Impact derived from discharge of ballast waters	*1*	*1*	*1*	*1*	**4-Low**
Impact derived from the physical presence and light emissions on commercially exploited species.	*2*	*1*	*1*	*1*	**5-Low**
Potential impact of underwater noise commercially exploited species	*2*	*1*	*1*	*1*	**5-Low**
Pipeline underwater noise activities potentially affecting commercially exploited species	*2*	*1*	*2*	*1*	**6-Low**
Economy and Employment					
Increased Government Revenue	*2*	*3*	*2*	*3*	**10-High Positive**
Employment opportunities and Skills Enhancement	*2*	*2*	*2*	*2*	**8-Medium-Positive**
Increased Procurement	*2*	*4*	*2*	*2*	**10-High Positive**
Enhanced Tourism Potential	*2*	*1*	*2*	*1*	**6-Low Positive**

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Increased Price Inflation and Economic Vulnerability	*2*	*1*	*3*	*2*	**8-Medium**
Workforce Demobilisation	*2*	*1*	*3*	*2*	**8-Medium**
Land and Livelihood					
Economic Displacement of Land-Based Livelihoods					
Economic Displacement of Farming in Land Acquisition Area	*4*	*1*	*3*	*2*	**10-High**
Disruption/Displacement of Fisheries-based livelihoods					
Restricted Access to Offshore Fishing Grounds due to Exclusion Zones	*2*	*1*	*1*	*2*	**6-Low**
Disruption of Onshore and near-shore Fishing activities	*2*	*1*	*2*	*2*	**7-Medium**
Damage to Fishing Gear	*2*	*1*	*2*	*2*	**7-Medium**
Lighting	*2*	*1*	*1*	*2*	**6-Low**
Socio-Cultural Change					
Changes to cultural and Social Norms	*2*	*1*	*3*	*1*	**7-Medium**
Increased anti-social behaviour	*2*	*1*	*3*	*1*	**7-Medium**
Tension and Conflict between Villages	*2*	*1*	*3*	*1*	**7-Medium**
Economy and Employment					
Cultural Heritage Resources	*2*	*1*	*2*	*1*	**6 Low**
Sense of Place	*2*	*1*	*3*	*1*	**7 Medium**
Infrastructure and public services					
Social Infrastructure	2	1	3	2	**8-Medium**
Road Infrastructure	2	2	3	2	**9-Medium**
Health Infrastructure	2	2	3	2	**9-Medium**
Marine Traffic and Infrastructure	2	4	1	2	**9-Medium**
Workers management and rights, and workers health and safety					
Worker health and Safety	2	1	2	1	**6-Low**

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Workers' Rights, retrenchment and accommodation	2	1	2	1	**6-Low**
Forced Labour	2	1	2	1	**6-Low**
Child Labour	2	1	2	1	**6-Low**
Community Health, Safety and Security					
Increased prevalence of Sexually Transmitted Infections including HIV/AIDS	2	2	2	2	**8-Medium**
Increased prevalence of Communicable diseases	2	2	2	2	**8-Medium**
Increased prevalence of malaria	2	1	1	2	**6-Low**
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	2	2	2	1	**7-Medium**
Increased pressure on health care resources	2	1	2	2	**7-Medium**
Site trespass and injury	2	1	2	1	**6-Low**
Environmental health	2	1	2	1	**6-Low**
Public security	2	1	1	1	**5-Low**

Note 1: Impacts on ecosystem services have been assessed using a different methodology and so results re not shown in this table.

Note 2: Impacts related to unplanned events and cumulative impacts have not been included in this table.

Table G134 Summary Table of Impacts - Operation phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Onshore Air Quality					
Increased atmospheric pollutant concentrations (CO, NOx) due to exhaust emissions from ORF facilities operation and vehicles involved in maintenance.	*4*	*1*	*2*	*1*	**8 - Medium**
Ambient Acoustic Conditions					
Increased noise emissions from power generators and compressors of the ORF and vehicles for maintenance operations	*4*	*1*	*2*	*1*	**8 - Medium**
Freshwater Resources					
Degradation of surface water quality due to potential contamination from improper handling of hazardous and non-hazardous waste	*2*	*1*	*2*	*1*	**6 - Low**
Degradation of surface water quality due to spillages of the fuels and chemicals used during operation	*2*	*1*	*2*	*1*	**6 - Low**
Groundwater Resources					
Reduction in Groundwater Resources due to Water Consumption	*4*	*1*	*2*	*2*	**9 - Medium**
Degradation of Groundwater Quality due to Seepage from Discharge of Wastewater and Improper Waste Storage and Handling	*4*	*1*	*2*	*1*	**8 - Medium**
Degradation of Groundwater Quality Due to Spillages of Fuels and Chemicals (Unplanned Event)	*4*	*1*	*2*	*2*	**9 - Medium**
Geology, Geomorphology and Soil					
Potential contamination of the Soil	*4*	*1*	*2*	*1*	**8 - Medium**
Soil compaction and erosion	*4*	*1*	*2*	*1*	**8 - Medium**
Flora					

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Impacts on flora due to degradation of Abiotic Components of Ecosystems	*4*	*1*	*2*	*1*	**8 - Medium**
Fauna					
Disturbance and/or Displacement of Fauna due to Pollution	*4*	*1*	*2*	*1*	**8 - Medium**
Increased Mortality of Wildlife	*4*	*1*	*2*	*2*	**9 - Medium**
Landscape and Visual Impacts					
Visual impacts due to presence of the ORF and associated infrastructure	*4*	*1*	*2*	*1*	**8- Medium**
Visual impacts due to the presence of the FPSO and vessel movement	*1*	*1*	*2*	*1*	**5 - Low**
Seawater Resources					
Potential Contamination due to FPSO operations	*4*	*1*	*2*	*1*	**8 – Medium**
Contamination from routine discharge from Vessel Operations	*4*	*1*	*2*	*1*	**8 – Medium**
Potential Contamination from pipeline anti corrosion anodes	*4*	*1*	*2*	*1*	**8 – Medium**
Seabed Quality					
Potential seabed contamination	*4*	*1*	*2*	*1*	**8 - Medium**
Sediment accumulation and/or scouring/ erosion	*4*	*1*	*2*	*1*	**8 - Medium**
Offshore Air Quality					
Vessels (and FPSO) exhausts for maintenance works	*4*	*1*	*1*	*1*	**7 - Medium**
Noise and Underwater Noise					
Increased underwater noise emissions due to general shipping activities and FPSO operation	*4*	*1*	*2*	*1*	**8 - Medium**
Marine Fauna					
Potential disturbance of marine fauna due to increased underwater noise emissions	*4*	*1*	*2*	*1*	**8 - Medium**

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Potential disturbance of marine fauna including seabirds, cetaceans and turtles due to physical presence (collision risk, light emissions, physical presence)	*4*	*1*	*2*	*1*	**8 - Medium**
Potential disturbance of marine fauna including benthos and nekton community due physical disturbance of the seabed (inspections and routine maintenance works)	*4*	*1*	*2*	*1*	**8 - Medium**
Potential disturbance to ecosysym due to the introduction of alien species due to the discharge of ballast water	*2*	*1*	*2*	*1*	**6 - Low**
Fisheries					
Impact derived from FPSO, and vessel discharges.	*4*	*1*	*1*	*1*	**7-Medium**
Impact derived from the physical presence and light emissions on commercially exploited species.	*4*	*1*	*1*	*1*	**7-Medium**
Potential impact of underwater noise commercially exploited species	*4*	*1*	*1*	*1*	**7-Medium**
Economy and Employment					
Increased Government Revenue	*4*	*3*	*2*	*3*	**13-Critical Positive**
Employment opportunities and Skills Enhancement	*4*	*2*	*2*	*2*	**10- High Positive**
Increased Procurement	*4*	*2*	*2*	*2*	**10- High Positive**
Tourism Development	*4*	*1*	*2*	*1*	**8- Medium Positive**
Increased Price Inflation and Economic Vulnerability	*2*	*1*	*1*	*1*	**5- Low**
Land and Livelihood					
Economic Displacement of Land-Based Livelihoods					
Economic Displacement of Farming in Land Acquisition Area	*4*	*1*	*3*	*2*	**10-High**

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Disruption/Displacement of Marine Fishing-based livelihoods					
Restricted Access to Offshore Fishing Grounds due to Exclusion Zones	*4*	*1*	*1*	*2*	**8-Medium**
Disruption of near-shore Fishing activities	*4*	*1*	*2*	*2*	**9-Medium**
Damage to Fishing Gear	*4*	*1*	*2*	*2*	**9-Medium**
Lighting	*4*	*1*	*1*	*2*	**8-Medium**
Socio-Cultural Change					
Changes to cultural and Social Norms	*4*	*1*	*1*	*1*	**7-Medium**
Increased anti-social behaviour	*4*	*1*	*1*	*1*	**7-Medium**
Tension and Conflict between Villages	*4*	*1*	*1*	*1*	**7-Medium**
Economy and Employment					
Cultural Heritage Resources	*4*	*1*	*1*	*1*	**7 Medium**
Sense of Place	*4*	*1*	*2*	*1*	**8 Medium**
Infrastructure and public services					
Social Infrastructure	*4*	*1*	*1*	*1*	**7-Medium**
Road Infrastructure	*4*	*1*	*2*	*1*	**8-Medium**
Health Infrastructure	*4*	*1*	*1*	*1*	**7-Medium**
Marine Traffic and Infrastructure	*4*	*2*	*1*	*1*	**8-Medium**
Workers management and rights, and workers health and safety					
Worker health and Safety	4	1	1	1	**7-Medium**
Workers' Rights and accommodation	4	1	1	1	**7-Medium**
Community Health, Safety and Security					
Increased prevalence of sexually transmitted infections, HIV/AIDS	4	1	2	1	**8 -Medium**
Increased prevalence of Communicable diseases	4	1	1	1	**8-Medium**
Increased transmission of Malaria	4	1	1	1	**7-Medium**

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Traffic accidents from increased traffic and presence of heavy vehicles in local roads	4	1	1	1	**7-Medium**
Public security	4	1	1	1	**7-Medium**

Note 1: Impacts on ecosystem services have been assessed using a different methodology and so results re not shown in this table.
Note 2: Impacts related to unplanned events and cumulative impacts have not been included in this table.

Table G135 Summary Table of Impacts - Decommissioning phase

Impacts	Duration	Extent	Importance / Resilience of Receptor / Resource	No. of Elements Involved	Impact Rank
Onshore Air Quality					
Increased dust emissions from earthworks and vehicle movement on unpaved surfaces and increased atmospheric pollutant concentrations (CO, NOx) due to exhaust emissions from vehicles involved in decommissioning.	*2*	*1*	*2*	*1*	**6 - Low**
Ambient Acoustic Conditions –Onshore Decommissioning					
Increased noise emissions from equipment involved in pipeline and ORF decommissioning	*2*	*1*	*2*	*1*	**6 - Low**
Geology, Geomorphology and Soil					
Potential contamination of the Soil	*2*	*1*	*2*	*1*	**6 - Low**
Soil Compaction and Erosion	*2*	*1*	*2*	*1*	**6 - Low**
Flora					
Impacts due to emissions	*2*	*1*	*2*	*1*	**6 - Low**

Impacts	**Duration**	**Extent**	**Importance / Resilience of Receptor / Resource**	**No. of Elements Involved**	**Impact Rank**
Onshore Air Quality					
Introduction of alien species	*2*	*1*	*2*	*1*	**6- Low**
Fauna					
Disturbance and/or Displacement of Fauna due to Pollution	*2*	*1*	*2*	*1*	**6 - Low**
Increased Mortality of Wildlife	*2*	*1*	*2*	*2*	**7 - Medium**
Offshore Air Quality					
Vessels exhausts for decommissioning activities	*2*	*1*	*1*	*1*	**5 - Low**

Note: additional impacts related to the decommissioning phase are discussed in this chapter, but where considered not significant and a formal rating was not produced.

ESHIA for GHANA OCTP BLOCK Phase 2

ANNEX H
Air Quality

ABSTRACT

Annex H provides an assessment of the impacts on air quality correlated to the onshore and offshore Project activities during construction and operation phases by means of modelling calculation tools

Date	Revision	Revision Description	Prepared	Checked	Approved
July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago

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ACRONYMS

Acronym	Definition
AQS	Air Quality Standards
ADMS	Atmospheric Dispersion Modelling Study
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CONCAWE	Conservation Of Clean Air And Water In Europe
DEM	Digital Elevation Model
EHS	Environmental Health And Safety
EPA	Environmental Protection Agency
FPSO	Floating Production Storage And Offloading
FAO	Food And Agriculture Organisation Of The United Nations
GLCN	Global Land Cover Network
GT	Gas Turbine
GT	Gross Tonnage
H_2S	Hydrogen Sulphide
MEET	Methodology For Estimate Air Pollutant Emissions From Transport
MM5	Fifth-Generation Penn State/NCAR Mesoscale Model
NASA	National Aeronautics And Space Administration
NCAR	National Centre For Atmospheric Research
NO_x	Nitrogen Oxides
NO_2	nitrogen dioxide
OCTP	Offshore Cape Three Points
ORF	Onshore Receiving Facilities
PM_{10}	Particulate Matter
SO_2	sulphur Dioxide
SOx	Sulphur Oxides
SRTM	Shuttle Radar Topography Mission
TIBL	Thermal Inversion Boundary Layer
US-EPA	US Environmental Protection Agency
VOC	Volatile Organic Compound
WBG	World Bank Group
WHO	World Health Organisation

H.1. Introduction

The development of the hydrocarbon reserves in the Offshore Cape Three Points (OCTP) and the related onshore Project activities has the potential to adversely impact local air quality. In order to support the assessment of the potential impact on local air quality, air quality modelling studies and qualitative/quantitative assessment of atmospheric emissions have been performed. Details about the Project Design Data, relevant assumptions and project information related to the OCTP project are presented in the Chapter 4 of the ESHIA, related to OCTP Phase 2.

Since the OCTP Project presents onshore and offshore component the impacts to the environment surrounding the onshore facilities, offshore installations and at the nearest sensitive receptors was supported with the following activities:

- A qualitative estimation of the emissions arising during the onshore construction and pre-commissioning phase;
- An Atmospheric Dispersion Modelling Study (ADMS) aimed at quantifying the impacts induced by the Onshore Receiving Facilities (ORF) operation. (labelled as ORF ADMS hereinafter);
- A quantitative estimation of the emissions arising during the offshore construction;
- An Atmospheric Dispersion Modelling Study (ADMS) aimed at quantifying the impacts induced by the Floating Production Storage And Offloading (FPSO) operation; (labelled as FPSO ADMS hereinafter).

The present Annex presents the modelling and emission estimation activities carried out to support of the assessment of impacts on local air quality performed for the Phase 2 ESHIA (presented in Annex G) and integrate the air quality impact assessment of the Phase 1 ESHIA. Annex G defines as well applicable mitigation measures, and therefore the impacts hereby presented have to be considered as residual impact, after the implementation of the identified mitigation measures.

H.2. Onshore

H.2.1 AIR QUALITY STANDARDS

Human Health

The performed ADMS quantified the atmospheric concentration of gaseous pollutants induced by the Project onshore construction, pre-commissioning and operation under normal operative conditions. These concentrations were compared against in force Air Quality Standards (AQS) set for the protection of human health by the Ghana Environmental Protection Agency (EPA) and by the World Bank Group (WBG) which in turns refer to the World Health Organisation (WHO).
The Ghana EPA has established legislation and guidelines governing air emissions and common air pollutants specific for industrial and residential areas (Table H2.1) The Ghana EPA AQS set for residential areas apply to this ESHIA.

Table H2.1 Ghana EPA Air Quality Standards

Substance	Average-time	Time-Weighted Average (TWA) [μg/m³]	
Sulphur Dioxide (SO_2)	1 h	900	Industrial
		200	Residential
	24 h	150	Industrial
		100	Residential
	Calendar year	80	Industrial
		50	Residential
Nitrogen oxides (Measured as NO_2)	1 h	400	Industrial
		90	Residential
	24 h	150	Industrial
		60	Residential
	Calendar year	100	Industrial
		30	Residential
Total Suspended Particulate (TSP)	1 h	230	Industrial
		150	Residential
	24 h	75	Industrial
		60	Residential
Particulate Matter PM_{10}	24 h	70	--

Carbon Monoxide (CO)	24 h 1 h	60 mg/m^3 10 mg/m^3

Source: Environmental Quality Guidelines for Ambient Air (EPA, 1996)

The WBG General Environmental Health and Safety (EHS) guidelines (World Bank Group 2007a) refer to the WHO air quality guidelines standards (WHO 2005). The international standards for the protection of human health presented in Table H2.2 include guideline values and interim targets levels. The latter, in excess of the guideline values [1], have been set by WHO to promote a steady progress towards meeting the air quality guideline value in developing countries where ambient air quality often exceed the guideline values. The WHO guideline standards are reference values for this ESHIA.

Table H2.2 WHO Ambient Air Quality Standards

Substance	**Averaging period**	**Guideline value [µg/m^3]**
Sulphur Dioxide (SO_2)	24 h	125 (Interim target-1) 50 (Interim target-2) **20 (guideline)**
	10 minute	500 (guideline)
Nitrogen Dioxide (NO_2)	Calendar year	**40 (guideline)**
	1 h	**200 (guideline)**
Particulate Matter PM10	Calendar year	70 (Interim target 1) 50 (Interim target 2) 30 (Interim target 3) **20 (Guideline)**
	24 h	150 (Interim target 1) 100 (Interim target 2) 75 (Interim target 3) **50 (Guideline)**
Particulate Matter PM2.5	Calendar year	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) **10 (guideline)**

[1] "WHO air quality guidelines global update 2005", Report on a working group meeting, Bonn, Germany, 18-20 October 2005.

Substance	Averaging period	Guideline value [μg/m³]
	24 h	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) **25 (guideline)**
Ozone	8-hour daily maximum	160 (Interim target-1) **100 (guideline)**

Source: WBG General EHSs Guidelines: Environmental Air Emissions And Ambient Air Quality (2007)

Vegetation

The Ghana EPA and the IFC do not set guidelines for the protection of sensitive vegetation. Instead the European Union standards for the protection of vegetation set by the Directive 2008/50/EC are used. These guidelines are used in the absence of any other relevant guidelines, and as they are largely not dependant on specific species type and morphology and can therefore be applied to any vegetation type. These standards are set out in Table 2.2.

Table H2.3 European Air Quality Standards for the Protection of Vegetation

Parameter	Measurement Period	Standard (μg/m³)
NO_x	Annual mean	30
SO_2	Annual mean	20

H.2.2 AIR QUALITY BASELINE

Air Quality baseline allows to evaluate whether the existing airshed is degraded or nont-degraded and to characterize the current air quality levels at sensitive receptors. This information in conjunction with the project contribution in terms of induced concentration, is key for the assessment of impacts on local air quality.

No major industrial activities and thus no significant sources of air pollutant emissions are located in the surroundings of the project facilities. The majority of emissions to air arise from the smoke of cooking fires; exhaust of generators used for power supply; and vegetation burning to clear land for farming. During the site inspection conducted in December 2014, on-going road construction along the length of the pipeline ROW was creating dust along the immediate stretch.

As part of the field surveys held in March 2014 and in October 2014, air quality measurements were taken during 24 hour at three sampling points, located at the eni concession, Sanzule and Eikwe communities respectively (Figure H2.1) located in the surroundings of the concession area, located at a distance from the ORF of about 700 m and 350 m respectively. Measurements of ambient air quality were carried out using the highly flexible AEROQUAL air quality monitor (AQM 60). The AQM instrument is based on analytic Gas Sensitive Semiconductor (GSS) technology. Twenty-four hour measurements of wind directions were collected alongside air quality measurements; wind direction measurements showed a predominant wind direction from North-North East both during March and October 2014 at the Sanzule and Eikwe communities.

Figure H2.1 Onshore Monitored Receptors

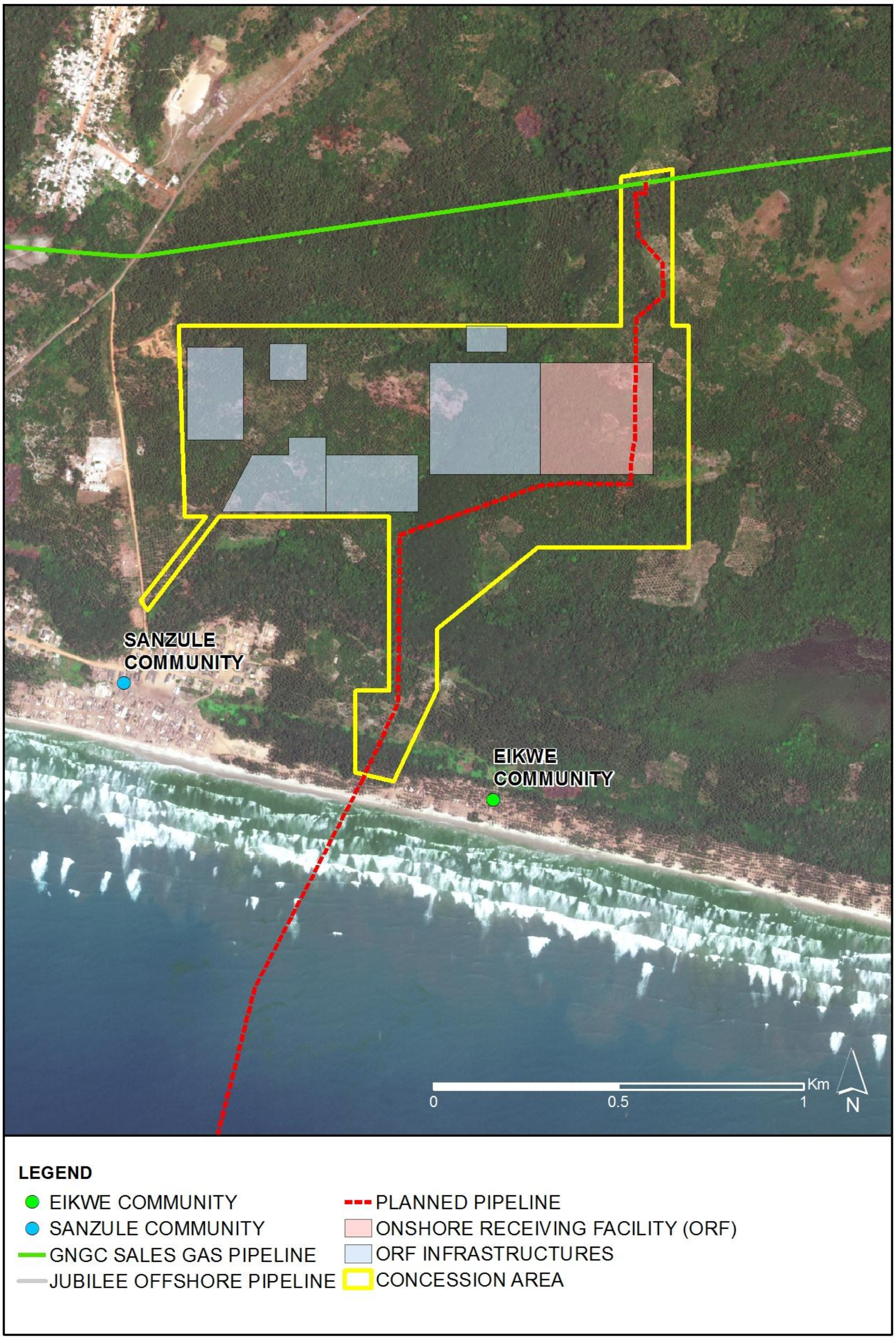


Table H2.4 and Table H2.5 present for the dry season and the wet season, respectively, air quality monitoring results along with in force Ghanaian AQS (for residential areas) and WBG/WHO guideline values.

Table H2.4 Ambient Air Quality (March 2014 dry season survey)

Parameter	**24 h Average Concentration**			**Ghana EPA** (2) **(24hour time weighted average)**	**World Bank Group EHS Guidelines (2007)**
	Eni concession	**Sanzule community**(1)	**Eikwe community**(1)		
NO_2 (µg/m^3)	1.90	1.88	1.38	150	40 (annual) 200 (1-hour)
SO_2 (µg/m^3)	**130.34** (b)	**78.65** (b)	**218.69** (a) (b)	150	20 (24-hour) 500 (10-minute)
TSP (µg/m^3)	19.04	28.76	25.72	150	NG
PM_{10} (µg/m^3)	14.56	20.32	21.28	70	20 (annual) 50 (24-hour)
VOC (ppm)	0.07	0.06	0.05	NG	NG

Notes:
NG=No Guideline
Values highlighted in **bold** exceeded the (a) Ghana EPA standard or (b) the WBG guideline.
The comparison with WBGWHO can be done only for SO_2 and PM_{10} for which a 24-hour guideline has been set by WBG/WHO.
(1) The Sanzule and the Eikwe communities are classified as residential areas. Therefore concentrations monitored at these locations were compared against Ghana EPA AQS set for residential areas
(2) *Set by the Environmental Quality Guidelines for Ambient Air (EPA, 1996) for residential areas*

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014)

Table H2.5 Ambient air quality results (October 2014 wet season survey)

Parameter	24hour Average Concentration			Ghana EPA [3] (24hour time weighted average)	World Bank Group EHS Guidelines (2007)
	eni Concession	Sanzule community[2]	Eikwe community[2]		
NO_2 (µg/m^3)	0.10	0.05	0.08	150	40 (annual) 200 (1-hour)
SO_2 (µg/m^3)	19.74	**65.93** (b)	**30.49** (b)	150	20 (24-hour) 500 (10-minute)
TSP (µg/m^3)	28.77	81.38	133.35	150	NG
PM_{10} (µg/m^3)	18.42	**52.53** (b)	**84.52** (a) (b)	70	20 (annual) 50 (24-hour)
VOC (ppm)	0.07	0.02	0.04	NG	NG
CO_2 (µg/m^3) [1]	542621.7	598222.89	585411.4	NG	NG

Notes:
NG=No Guideline
Values highlighted in **bold** exceeded the (a) Ghana EPA guideline or (b) the WBG standard.
The comparison with WBG/WHO can be done only for SO_2 and PM_{10} for which a 24-hour limit has been set by WBG.

(1) CO_2 is not considered an air pollutant, and no concentration limit or emission limit for CO_2 is defined by international standards. Anyway, as greenhouse gas, it was included in the monitoring activity.
(2) The Sanzule and the Eikwe communities are classified as residential areas. Therefore concentrations monitored at these locations were compared against Ghana EPA AQS set for residential areas
(3) *Set by the Environmental Quality Guidelines for Ambient Air (EPA, 1996) for residential areas*

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014)

During the dry season all the pollutants monitored at the 3 monitoring locations are below the Ghana EPA residential limit and WBG guideline values with the exception of SO_2 concentrations. The SO_2 levels in Eikwe are likely to be a result of fish smoking process or waste burning.

For the wet season concentrations monitored at Sanzule and Eikwe comply with the Ghanaian residential limit and WBG guideline values for all pollutants with the exception of SO_2 and PM10. High monitored levels of SO_2 are likely to be a result of the fish smoking process or waste burning; whereas the elevated PM_{10} concentration are likely to be a consequence of road construction works.

H.2.3 METHODOLOGY

The following activities were performed in support of the assessment of air quality impacts potentially induced by the onshore Project:

- A qualitative estimation of the emissions arising during the construction and pre-commissioning phase;

- An Atmospheric Dispersion Modelling Study (ADMS) aimed at quantifying the impacts induced by the Onshore Receiving Facilities (ORF) operation (labelled as ORF ADMS hereinafter).

H.2.4 ASSESSMENT

H.2.4.1 Construction

Impacts on ambient air quality arising during the onshore Project construction have been assessed based on available project design data; the detailed impact assessment is presented in Annex G.

The main project activities with the potential to impact the air quality during the construction of the pipeline landing and ORF facilities, are: site clearance and preparation, building construction, the movement of vehicles, equipment and personnel (including the procurement of goods and services and the use of borrow pits and quarries), trenching and laying of pipes, backfilling and reinstatement of the pipeline trench and land temporarily disturbed by construction, hydrostatic testing for pipeline and equipment.

These activities involve two different types of potential direct negative impacts on air quality:

- An increase in atmospheric concentrations of dust particles due to dust emissions. Temporary dust emissions will arise from earthwork activities (i.e., site clearance, trenching, backfilling); in addition, vehicle movement along the short working strip, pipe laydown area, ORF area and access roads will cause dust re-suspension.
- An increase in atmospheric concentrations of air pollutants from exhaust emissions from combustion source. Air pollutants typically emitted by combustion sources are carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx) and Particulate matter (PM10 and PM2.5). Other chemical pollutants expected to be emitted in lower quantities are volatile organic compounds (VOCs). Temporary exhaust gas emissions will be generated by: vehicles and heavy machinery (i.e., excavators, bulldozers, side booms, trucks) used in construction activities such as site preparation and the transport of goods, supplies and personnel); engine-driven machinery and power generators (i.e., diesel engines and diesel generators, engine-driven compressors for hydrostatic testing) used to supply electrical power during the construction and pre-commissioning activities.

The main receptors that could be directly affected by dust emissions are:

- The local population in settlements located less than 1 km from the ORF construction area (i.e., Sanzule and Eikwe villages);
- Flora and fauna, if present in the proximity of the construction area. For example high levels of dust concentration can affect plant photosynthesis processes and animal respiratory systems.

The main receptors that could be directly affected by exhaust emissions are:

- The local population located less than 1 km from the ORF construction area (i.e., Sanzule and Eikwe villages);

- Flora: NOx can be a precursor of acid deposition (as can SOx) and ozone formation, which can damage plants. PM10 and PM2.5 may affects plant growth and ecosystem processes;
- Fauna: exposure to high concentrations of PM10, PM2.5, SOx and CO can affect the respiratory and circulatory systems of animals. High concentrations of VOCs can also cause necrosis in fauna.

Dust emissions will be related to the volumes of handled material and duration of activities. It has to be noted that the performed air quality field survey highlighted the current presence of dust sources, in particular dust raised by road traffic (lifting and dropping of particles by the rolling wheels). This has been monitored particularly for Sanzule.

The volumes and concentrations of exhaust gases emitted into the atmosphere, instead, will be directly related to the amount of fuel consumption. The vehicles and engine-driven machinery involved in the construction phase will generally be fuelled with diesel supplied by tank-trucks. Information on the daily fuel consumption or vehicles fleet required for the entire construction phase is not yet available at this stage of the project. However, exhaust emissions may have an adverse effect on the local population located in the near proximity of the construction sites, as exhaust emissions are likely to disperse within a few hundred of meters of the source.

Construction activities are expected to last approximately 3 years. Standars mitigation measures will be implemented to reduce dust emissions, such as covering of aggregate material, dust suppression using water, limited speed vehicles. Moreover a traffic management plan will ensure the minimisation of traffic exhaust gas emissions and good maintenance programs will be adopted to guarantee low emissions and prevent inefficiencies.

Considering the implementation of the mitigation and management measures described above, the magnitude of impacts on air quality during construction is expected to be low.

H.2.4.2 Pre-commissioning

The pipeline hydrostatic testing involves the operation of one diesel generator providing power supply to the pump units. The power generator will release atmosphere emissions of gaseous pollutants into the atmosphere. To date information on the type of generator is not available.

The Hydrostatic Testing is planned to be undertaken continuously throughout the entire day (24/day) only for a few days (less than 2 weeks).

In light of the short duration of the hydrotesting activities, and on the number of equipment releasing atmospheric emissions of pollutants (one diesel generator) the pre-commissioning phase is unlikely to cause any adverse impact on ambient air quality and no mitigation measures are required. Thus, the impacts on air quality during hydrotesting activities are expected to be low.

H.2.4.3 Operation

As part of the OCTP Phase 2, the ORF operation under normal operative conditions will release atmospheric emissions of airborne gaseous pollutants. In particular continuous atmospheric emissions will be related to the activity of the compressor unit and power generation unit. These units will release emissions of atmospheric pollutants, such as NOx, SO_2 and CO, into the atmosphere. Therefore, the operation of the ORF is likely to determine a change of the existing air quality conditions (in terms of NOx, SO_2 and CO concentrations), resulting in a potential impact on local air quality.

Potential impact on local air quality has been assessed in Annex G on the base of the outcome of a dedicated ADMS. The ADMS was performed with the CALPUFF modelling system (version 5.8), adopted and recommended by US-EPA (http://www.epa.gov/scram001/dispersion_prefrec.htm#calpuff) presented in the following part of this Section along with modelling set up, modelling dispersion tool, model domains and meteorological data.

<u>Atmospheric Dispersion Modelling</u>

Ground level concentrations of macro-pollutants generated by the ORF atmospheric emission sources have been quantified by means of a dedicated Air Dispersion Modelling Study (ADMS) labelled hereinafter as ORF ADMS. Results obtained from the ORF ADMS have been subsequently compared against National and International Air Quality Standards (AQS) and enabled a quantitative assessment of the impacts on local air quality.

The ORF ADMS was performed with the CALMET–CALPUFF modelling system (version 5.8), adopted and recommended by the US-EPA. The following part of this Section provides an overview of the adopted modelling system, its set up input and output.

CALMET-CALPUF Modelling System

Model Overview

The performed ADMS was carried out with the CALPUFF modelling system (version 5.8), adopted and recommended by US-EPA (http://www.epa.gov/scram001/dispersion_prefrec.htm#calpuff). The chosen modelling system represents the state-of-the–art in Lagrangian puff modelling for assessing impacts of the long-range transport of certain air pollutants.(1)

The CALPUFF modelling system consists of three main components, including a pre-processor and post-processor. The meteorological pre-processor CALMET produces the three-dimensional fields for the main meteorological variables, temperature, wind speed and direction, over the simulation domain.

The processor CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing modules for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation.(2)

(1)Peer Review Of The Calmet/Calpuff Modeling System, Allwine, Dabberdt, Simmons, 1998.

(2)A User's Guide for the CALPUFF Dispersion Model (Version 5), Scire, Strimaitis, Yamartino 2000

The post-processor CALPOST statistically analyses CALPUFF output data and produces datasets suitable for further analysis. Post-processed CALPUFF outputs consist of matrices of concentration values. Receptors in the simulation domain can be discrete or gridded. The values calculated at each receptor could be referred to one or more sources.

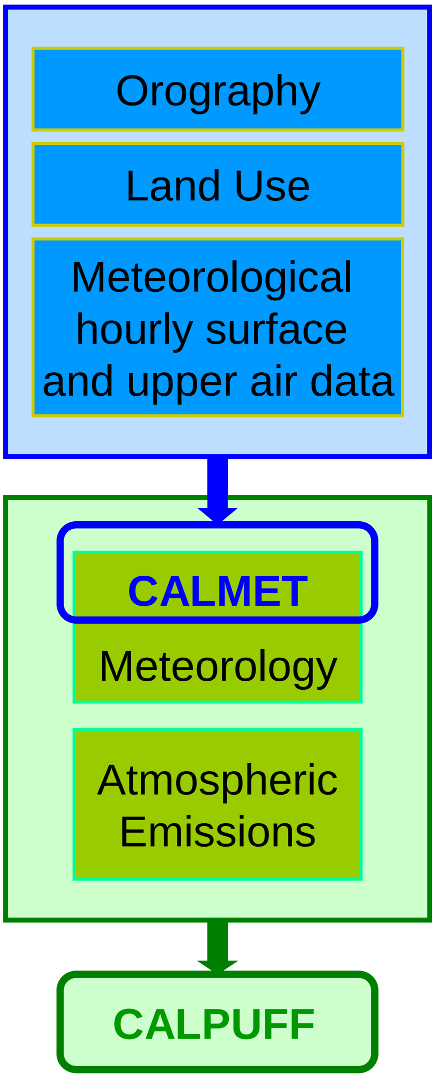
The results can be processed by any GIS software, creating iso-concentration maps.

The CALPUFF modelling system requires the following input data:

- meteorological variables' surface data and height profile, to build the three-dimensional wind field, with the meteorological pre-processor CALMET; and
- source characteristics and emission data, to simulate the pollutants atmospheric dispersion, with CALPUFF.

The following Figure H2.2 presents a flow chart of the CALPUFF modelling system inputs, while the Box H2.1 gives a summary of the CALMET CALPUFF and CALPOST characteristics.

Figure H2.2 CALPUFF Modelling System INPUTS



Box H2.1 Features of the Pre-Processor CALMET, CALPUFF and Post-Processor CALPOST

CALMET is a diagnostic meteorological pre-processor able to reproduce three-dimensional fields of temperature, wind speed and direction along with two-dimensional fields of other parameters representative of atmospheric turbulence. CALMET is able to simulate wind fields in complex orography domains characterized by different types of land use. The final wind field is obtained through consecutive steps, starting from an initial wind field often derived from geostrophic wind. The wind field is linked to the orography, since the model interpolates the monitoring station values and applies specific algorithms to simulate the interaction between ground and flow lines. The module contains a micro-meteorological module determining thermal and mechanical structures (turbulence) of lower atmospheric layers.
CALPUFF is a hybrid dispersion model (commonly defined 'puff model'). It is a multi-layer and non-steady-state model. It simulates transport, dispersion, transformation and deposition of pollutants, in meteorological conditions varying in space and time. CALPUFF uses the meteorological fields produced by CALMET, but for simple simulations an external steady wind field, with constant values of wind speed and direction over the simulation domain, can be used as input. The module contains different algorithms to simulate different processes, such as: • buildings downwash and stack-tip downwash; • wind vertical shear; • dry and wet deposition; • atmospheric chemical transformations; • complex orography and seaboard.[1] Besides, CALPUFF allows the selection of the source geometry (point, linear or areal), improving in this way the accuracy of the emission input. Point sources simulate emissions coming from a small area while areal sources describe a diffuse emission coming from a wider area; emissions from linear sources are distributed along a main direction (i.e. roads).
CALPOST processes CALPUFF outputs producing an outputs' format suitable for further analysis. CALPOST output files can be fed into graphic software to create concentration or deposition maps

Model Domains

The CALMET meteorological domain represents the area in which the CALMET pre-processor computes all the meteorology variables (i.e. temperature, wind directions, wind speed, atmospheric stability) needed to perform the pollutants air dispersion.

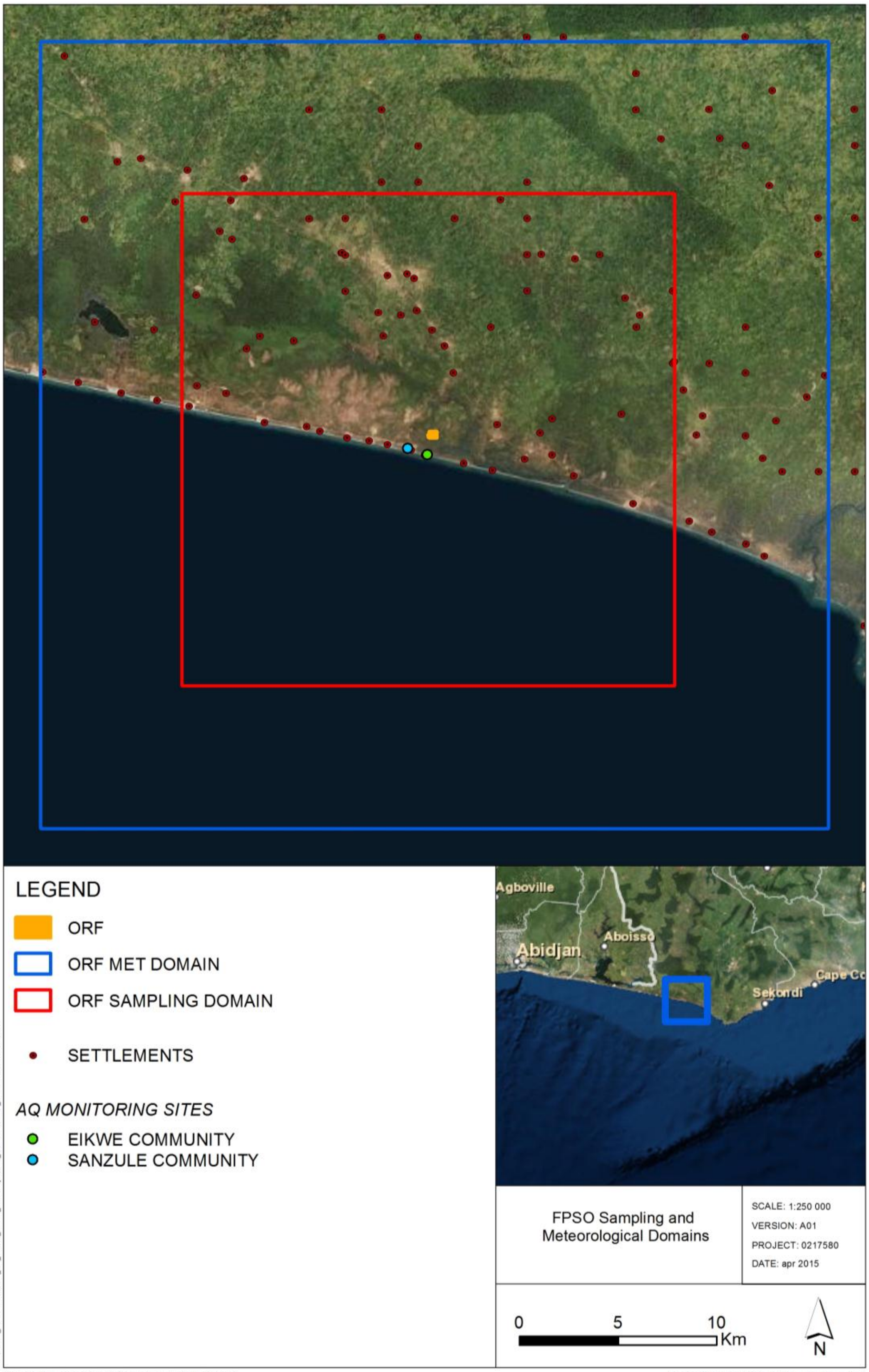
The sampling simulation domain represents the matrix of gridded receptors at whose locations the model CALPUFF calculates the pollutant concentrations. The central point of

(1) [1] In marine coastal areas, CALPUFF considers breeze phenomena in order to model efficiently the Thermal Inversion Boundary Layer (TIBL) as in case of coastal sources, the TIBL causes a quick fall of pollutants to the ground.

each cell in the sampling domain represents a gridded receptor, whose elevation depends on the local orography and is given by the Digital Elevation Model of the area.

Ground concentrations of macro pollutants produced by the ORF under operational conditions were modelled over a 25 km x 25 km sampling domain, approximately centred on the ORF location. Figure H2.3 below shows the ORF AMS sampling domain and meteorological domain highlighting the ORF location.

Figure H2.3 ORF Simulation Domain

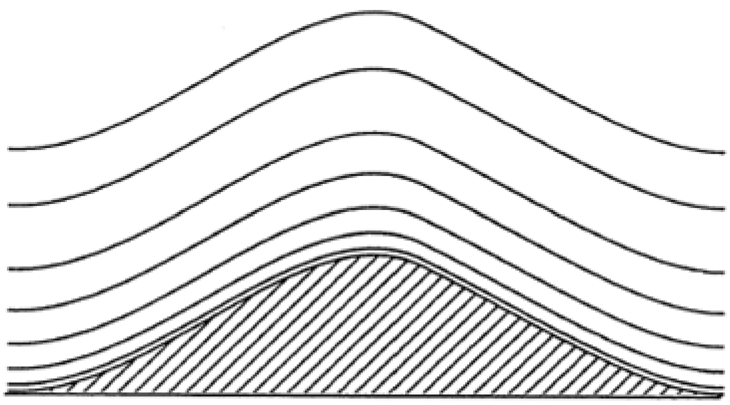


SOURCE: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

PROJECTION: WGS 1984 UTM Zone 30N

The CALMET-CALPUFF models operate in a terrain-following vertical coordinate system; terrain-following vertical coordinates are given by the Cartesian vertical coordinate minus the terrain height (the latter is available from the Digital Elevation Model (DEM)). The concept of a coordinate system following the terrain is shown in the figure below.

Figure H2.4 Concept of Terrain Following Vertical Coordinate System



The vertical layers resolution is usually higher near the surface, (Planetary Boundary Layer), where the transport and the dispersion of air pollutants take place, in order to investigate more accurately these dynamics and their interactions with the local orography.

The dispersion modelling temporal domain or simulation period is the time period simulated by the model; in the ORF ADMS the year 2014 was chosen as temporal domain.

Model Input

Orography and Land use

Land cover data was taken from the Global Land Cover Network (GLCN) developed by the Food and Agriculture organisation of the United Nations (FAO), whereas the digital elevation data was taken from the SRTM database produced by NASA.

Meteorology

For the ORF ADMS the CALPUFF meteorological input was obtained with the meteorological pre-processor CALMET.

CALMET requires in input hourly surface data of: wind speed and direction, temperature, atmospheric pressure, relative humidity, cloud cover and ceiling height; and upper air data with a temporal resolution of at least 12 hours for: atmospheric pressure, temperature, wind speed and direction. Upper air data are necessary to characterize the wind regime and the atmosphere diffusive parameters (stability class, mixing height, thermal inversion, etc.), and to produce a three-dimensional simulation.

CALMET input meteorological surface data are typically taken from surface weather stations, if these stations are sufficiently close to the study area to be considered representative of its meteorological conditions. Upper air data are usually taken from radiosondes surveys, representative for the study area.

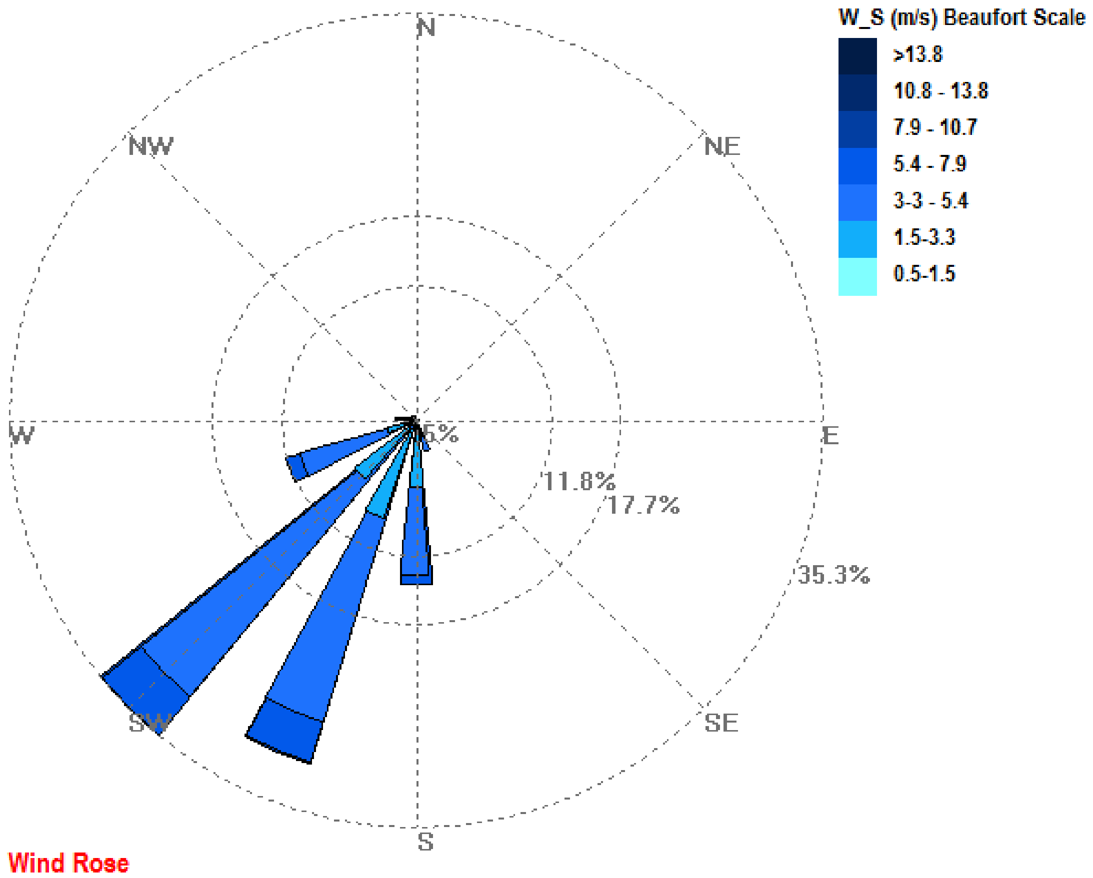
Due to the lack of radiosondes data and of representative weather stations monitoring meteorological variable over the above presented meteorological domains, CALMET surface and upper air input data for this study have been taken from MM5 meteorological model.

MM5 is a widely-used three-dimensional numerical meteorological model which contains non-hydrostatic dynamics, a variety of physics options for parameterising cumulus clouds, microphysics, the planetary boundary layer and atmospheric radiation.

MM5 is developed by Pennsylvania State University and the U.S. National Centre for Atmospheric Research (NCAR) and raw MM5 output can be converted into a format recognized by CALMET. All the MM5 meteorological data acquired as input for this study have been provided by Lakes Environmental™ , a worldwide provider of environmental data (terrain and meteorology), recognized internationally for its technologically advanced air dispersion modelling software.

Figure H2.5 shows the wind rose extracted from the CALMET run performed for the year 2014, at the ORF location.

Figure H2.5 Wind Rose Extracted from the CALMET run (2014) at the ORF Location



NOTE: according to WMO (World Meteorological Organization) standards, the wind direction plotted in the wind rose is the wind provenance direction.

The wind rose shows that winds in the Project area presents a predominant wind directions from SW. In terms of wind speeds, moderate winds are prevailing in the area (between 3.3 and 5.4 m/s). The wind calms (< 0.5 m/s) are the 0.55%.

Emission scenario

The main continuous atmospheric emissions arising during the ORF normal operation are released by:

- The compression unit, which consists of two booster compressors with a capacity of 6.9 MWth and 9.3 MWth.
- The power generation unit: which consists of a gas turbine with an installed power of 3 MWth.

The above mentioned facilities will be fuelled with gas and will primarily release gaseous emissions NO_x and CO into the atmosphere. The fuel gas is contaminated with H_2S therefore minor SO_2 emissions are also expected, whereas PM emissions are not expected to occur from the combustion of gaseous fuel.

Table H2.6 presents the geographical location and the characteristics of the ORF emission sources included in the performed ADMS and is based on available Project design data.

Table H2.6 ORF Operation: Emission Sources Geographical Location and Characteristics

Emission Source	ID	X	Y	Stack Height	Stack diameter	Flue Gas Temperature	Flue Gas Velocity
		UTM 30 N [km]		[m]	[m]	[°C]	[m/s]
Booster compressor	ORF-GT1	561.724	548.948	10	1.38	510	33.9
Booster compressor	ORF-GT2	561.748	548.948	10	1.60	510	33.9
Power generation	ORF-GT3	561.650	548.970	10	1.11	445	34.0

The following Table H2.7 presents the emissions rate and compositions (NO_x , SO_2 and CO) used as input in the modelling study.

Table H2.7 ORF Operation: Emissions Rate and Composition

Emission Source	ID	Concentration in flue gases(1) [mg/Nm³]			Emission rate [g/s]		
		NO_x	SO_2	CO	NO_x	SO_2	CO
Booster compressor	ORF-GT1	205(2)	5.7	18.7	3.63	0.10	0.33
Booster compressor	ORF-GT2	205(2)	5.7	18.7	4.89	0.14	0.45
Power generation	ORF-GT3	86(3)	5.7	18.7	1.08	0.07	0.23

(1) Reference oxygen content [15%]
(2) Equivalent to the limit of 100 ppmv set by WBG (in the General EHSs Guidelines: Environmental Air Emissions And Ambient Air Quality) for gas turbine =3Mw to <15Mw (Mechanical drive)
(3) Equivalent to the limit of 42 ppmv set by WBG (in the General EHSs Guidelines: Environmental Air Emissions And Ambient Air Quality) for gas turbine =3Mw to <15Mw (Electric generation)

Results

Model results should be interpreted in light of the following conservative assumptions:

- Simulated NOx have been conservatively compared against the AQS set on NO_2 concentrations. In reality only a part of NOx converts to NO_2 in the atmosphere depending on different factors (e.g. solar radiation, temperature, and atmospheric hydrocarbon concentration). Hence, simulated NO_2 concentrations were conservatively overestimated.
- The model does not account for dry and wet deposition or photochemical reactions of the pollutants which in reality takes place and would reduce macro pollutants concentrations in the atmosphere. Thus results are overestimating the likely actual contribution of the sources. The approach again is on the safe side of assumptions and gives a conservative picture maximising pollutants modelled concentration values over the sampling domain.
- The definition of the emission scenario assumed project equipment operating at full power and continuously throughout the simulated year.

The ADMS results obtained from the model run performed for the ORF Operation are presented in Table H2.8 along with Ghanaian and International (WBG/WHO) Air Quality Standards (AQS) set for the protection of human health. Comparison of ADMS results against the European Union standards for the protection of vegetation are reported in table H2.9. Short term concentrations reported in Table H2.8 represent the maximum values predicted by the model over the simulation domain and the chosen temporal domain of one year (2014).

Table H2.8 ORF Operation: Modelled Maximum Concentrations of Atmospheric Pollutants in Comparison with AQS for the Protection of Human Health

Pollutant	Averaging Period	Modelled concentrations [μg/m³]	Ghanaian AQS (1) [μg/m³]	WBG/WHO AQS(2) [μg/m³]	% of Ghanaian AQS	% of WBG/WHO AQS
NO_2	1-year	1.19	30	40	4.0 %	3.0 %
	1-hour	41.33	90	200	45.9 %	20.7 %
	24-hours	6.41	60	-	10.7 %	-
SO_2	1-year	0.05	50	-	0.1 %	-
	1-hour	1.36	200	-	0.7 %	-
	24-hours	0.23	100	20	0.2 %	1.2 %
CO	1-hour	4.46	10000	-	0.045 %	-
	24-hours	0.75	60000	-	0.001 %	-

(1)Set by the Environmental Quality Guidelines for Ambient Air (EPA, 1996) for residential areas
(2) Set by the WBG Environmental, Health, and Safety Guidelines for Air Emissions and Ambient Air Quality published on 2007 which refers to the WHO Air Quality Guidelines "WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide" Global update 2005.

Table H2.9 ORF Operation: Modelled Maximum Concentrations of Atmospheric Pollutants in Comparison with AQS for the Protection of Vegetation

Pollutant	Averaging Period	Modelled concentrations [µg/m³]	European AQS (1) [µg/m³]	% of European AQS
NO_x	1-year	1.19	30	4.0%
SO_2	1-year	0.05	20	0.25%
(1) European Union standards for the protection of vegetation set by the European Directive 2008/50/EC				

From Table H2.8 and Table H2.9 it can be concluded that modelled pollutant concentrations comply with National and WBG/WHO AQS set for the protection of human health and with European standards set for the protection vegetation.

In addition to the above presented model results, Table H2.10 reports the NO_2 and SO_2 maximum daily concentrations predicted by the model at the villages of Sanzule and Eikwe in comparison with air quality baseline measurements (presented in Section H.2.2). Performed air quality measurements monitored daily concentrations of NO_2 and SO_2 in the dry and wet seasons, the highest atmospheric concentrations were monitored in the dry season and are reported in the following Table H2.10 along with model predictions and Ghanaian and WHO/WBG AQS.

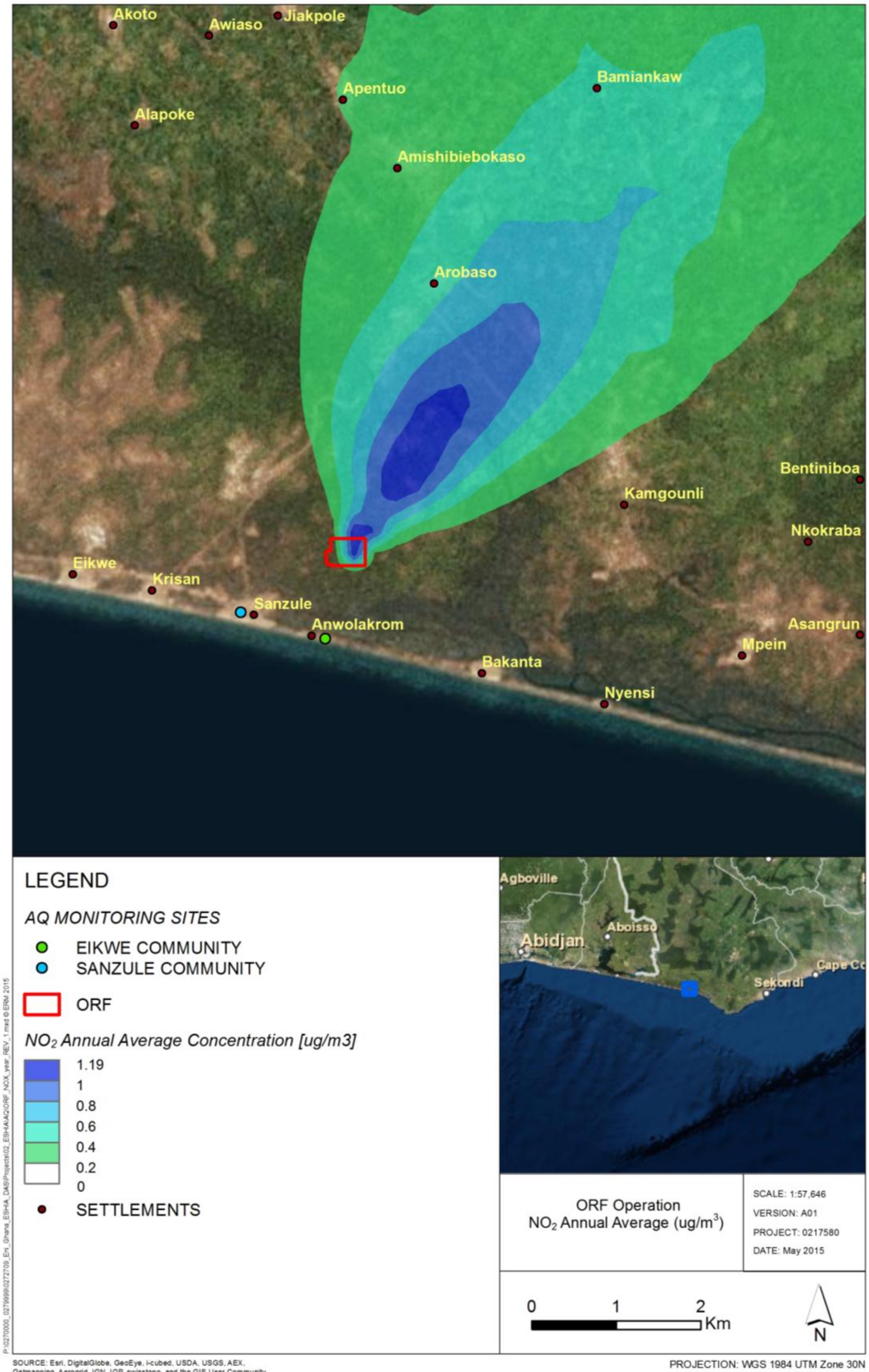
Table H2.10 ORF Operation: Modelled Concentrations of Atmospheric Pollutant

Pollutant	Averaging Period	Modelled concentrations [µg/m³]		Observed concentrations(3) [µg/m³]		Ghanaian AQS (1) [µg/m³]	WBG/WHO AQS(2) [µg/m³]
		Sanzule	Eikwe	Sanzule	Eikwe		
NO_2	24-hours	0.65	0.51	1.88	1.38	60	-
SO_2	24-hours	0.022	0.021	78.65	218.69	100	20
(1) Set by the Environmental Quality Guidelines for Ambient Air (EPA, 1996) for residential areas (2) Set by the WBG Environmental, Health, and Safety Guidelines for Air Emissions and Ambient Air Quality published on 2007 which refers to the WHO Air Quality Guidelines "WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide" Global update 2005. (3) Concentrations observed during the dry season survey							

The ORF contribution in terms of NO_2 daily concentrations predicted by the model at the Sanzule and Eikwe villages account at maximum for the 37% of monitored background level concentrations. With regard to SO_2 daily concentrations, the model contribution accounts at maximum for the 0.03 % of monitored background level. NO_2 background concentration are well below the regulatory limit, thus NO_2 concentration resulting from the ORF operation and the existing background level complies with Ghanaian AQS. Existing SO_2 concentrations do not comply with the Ghanaian nor with the WBG/WHO AQS and the contribution of the ORF operation is not expected to alter or worsen the current situation.

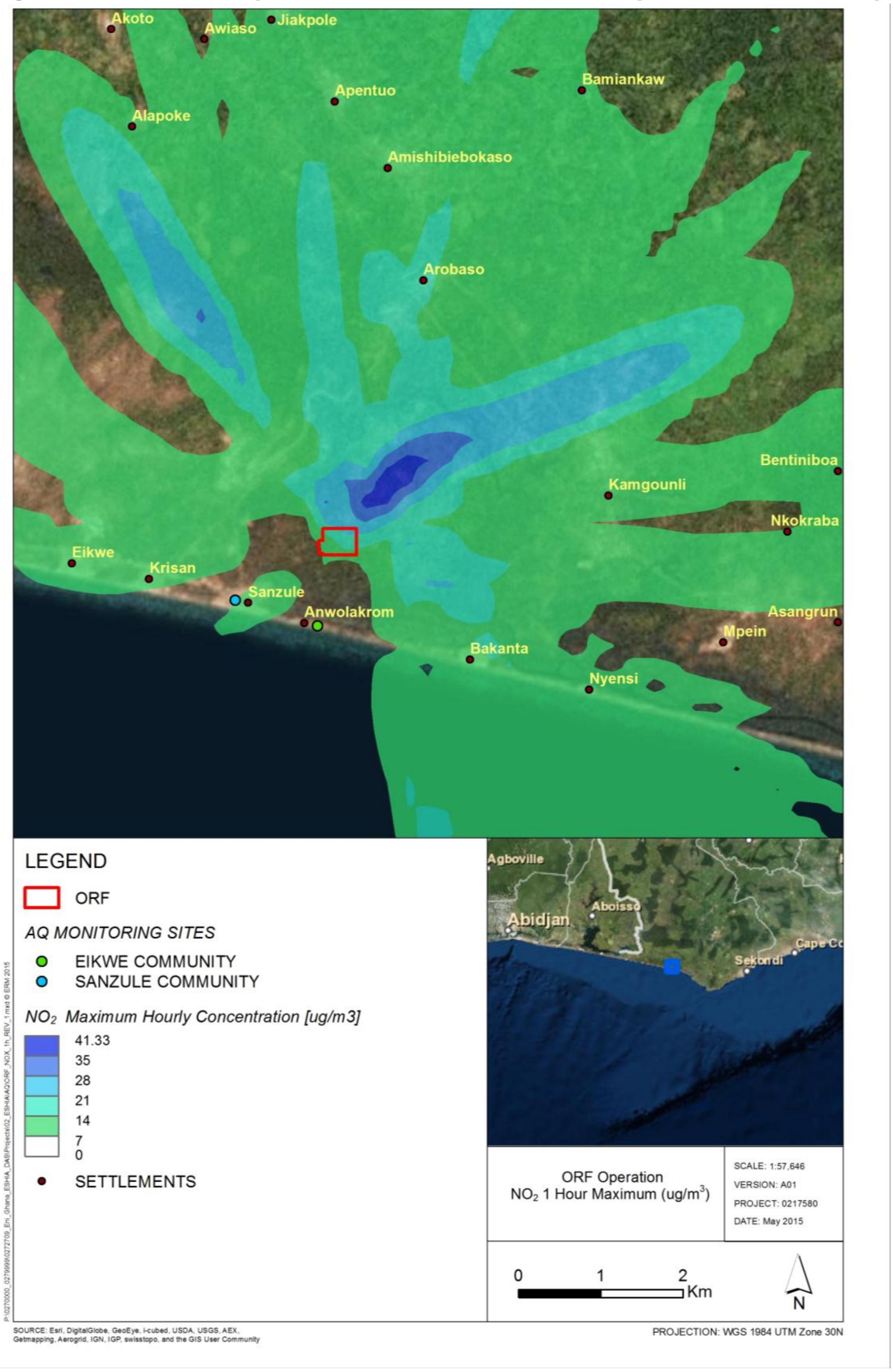
In comparison with AQS, predicted concentrations of NO_2 are the highest among the modelled pollutants even though well below AQS (as reported in Table H2.8 at most NO_2 hourly maximum concentration accounts for 50% of the AQS). Modelled pollutants concentration of NO_2 were spatially localised by mean of iso-concentration maps. The latter are presented in the following Figures.

Figure H2.6 ORF Operation - NO_2 Annual Concentration Map



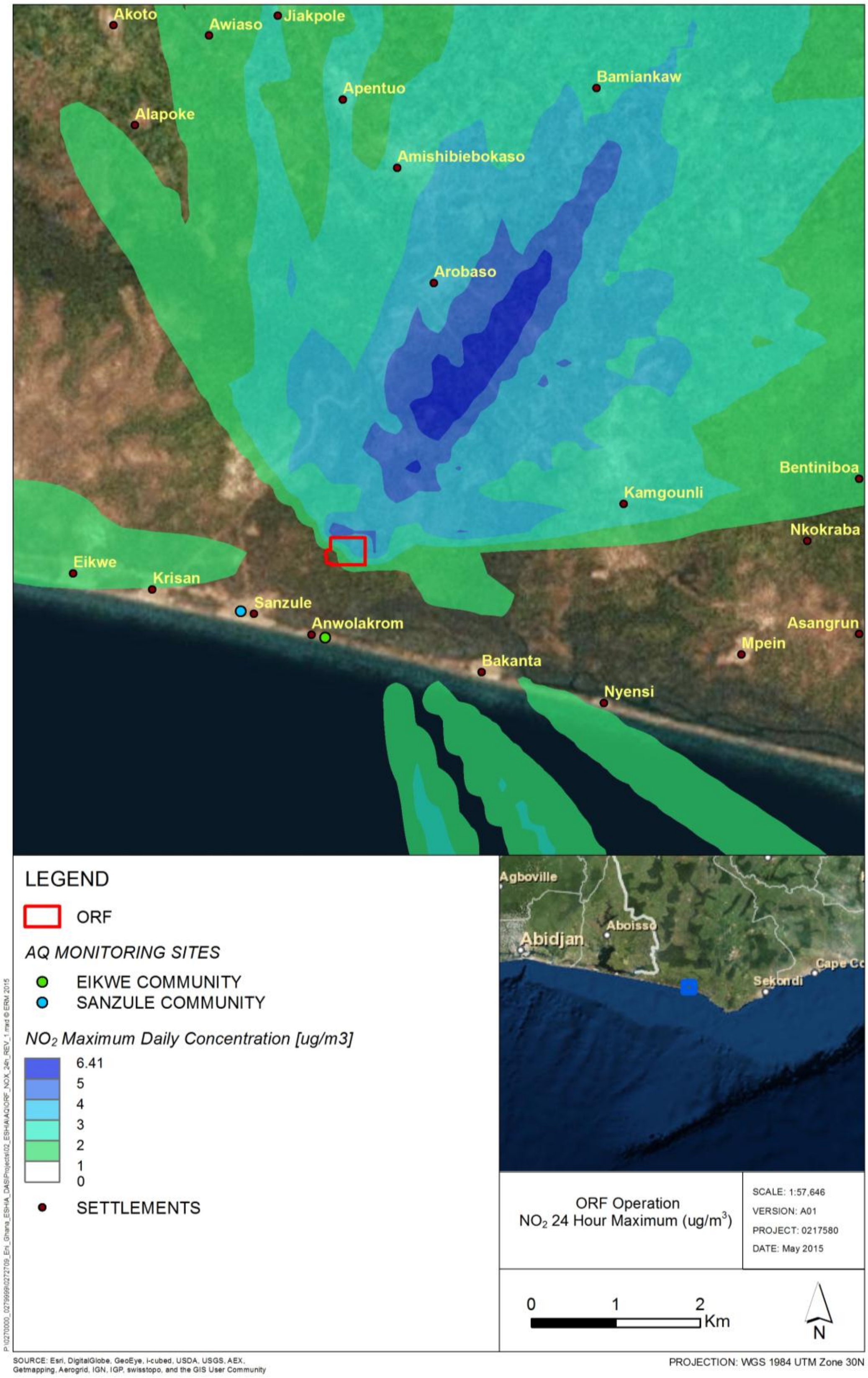
Ghana EPA AQS (for residential areas) = 30 μm3
WBG/WHO (Guideline values) = 40 μm3

Figure H2.7 ORF Operation - NO_2 Maximum Hourly Concentration Map



Ghana EPA AQS (for residential areas) = 90 μm³
WBG/WHO (Guideline values) = 200 μm³

Figure H2.8 ORF Operation - NO_2 Maximum Daily Concentration Map



Ghana EPA AQS (for residential areas) = 60 µm³

As reported in the iso-concentration maps NO_2 concentration maxima fall within a distance of 1.5 km from the ORF and do not affect the closest villages Eikwe and Sanzule.

Atmospheric concentrations of airborne pollutants induced by the ORF operation comply with National and International AQS related to human health and vegetation. Moreover, induced concentration maxima do not affect human and vegetation receptors. Therefore low impacts are foreseen on air quality during operation and no specific mitigation measures but only good management and maintenance measures are expected to be implemented.

Since the performed modelling study did not highlight any criticalities in terms of induced air pollution levels, no specific mitigations are recommended and the following actions are expected to be undertaken:

- Repetition of the ADMS once actual design data are available;
- Implementation of an air emission and ambient air quality monitoring program during operations.

H.3. Offshore

H.3.1 Air Quality Standards

The offshore impact assessment refers to the same AQS presented and adopted for the onshore impact assessment. These AQS are:

- Ghanaian AQS set by the EPA Ghana for residential areas, presented in Table H2.1
- WBG/WHO guideline values presented in Table H2.2.

H.3.2 Air Quality Baseline

The FPSO and the production wells are located at a significant distance from the coast, at about 60 km south of the village of Sanzule, thus no permanent human sensitive receptors are expected to be continuously exposed to project emissions with the exception of the FPSO workers. Other human sensitive receptors, namely fishing, commercial and recreational vessels, will only be exposed discontinuously and occasionally to the project emissions. Therefore the air quality field surveys held in March 2014 and in October 2014 focused on monitoring onshore air quality at permanent sensitive receptors and offshore measurements were not performed.

H.3.3 Methodology

The following activities were performed in support of the assessment of air quality impacts potentially induced by the offshore Project:

- A quantitative estimation of the emissions arising during the offshore construction;
- An Atmospheric Dispersion Modelling Study (ADMS) aimed at quantifying the impacts induced by the Floating Production Storage And Offloading (FPSO) operation; (labelled as FPSO ADMS hereinafter).

H.3.4 Assessment

H.3.4.1 Construction

The main atmospheric emissions arising from the project offshore construction are exhaust emission released by the vessels involved in the wells drilling and completion, FPSO installation and pipe laying activities.
The assessment of impact on local air quality produced by Project vessels activities (reported in Annex G) has been supported with a quantitative estimation of vessels emissions presented in the following part of this Section.

Methodology for Estimate Air Pollutant Emissions from Transport - MEET Methodology

The calculation of ship transport emissions was based on the *Methodology for Estimate Air Pollutant Emissions from Transport* (MEET here after). The latter has been developed by the UK Transport Research Laboratory, under the Transport RTD programme of the 4th Framework programme, funded by the European Commission.

The MEET provides two methods, a simplified method and one that is more detailed. The choice of method for a particular application depends mainly on the amount of information that is available to describe the shipping activity.

The detailed methodology has been applied in the present study. According to the MEET detailed vessels' emissions estimation method, the ship transport emissions for each pollutant of interest, have been calculated as a function of fuel consumption, number of working days, operating modes and pollutant-specific emission factor, and have been obtained as:

$$E_i = \sum_{j,k,l,m} E_{i,j,k,l,m}$$

$$E_{i,j,k,l} = S_{j,k,m}(GT) \times t_{j,k,l,m} \times F_{i,j,l,m}$$

Where:

- i is the pollutant
- j is the fuel
- k is the ship class
- l is the engine type class
- m is the operating mode or phase of the journey (cruising between ports, manoeuvring in the harbour area, and hoteling at the dockside)
- E_i is the total emissions of pollutant i
- E_{ijklm} is the total emission of pollutant i from use of fuel j on ship class k with engine type l in operating mode m
- S_{jkm} *(GT)* is the daily consumption of fuel j in ship class k in operating mode m as a function of gross tonnage.
- t_{jklm} is the number of days in navigation of ships of class k with engine type l using fuel j in operating mode m
- F_{ijlm} is the average emission factor of pollutant i from fuel j in engines type l in operating mode m

The MEET detailed method provides all the elements to identify the daily fuel consumption for a specific fuel, ship class and operating mode as a function of gross tonnage [S_{jkm} *(GT)]* (if available), and to identify a pollutant specific emission factor for a specific fuel, engine type and operating mode [F_{ijl}].

Table H3.1 reports the average daily consumption at full power of fuel j in ship class k (C_{jk}) provided by MEET; for those ships whose gross tonnage is known, MEET recommends to calculate the average daily fuel consumption at full power as a function of gross tonnage as indicated in Table H3.1*;* subsequently the daily consumption of fuel j in ship class k in operating mode m (S_{jkm}) is determined by multiplying the consumption at full load (C_{jk}) by the fraction of maximum fuel consumption in different modes indicated in Table H3.2.

Table H3.1 Average Fuel Consumption at Full Power and Linear Regression Equations of Consumption at Full Power as a Function of Gross Tonnage

Ship type	**Average Consumption (t/day)**	**Consumption at full power (t/day) as function of gross tonnage (GT)**
General cargo	33.80	Cjk = 20.186 + .00049 * GT
Liquid bulk	41.15	Cjk = 14.685 + .00079 * GT
Solid bulk	21.27	Cjk = 9.8197 + .00143 * GT
Container	65.88	Cjk = 8.0552 + .00235 * GT
Passenger/Ro-Ro/Cargo	32.28	Cjk = 12.834 + .00156 * GT
Passenger	70.23	Cjk = 16.904 + .00198 * GT
High speed ferry	80.42	Cjk = 39.483 + .00972 * GT
Inland cargo	21.27	Cjk = 9.8197 + .00143 * GT
Sail ships	3.38	Cjk = .42682 + .00100 * GT
Tugs	14.35	Cjk = 5.6511 + .01048 * GT
Fishing	5.51	Cjk = 1.9387 + .00448 * GT
Other ships	26.40	Cjk = 9.7126 + .00091 * GT
All ships	32.78	Cjk = 16.263 + 0.001 * GT

Table H3.2 Fraction of Maximum Fuel Consumption in Different Modes

Mode		***Fraction***
Cruising		0.80
Manoeuvring		0.40
Hotelling		0.20
	Passenger	0.32
	Tanker	0.20
	Other	0.12
Tug	Ship assistance	0.20
	Moderate activity	0.50
	Under tow	0.80

The average emission factor of NO_X, CO, CO_2, VOC, PM, SO_X, expressed in kg of pollutant emitted for ton of fuel burned, is then determined for a specific fuel, engine type and operating mode, F_{ijlm}, according to the following Table H3.3, Table H3.4 and Table H3.5**.** The latter refer to the cruising, manoeuvring and hoteling phase respectively and express sulphur oxides as a function of the sulphur content of the fuel, and particulate emissions as the total particulate mass.

All tables presented in this section are provided by MEET and are derived from information supplied by EPA, IMO, CONCAWE, Lloyd's Register and organisations that work on maritime activities such as Marintek and Mariterm.

Table H3.3 Proposed Cruising Emission Factors (kg/ton of fuel)

Engine type	***NO_X***	***CO***	***CO_2***	***VOC***	***PM***	***SO_X***
Steam turbines - BFO engines	6.98	0.431	3200	0.085	2.5	20S
Steam turbines - MDO engines	6.25	0.6	3200	0.5	2.08	20S
High speed diesel engines	70	9	3200	3	1.5	20S
Medium speed diesel engines	57	7.4	3200	2.4	1.2	20S
Slow speed diesel engines	87	7.4	3200	2.4	1.2	20S
Gas turbines	16	0.5	3200	0.2	1.1	20S
Inboard engine – pleasure craft - diesel	48	20	3200	26	Neg.	20S
Inboard engine –pleasure craft -gasoline	21.2	201	3200	13.9	Neg	20S
Outboard engines – gasoline	1.07	540	3000	176	Neg	20S
S is the sulphur content of the fuel.						

Table H3.4 Proposed Manoeuvring Emission Factors (kg/ton of fuel)

Engine type	***NO_X***	***CO***	***CO_2***	***VOC***	***PM***	***SO_X***
Steam turbines - BFO engines	6.11	0.19	3200	0.85	2.5	20S
Steam turbines - MDO engines	5.47	0.27	3200	5.0	2.08	20S
High speed diesel engines	63	34	3200	4.5	1.5	20S
Medium speed diesel engines	51	28	3200	3.6	1.2	20S
Slow speed diesel engines	78	28	3200	3.6	1.2	20S
Gas turbines	14	1.9	3200	0.3	1.1	20S
Inboard engine – pleasure craft - diesel	48	20	3200	26	Neg.	20S
Inboard engine –pleasure craft -gasoline	21.2	201	3200	13.9	Neg	20S
Outboard engines – gasoline	1.07	540	3000	176	Neg	20S
S is the sulphur content of the fuel.						

Table H3.5 Proposed Hoteling Emission Factors (kg/ton of fuel)

Engine type	*NO_X*	*CO*	*CO_2*	*VOC*	*PM*	*SO_X*
Steam turbines - BFO engines	4.55	0	3200	0.4	1.25	20S
Steam turbines - MDO engines	3.11	0.6	3200	0.5	2.11	20S
High speed diesel engines	28	120	3200	28.9	1.5	20S
Medium speed diesel engines	23	99	3200	23.1	1.2	20S
Slow speed diesel engines	35	99	3200	23.1	1.2	20S
Gas turbines	6	7	3200	1.9	1.1	20S
Inboard engine – pleasure craft - diesel	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Inboard engine –pleasure craft -gasoline	Neg.	Neg.	Neg.	Neg.	Neg	Neg.
Outboard engines – gasoline	Neg.	Neg.	Neg.	Neg.	Neg	Neg.
S is the sulphur content of the fuel.						

Vessel's Emission Estimation

The wells drilling and completion, FPSO installation and pipe laying activities will not occur simultaneously, therefore three atmospheric emission estimates were performed for each activity following the above presented detailed *MEET* method.

In order to apply the MEET methodology, the following input information has been identified for the Project vessels and is presented in Table H3.6:

- Ship type and number per day, based on Project design data available to date;
- Working hours per day, assumed as 24 continuous hours of work per day;
- Ship overall working time, based on Project design data available to date;
- Ship class (Gross Tonnage), based on Project design data available to date;
- Operating mode, assumed on the base of the ship type and activities;
- Engine type class, assumed on the base of ship type; and
- Type of fuel, assumed on the base of ship type.

Table H3.6 Vessels Involved in the wells Drilling, FPSO Installation and Pipe laying activities

Type of Vessel	Number of ships per day	Working hours per day	Working time	Gross Tonnage	Operating mode	Engine Type
Wells drilling and completion						
Drill ship	1	24	25 month	60683	Hotelling	Medium

Support vessel	2	24	25 month	na	Cruising	
FPSO installation						
AHTSs	2	24	4 weeks	na	Manoeuvring	Medium speed diesel engines
AHVs	3	24	60 days	na	Hotelling	
Construction Vessel	1	24	60 days	na	Manoeuvring	
Pipe Laying						
Pipelay barge	2	24	4 months	na	Manoeuvring	Medium speed diesel engines
AHTSs	2	24	4 months	na	Hotelling	
Supply vessel	7	24	4 months	na	Cruising	
Cargo barge	4	24	4 months	na	Cruising	
Tugs	4	24	4 months	na	Hotelling	
Construction vessels	2	24	4 months	na	Manoeuvring	
ROV vessels	4	24	4 months	na	Cruising	

As reported in Table H3.6 the cruising mode was assumed for ro-ro cargo ship, whereas manoeuvring and hoteling operating modes were assumed for the other ships (e.g. tugs, construction vessels). A medium speed diesel engines (< 200 r/min) were assumed for the types of vessels considered. Moreover, the calculation assumed one working day as 24 continuous hours of work.

Vessels emissions of the main atmospheric pollutants have been estimated based on the data presented in Table H3.7 by applying the MEET methodology. The average daily fuel consumption was calculated as a function of GT when available, alternatively the default average emissions provided by the MEET detailed method was used (Table H3.1). Results are presented in *Table H3.7.* It is assumed that all the vessels that will be used for the activities will be fuelled with low Sulphur fuels (4% Sulphur content maximum) and will be in compliance with the emission standard required by MARPOL Convention 73/78.

Table H3.7 Estimate of Air Pollutant Emissions from Vessels to total number of working days for the Drilling, Installation and Commissioning Phase

Pollutant	Tonnes emitted (t)
Wells drilling and completion	
NO_X	2431.97
CO	1250.92
CO_2	155123.58
VOC	317.96
PM	58.17
SO_X	38.78
FPSO installation	
NO_X	45.84
CO	69.79
CO_2	3783.81
VOC	14.33
PM	1.42
SO_X	0.95
Pipe Laying	
NO_X	2896.58
CO	658.09
CO_2	167877.12
VOC	173.38
PM	62.95
SO_X	41.97

The offshore construction activities is temporary. Atmospheric emissions will be released offshore at a distance of more than 60km from the closest permanent human receptors located on the coast. 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. Additionally, emissions from vessels will be mobile and temporary and this will increase the dispersion of pollutants. Therefore, in light of the temporary and local nature of the atmospheric emissions and of the absence of permanent human receptors in the near proximity of the emission sources, the Project offshore construction phase, is not unlikely to produce any adverse effect on air quality at receptors. No specific mitigation measures but only good management and maintenance measures are expected to be implemented.

H.3.4.2 Operation

The FPSO operation under normal operative conditions will release atmospheric emissions of airborne gaseous pollutants. In particular continuous atmospheric emissions will be related by the activity of the power generation unit, one boiler and of the compressor unit. These units will release emissions of atmospheric pollutants, such as NOx, SO_2 and CO, into the atmosphere. Therefore, the operation of the FPSO is likely to determine a change of the existing air quality conditions (in terms of NOx, SO_2 and CO concentrations), resulting in a potential impact on local air quality.

Potential impact on local air quality has been quantitatively assessed by means of a dedicated modelling study.

Atmospheric Dispersion Modelling

Ground level concentrations of macro-pollutants generated by the FPSO atmospheric emission sources have been quantified by means of a dedicated Air Dispersion Modelling Study (ADMS) labelled hereinafter as FPSO ADMS. Results obtained from the FPSO ADMS have been subsequently compared against National and International Air Quality Standards (AQS) and enabled a quantitative assessment of the impacts on local air quality.

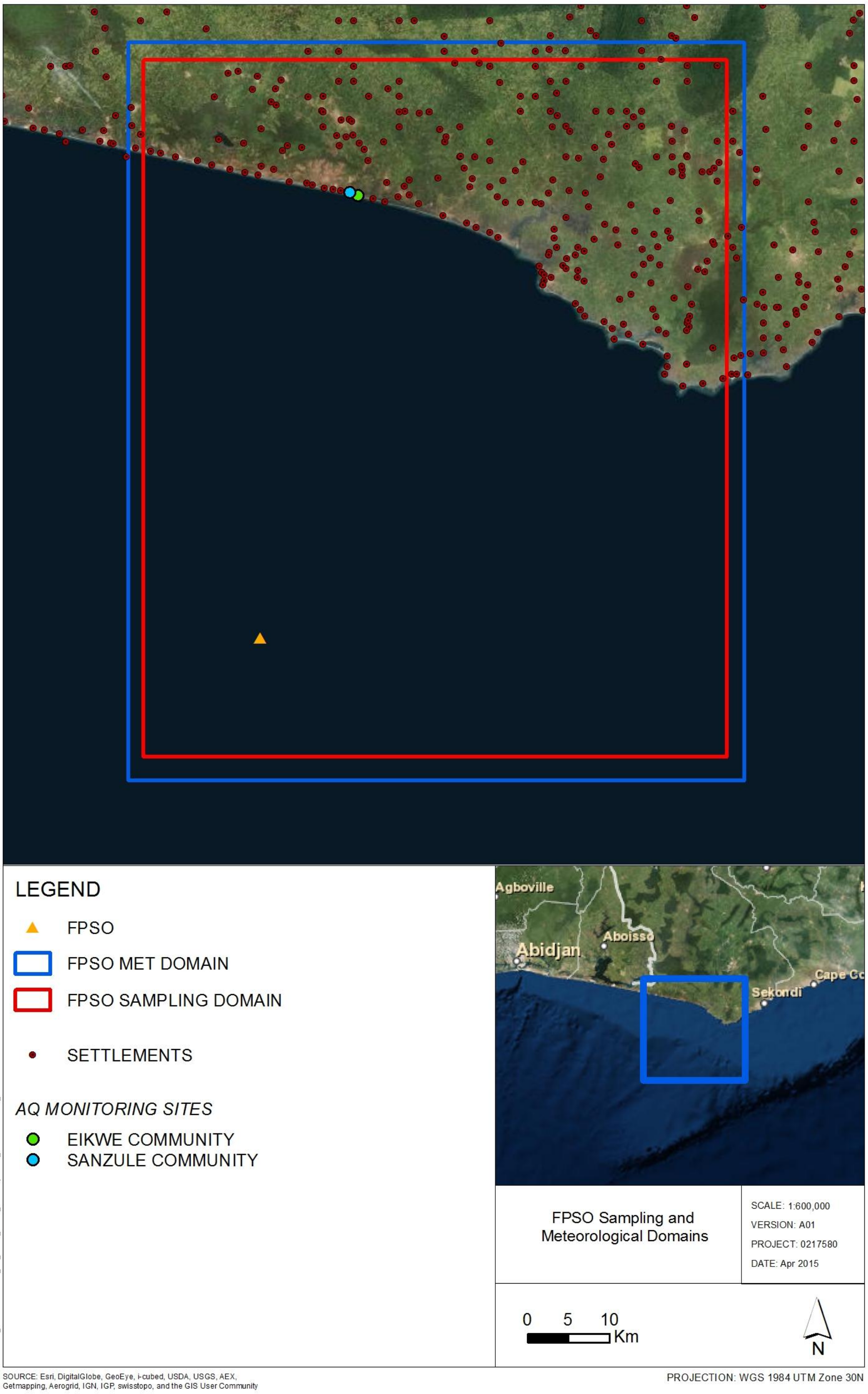
The FPSO ADMS was performed with the same modelling system used for the ORF ADMS, the CALMET–CALPUFF modelling system (version 5.8), adopted and recommended by the US-EPA. The following part of this Section provides an overview of the adopted modelling system, its set up input and output.

CALMET-CALPUF Modelling System

Model Overview
Similarly to the ORF ADMS, the FPSO ADMS was performed with the CALMET–CALPUFF modelling system. An overview of the adopted modelling system is provided in Section H.2.4.3.

Model Domains
The definition of the model meteorological and sampling domains is provided in Section H.2.4.3. Ground concentrations of macro pollutants produced by the FPSO under operational conditions were modelled over a 75 km x 90 km sampling domain. Figure H3.1 below shows the FPSO ADMS, highlighting the FPSO location.

Figure H3.1 FPSO Simulation Domain



The meteorological time period chosen for the FPSO ADMS is the entire year 2014.

Model Input

Orography and Land use

The meteorological and sampling domain chosen for the FPSO ADMS is mostly located offshore. For the offshore parts of the domain the Land Cover has been assumed as water and the elevation equal to zero meters above sea level (m.a.s.l.). For the onshore part of the domain land cover data was taken from the Global Land Cover Network (GLCN) developed by the Food and Agriculture organisation of the United Nations (FAO). Digital elevation data was taken from the SRTM database produced by NASA.

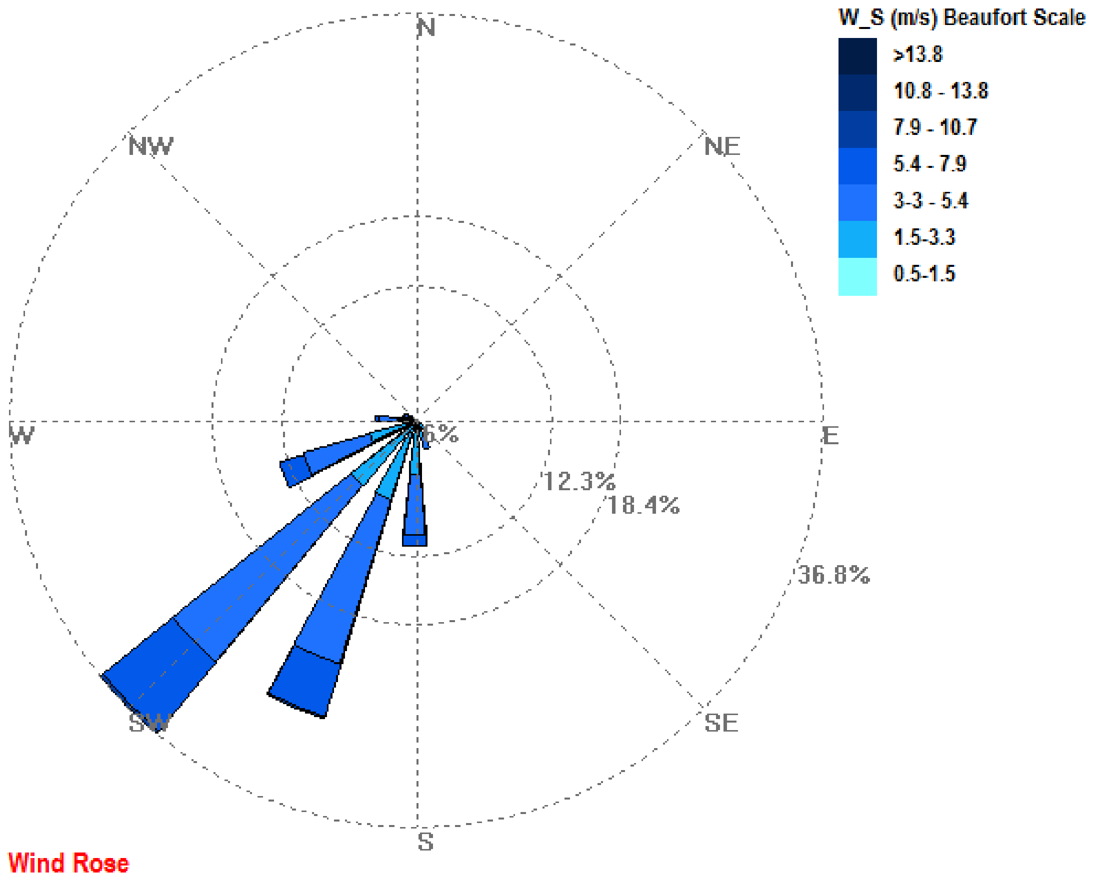
Meteorology

For the FPSO ADMS the CALPUFF meteorological input was obtained with the meteorological pre-processor CALMET. Details on the CALMET input requirements are provided in Section H.2.4.3.

Similarly to the ORF ADMS, CALMET surface and upper air input data for this study have been taken from MM5 meteorological model. This is due to the lack of radiosondes data and of representative weather stations monitoring meteorological variable over the above presented meteorological domains.

Figure H3.2 shows the wind rose extracted from the CALMET run performed for the year 2014, at the FPSO location.

Figure H3.2 Wind Rose Extracted from the CALMET run (2014) at the FPSO Location



NOTE: according to WMO (World Meteorological Organization) standards, the wind direction plotted in the wind rose is the wind provenance direction.

The wind rose shows that winds in the Project area presents a predominant wind directions from SW. In terms of wind speeds, moderate winds are prevailing in the area (between 3.3 and 5.4 m/s). The wind calms (< 0.5 m/s) are the 0.55%.

<u>Emission Scenario</u>

The definition of the emission inventory for the FPSO operation under normal conditions took into account two development steps:

- First development step representative of the FPSO operation and related emission up to 2026, when the continuous atmospheric emissions will be emitted by the power generation unit and the boiler;
- Second development step representative of the FPSO operation and related emission from 2026 onwards, when a compressor unit will be added to the FPSO due to the decrease of pressure of the reservoir.

FPSO first development step (up to 2026)

The main continuous atmospheric emissions released by the FPSO normal operation during the first development step are emitted by:

- The power generation unit: which consists of two gas turbines with an installed power of 34 MWth each; and
- One boiler fuelled with gas and producing 2 x 45 tons of vapour per hour.

The above mentioned facilities will be fuelled with gas and will primarily release gaseous emissions NO_x and CO into the atmosphere. The fuel gas is contaminated with H_2S therefore minor SO_2 emissions are also expected, whereas PM emissions are not expected to occur from the combustion of gaseous fuel.

Table H3.8 presents the geographical location and the characteristics of the FPSO emission sources included in the performed ADMS and is based on available Project design data.

Table H3.8 Operational Scenario: Emission Sources Geographical Location and Characteristics

Emission Source	ID	X	Y	Stack Height(1)	Stack diameter	Flue Gas Temperature	Flue Gas Velocity
		UTM 30 N [m]		[m]	[m]	[°C]	[m/s]
Power generation	FPSO-GT1	549.549	494.023	39.0	3.25	400	20.59
Power generation	FPSO-GT2	549.540	494.023	39.0	3.25	400	20.59
Boiler	FPSO-B1	594.529	494.023	27	2.39	289	22.1
(1) Above sea level							

The following Table H3.9 presents the emissions rate and compositions (NO_x , SO_2 and CO) used as input in the modelling study.

Table H3.9 Operational Scenario: Emissions Rate and Composition

Emission Source	ID	Concentration in flue gases(1) [mg/Nm³]			Emission rate [g/s]		
		NO_x	SO_2	CO	NO_x	SO_2	CO
Power generation	FPSO-GT1	738.8	5.7	18.7	51.19	0.39	1.30
Power generation	FPSO-GT2	738.8	5.7	18.7	51.19	0.39	1.30
Boiler	FPSO-B1	320	-	50	3.46	-	0.54
(1)Reference oxygen content [15%] for power generation and [2%] for the boiler							

FPSO second development step (from 2026 onwards)
The main continuous atmospheric emissions released by the FPSO normal operation during the second development step are emitted by:

- The power generation unit: which consists of two gas turbines with an installed power of 34 MWth each;
- One boiler fuelled with gas (for vapour production);
- Boosting compression unit: which consists of a two gas turbines with an installed power of 25 MWth each.

The above mentioned facilities will be fuelled with gas and will primarily release gaseous emissions NO_x and CO into the atmosphere. The fuel gas is contaminated with H_2S therefore minor SO_2 emissions are also expected, whereas PM emissions are not expected to occur from the combustion of gaseous fuel.

Table H3.10 presents the geographical location and the characteristics of the FPSO emission sources included in the performed ADMS and is based on available Project design data.

Table H3.10 Operational Scenario: Emission Sources Geographical Location and Characteristics

Emission Source	ID	X	Y	Stack Height(1)	Stack diameter	Flue Gas Temperature	Flue Gas Velocity
		UTM 30 N [m]		[m]	[m]	[°C]	[m/s]
Power generation	FPSO-GT1	549.549	494.023	39.0	3.25	400	20.59
Power generation	FPSO-GT2	549.544	494.023	39.0	3.25	400	20.59
Boiler	FPSO-B1	594.529	494.023	27	2.39	289	22.1
Boosting compressor	FPSO-GT3	549.549	494.053	39.0	2.79	550	25.18
Boosting compressor	FPSO-GT4	549.549	494.048	39.0	2.79	550	25.18
(1) Above sea level							

The following Table H3.11 presents the emissions rate and compositions (NO_x , SO_2 and CO) used as input in the modelling study.

Table H3.11 Operational Scenario: Emissions Rate and Composition

Emission Source	ID	Concentration in flue gases(1) [mg/Nm³]			Emission rate [g/s]		
		NO_x	SO_2	CO	NO_x	SO_2	CO
Power generation	FPSO-GT1	738.8	5.7	18.7	51.19	0.39	1.30
Power generation	FPSO-GT2	738.8	5.7	18.7	51.19	0.39	1.30
Boiler	FPSO-B1	320	-	50	3.46	-	0.54
Boosting compressor	FPSO-GT3	738.8	5.7	18.7	37.64	0.29	2.55
Boosting compressor	FPSO-GT4	738.8	5.7	18.7	37.64	0.29	2.55
(1) Reference oxygen content [15%] for power generation and [2%] for the boiler							

<u>Results</u>

Model results should be interpreted in light of the following conservative assumptions:

- Simulated NOx have been conservatively compared against the AQS set on NO_2 concentrations. In reality only a part of NOx converts to NO_2 in the atmosphere depending on different factors (e.g. solar radiation, temperature, and atmospheric hydrocarbon concentration). Hence, simulated NO_2 concentrations were conservatively overestimated.

- The model does not account for dry and wet deposition or photochemical reactions of the pollutants which in reality takes place and would reduce macro pollutants concentrations in the atmosphere. Thus results are overestimating the likely actual contribution of the sources. The approach again is on the safe side of assumptions and gives a conservative picture maximising pollutants modelled concentration values over the sampling domain.
- The definition of the emission scenario assumed project equipment operating at full power and continuously throughout the simulated year.

FPSO first development step (up to 2026)

The ADMS results obtained from the model run performed for the 1st development step of the FPSO are presented in *Table H3.12* along with Ghanaian and WBG/ WHO AQS. Standards (AQS). Short term concentrations reported in *Table H3.12* represent the maximum values predicted by the model over the simulation domain and the chosen temporal domain of one year (2014).

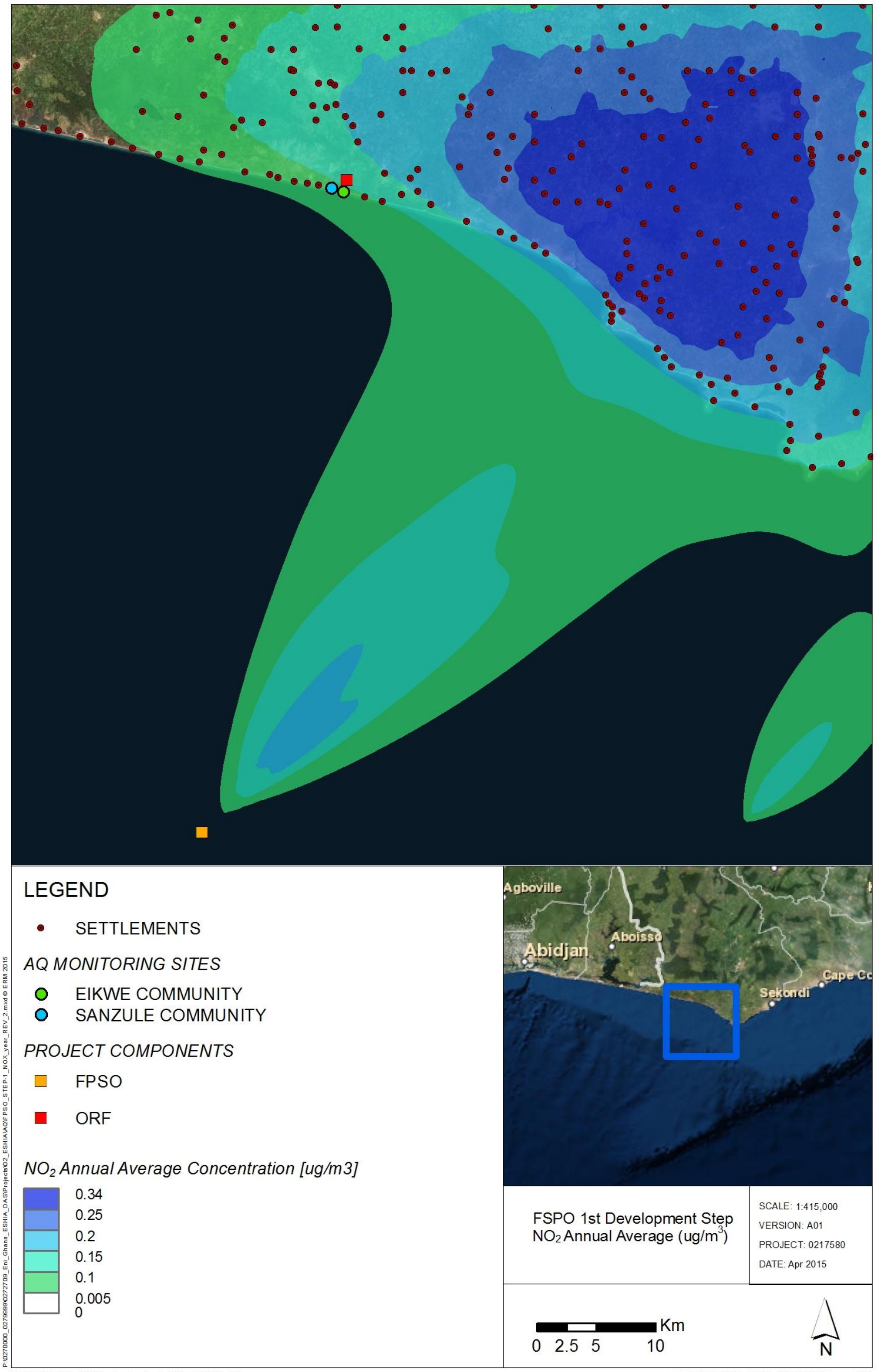
Table H3.12 FPSO 1st Development Step: Modelled Maximum Concentrations of Atmospheric Pollutants

Pollutant	Averaging Period	Modelled concentrations [µg/m³]	Distance from FPSO [km]	Ghanaian AQS (1) [µg/m³]	WBG/WHO AQS(2) [µg/m³]	% of Ghanaian AQS	% of WBG/WHO AQS
NO_2	1-year	0.34	65	30	40	1.1 %	0.8 %
	1-hour	12.51	10	90	200	13.9 %	6.3 %
	24-hours	7.35	10	60	-	12.2 %	-
SO_2	1-year	0.003	65	50	-	0.005 %	-
	1-hour	0.10	10	200	-	0.05 %	-
	24-hours	0.06	10	100	20	0.1 %	0.3 %
CO	1-hour	0.77	48	10000	-	0.01 %	-
	24-hours	0.23	47	60000	-	0.0004 %	-

(1)Set by the Environmental Quality Guidelines for Ambient Air (EPA, 1996) for residential areas
(2) Set by the WBG Environmental, Health, and Safety Guidelines for Air Emissions and Ambient Air Quality published on 2007 which refers to the WHO Air Quality Guidelines "WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide" Global update 2005.

From *Table H3.12* it can be concluded that pollutant concentrations maxima predicted by the model comply with National and WBG/WHO AQS. In comparison with AQS, predicted concentrations of NO_2 are the highest among the modelled pollutants, even though well below AQS (at most NO_2 hourly maximum concentration accounts for 13.9% of the Ghanaian AQS). Modelled pollutants concentration of NO_2 were spatially localised by mean of iso-concentration maps. The latter are presented in the following Figures.

Figure H3.3 FPSO Operation 1st Development Step - NO_2 Annual Concentration Map

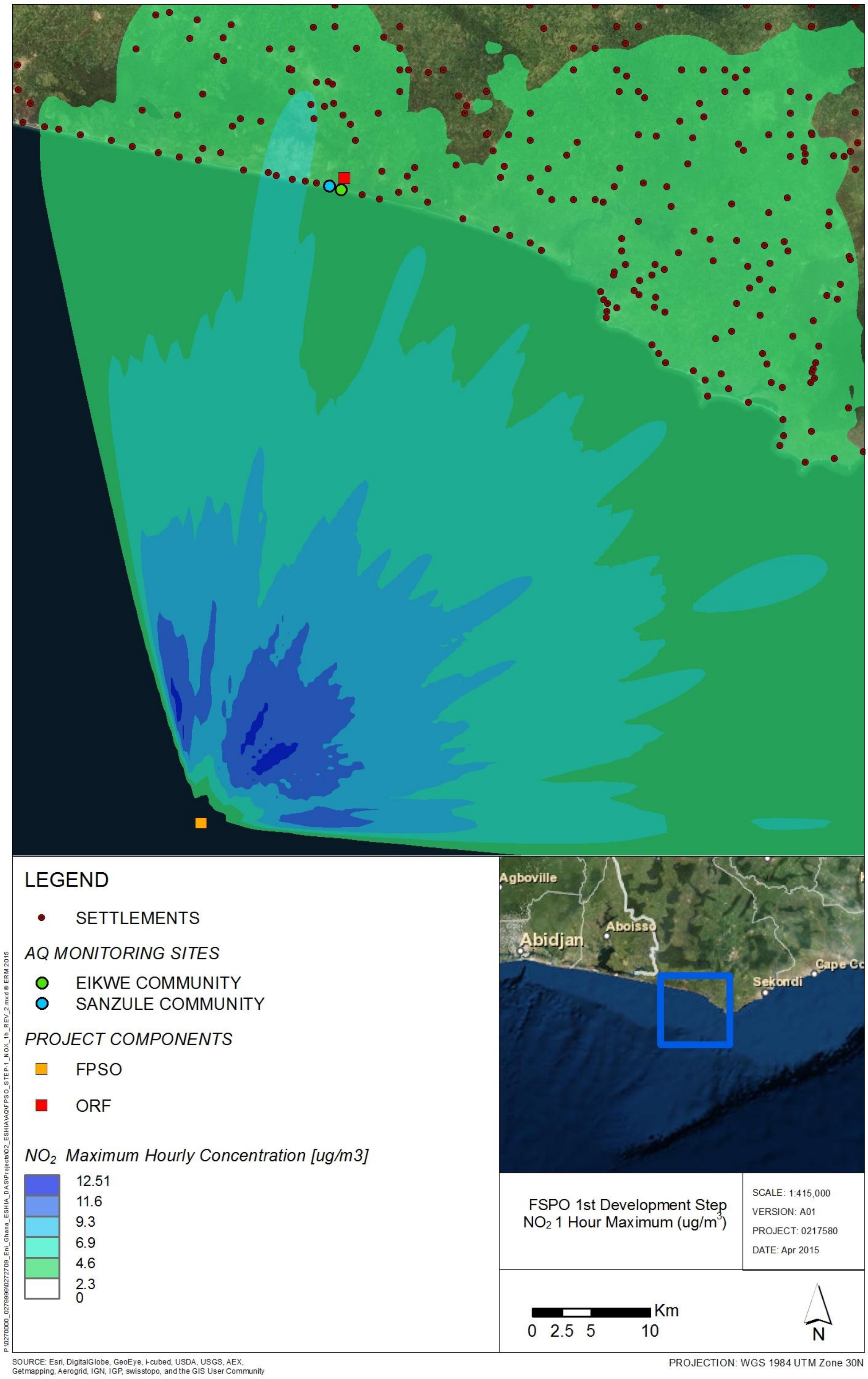


SOURCE: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

PROJECTION: WGS 1984 UTM Zone 30N

Ghana EPA AQS (for residential areas) = 30 μm3
WBG/WHO (Guideline values) = 40 μm3

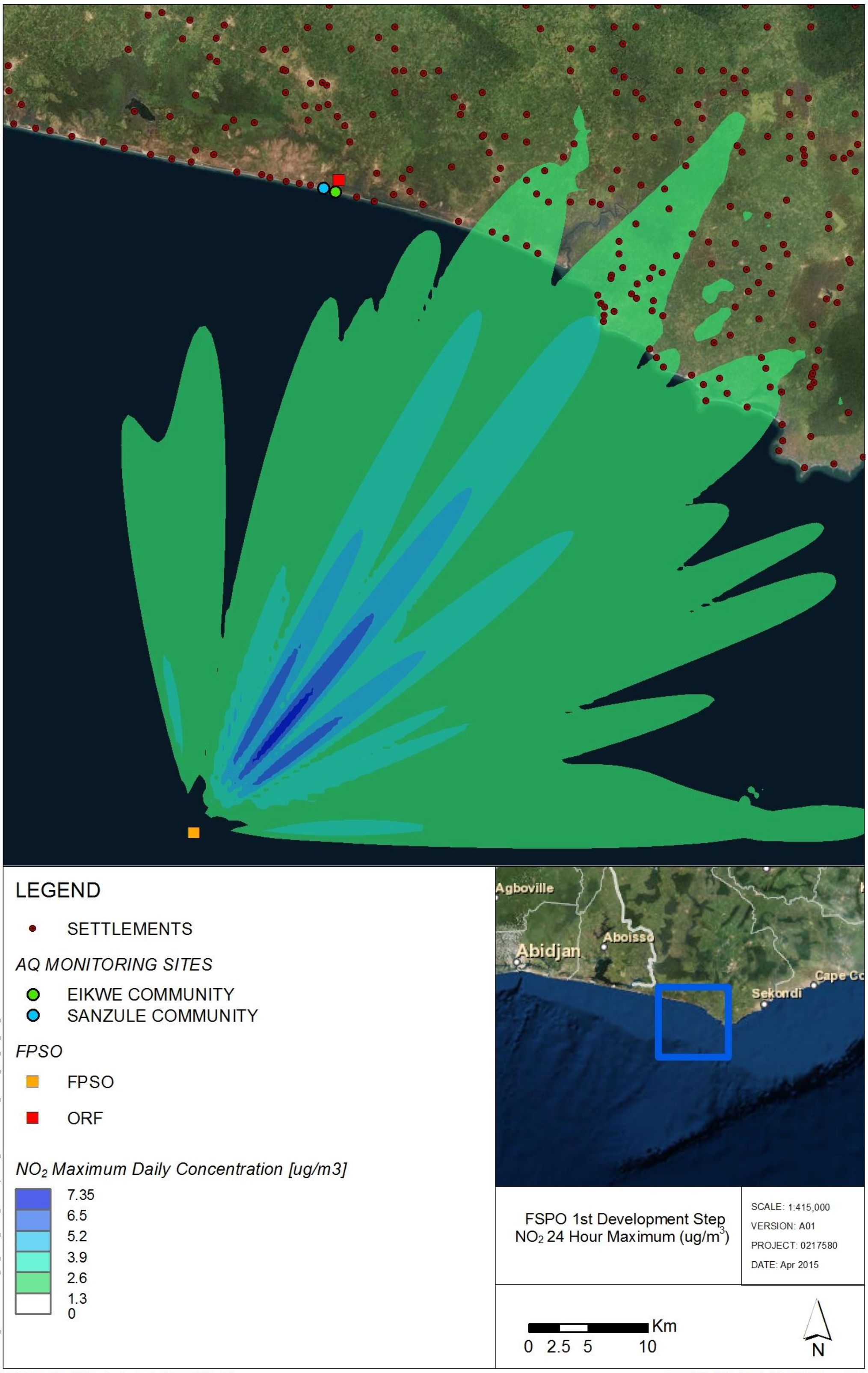
Figure H3.4 FPSO Operation 1st Development Step - NO₂ Maximum Hourly Concentration Map



Ghana EPA AQS (for residential areas) = 90 μm³

WBG/WHO (Guideline values) = 200 μm³

Figure H3.5 FPSO Operation 1st Development Step - NO_2 Maximum Daily Concentration Map



SOURCE: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

PROJECTION: WGS 1984 UTM Zone 30N

Ghana EPA AQS (for residential areas) = 60 μm³

The NO_2 annual concentration map shows that the highest concentrations fall on the coast, downwind to the FPSO. This is mainly due to the presence of a coastal upland downwind with respect to the FPSO and to interaction between the atmospheric dispersion of pollutants and the local orography. However, maximum NO_2 annual concentration predicted over the sampling domain are two orders of magnitude lower than regulatory limit and one order of magnitude lower than monitored baseline concentration. Moreover predicted annual concentrations are comparable with the typical NO_2 background atmospheric concentration for marine environments, which ranges between 0,4 and 9,4 µg/m³ [1].
In light of the above considerations it can be concluded that annual NO_2 concentrations induced by the FPSO operation in its 1st development step are not likely to cause any significant change on existing air quality level, nor harm on human receptors.
NO_2 short-term concentration maxima (1h, 24h) fall within a distance of 8-10 km from the FPSO and do not affect permanent human receptors located along the coast. Lower concentrations, about 2 orders of magnitude lower than regulatory limit, reach the coast but are not likely to cause any harm on human receptors.

Atmospheric concentrations of airborne pollutants induced by the FPSO operation in its 1st development step comply with National and WBG/WHO AQS. Moreover, induced concentration maxima do not affect receptors. Therefore no specific mitigation will be implemented.

FPSO second development step (from 2026 onwards)
The ADMS results obtained from the model run performed for the 2nd development step of the FPSO are presented in Table H3.13 along with Ghanaian and International Air Quality Standards (AQS). Short term concentrations reported in Table H3.13 represent the maximum values predicted by the model over the simulation domain and the chosen temporal domain of one year (2014).

It should be noted that simulated NOx have been conservatively compared against the AQS set on NO_2 concentrations. In reality only a part of NOx converts to NO_2 in the atmosphere depending on different factors (e.g. solar radiation, temperature, and atmospheric hydrocarbon concentration). Hence, simulated NO_2 concentrations were overestimated.

[1] Seinfeld, J.H., Pandis , S. N. , 2006. Atmospheric chemistry and physics: From air pollution to climate change. John Wiley and Sons Inc.: New York.

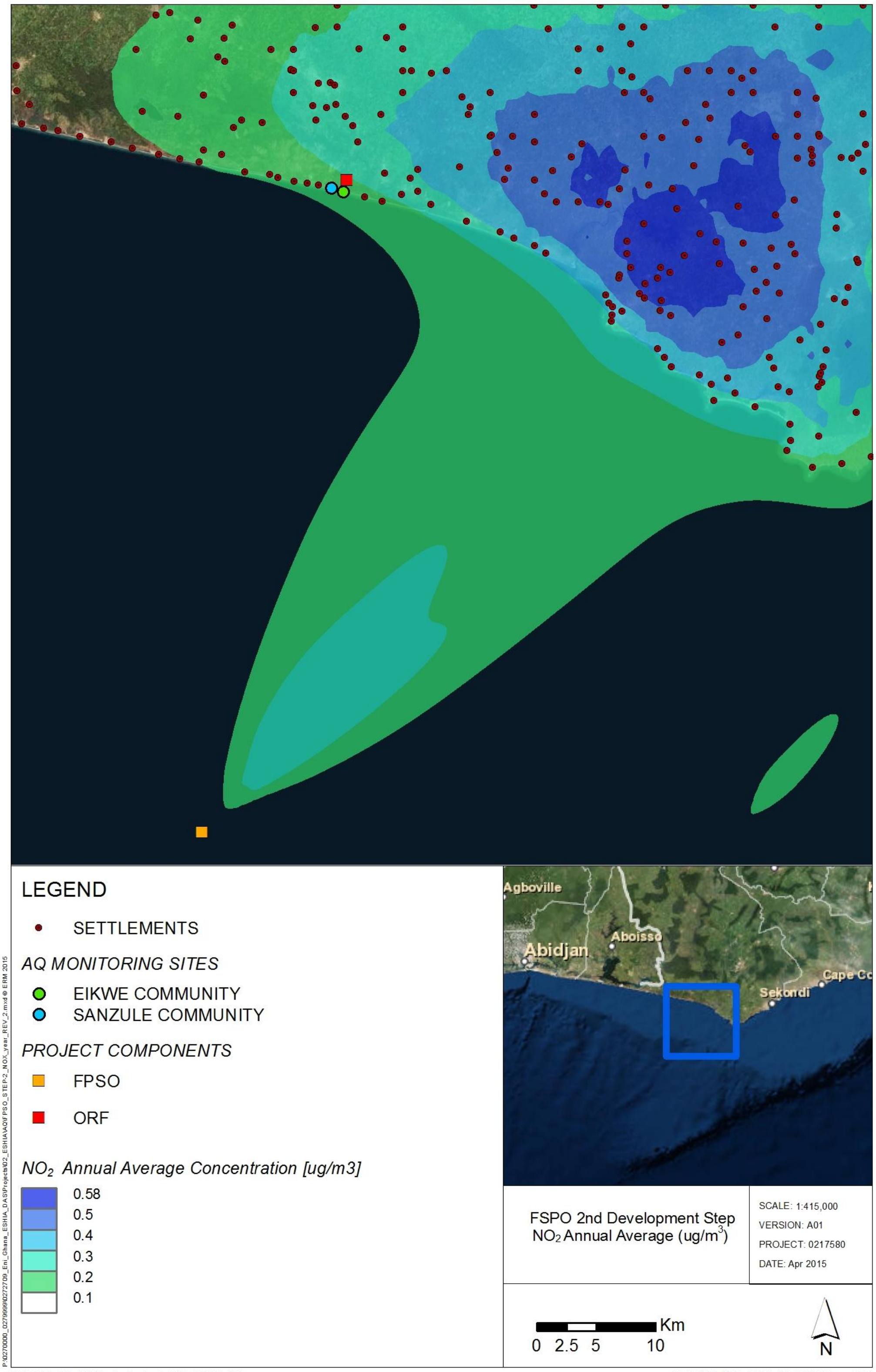
Table H3.13 FPSO 2nd Development Step: Modelled Maximum Concentrations of Atmospheric Pollutants

Pollutant	Averaging Period	Modelled concentrations [µg/m³]	Distance from FPSO [km]	Ghanaian AQS (1) [µg/m³]	WBG/WHO AQS(2) [µg/m³]	% of Ghanaian AQS	% of WBG/WHO AQS
NO_2	1-year	0.58	65	30	40	1.9 %	1.5 %
	1-hour	21.43	10	90	200	23.8 %	10.7 %
	24-hours	12.53	10	60	-	20.9 %	
SO_2	1-year	0.004	65	50	-	0.009 %	
	1-hour	0.17	10	200	-	0.08 %	
	24-hours	0.10	10	100	20	0.1 %	0.5 %
CO	1-hour	0.78	48	10000	-	0.01 %	
	24-hours	0.47	10	60000	-	0.0005 %	

(1) Set by the Environmental Quality Guidelines for Ambient Air (EPA, 1996) for residential areas
(2) Set by the WBG Environmental, Health, and Safety Guidelines for Air Emissions and Ambient Air Quality published on 2007 which refers to the WHO Air Quality Guidelines "WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide" Global update 2005.

From Table H3.13 it can be concluded that modelled pollutant concentrations comply with National and International AQS. In comparison with AQS, predicted concentrations of NO_2 are the highest among the modelled pollutants, even though well below AQS (at most NO_2 hourly maximum concentration accounts for 25.5% of the AQS). Modelled pollutants concentration of NO_2 were spatially localised by mean of iso-concentration maps. The latter are presented in the following Figures.

Figure H3.6 FPSO Operation 2nd Development Step - NO_2 Annual Concentration Map



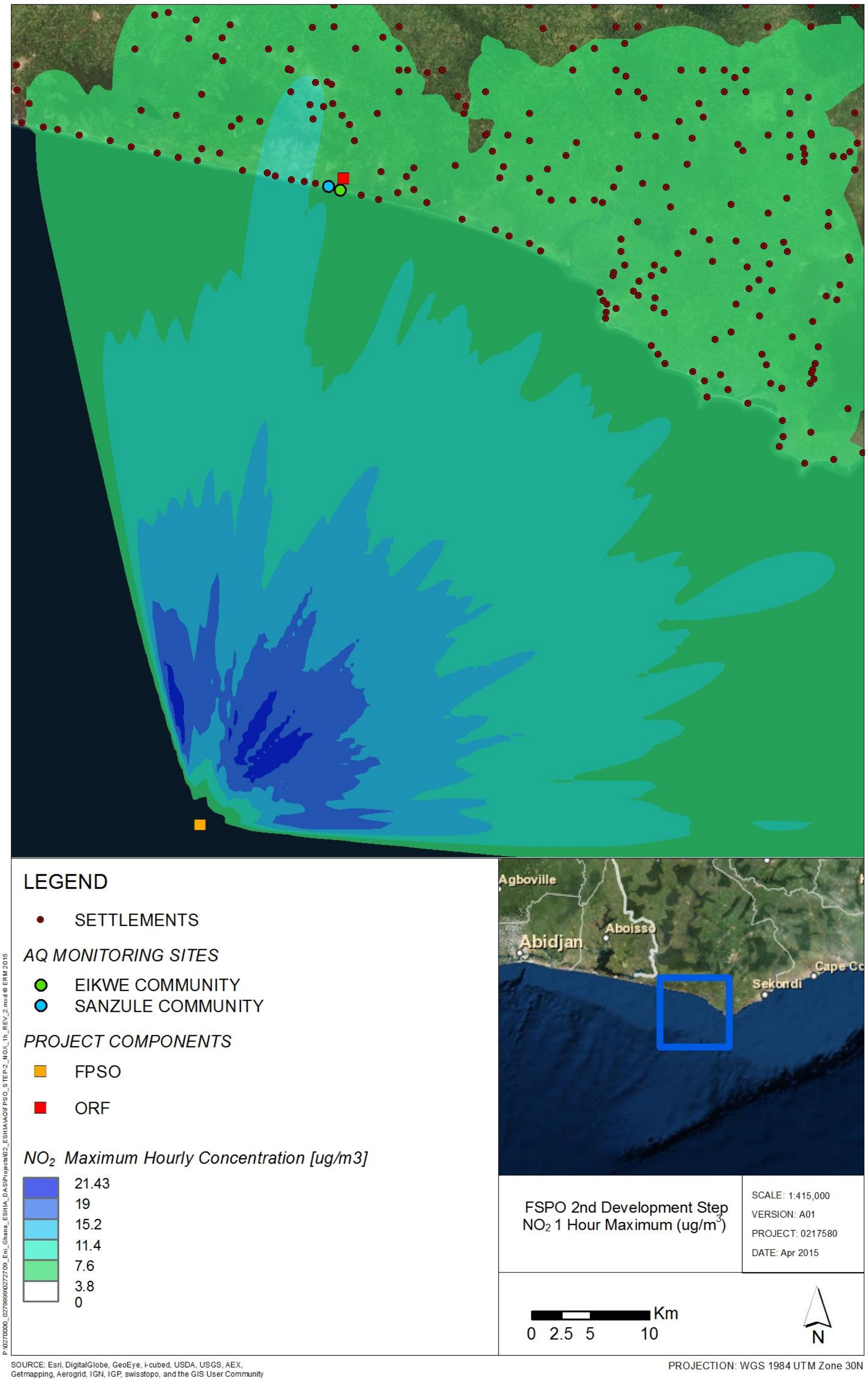
SOURCE: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

PROJECTION: WGS 1984 UTM Zone 30N

Ghana EPA AQS (for residential areas) = 30 μm³

WBG/WHO (Guideline values) = 40 μm³

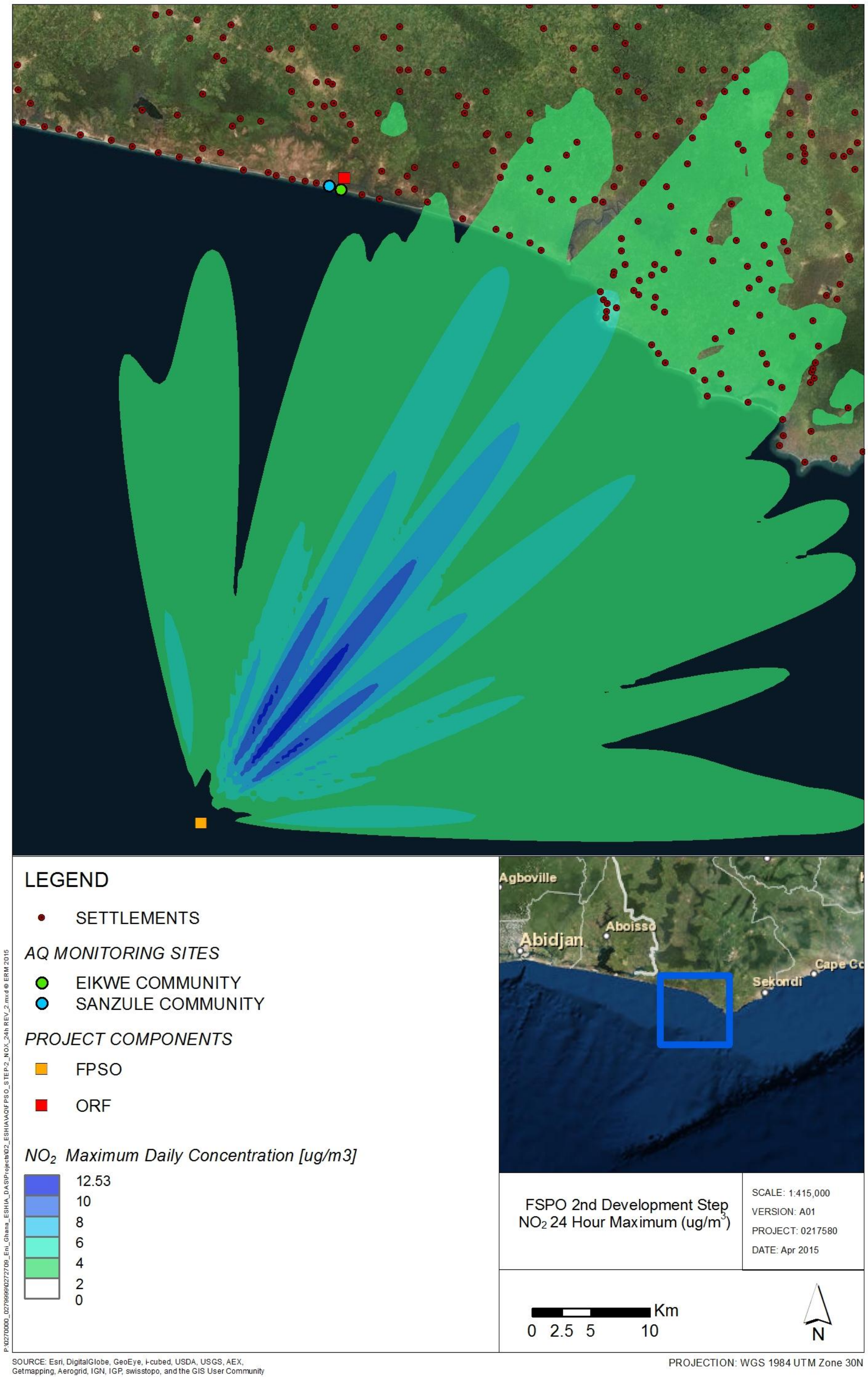
Figure H3.7 FPSO Operation 2[nd] Development Step - NO_2 Maximum Hourly Concentration Map



Ghana EPA AQS (for residential areas) = 90 μm^3

WBG/WHO (Guideline values) = 200 μm^3

Figure H3.8 FPSO Operation 2nd Development Step - NO_2 Maximum Daily Concentration Map



Ghana EPA AQS (for residential areas) = 60 µm³

The NO_2 annual concentration map shows that the highest concentrations fall on the coast, downwind to the FPSO. This is mainly due to the presence of a coastal upland downwind with respect to the FPSO and to interaction between the atmospheric dispersion of pollutants and the local orography. However, maximum NO_2 annual concentration predicted over the sampling domain are two orders of magnitude lower than regulatory limit and one order of magnitude lower than monitored baseline concentration. Moreover predicted annual concentrations are comparable with the typical NO_2 background atmospheric concentration for marine environments, which ranges between 0,4 and 9,4 µg/m³ [1].
In light of the above considerations it can be concluded that annual NO_2 concentrations induced by the FPSO operation in its 2nd development step are not likely to cause any significant change on existing air quality level, nor harm on human receptors.

NO_2 short-term concentration maxima (1h, 24h) fall within a distance of 8-10 km from the FPSO and do not affect permanent human receptors located along the coast. Lower concentrations, about 2 orders of magnitude lower than regulatory limit, reach the coast but are not likely to cause any harm on human receptors.

Atmospheric concentrations of airborne pollutants induced by the FPSO operation in its 2nd development step comply with National and International AQS. Moreover, induced concentration maxima do not affect receptors. In comparison with the FPSO 1st development step, the 2nd development step does not show a significant increase of the induced atmospheric concentrations of airborne pollutants. In particular, maxima induced concentrations of NO_2 are at least one order of magnitude lower than regulatory limits, similarly to what is observed for the FPSO 1st development step.

The performed modelling study did not highlight any criticalities in terms of induced air pollution levels, thus no specific mitigations are recommended and the following actions are expected to be undertaken:

- Repetition of the ADMS once actual design data are available;
- Implementation of an air emission and ambient air quality monitoring program during operations.

[1] Seinfeld, J.H., Pandis , S. N. , 2006. Atmospheric chemistry and physics: From air pollution to climate change. John Wiley and Sons Inc.: New York.

H.4. ASSESSMENT OF IMPACTS AND CONCLUSIONS

The emissions released during the Project onshore construction and pre-commissioning have been qualitatively assessed along with mitigation measures to be implemented. Due to the temporary nature of the identified emissions, low impacts are expected to arise from this phase.

The impact of the ORF emissions during the Project onshore operation has been quantified by means of a dedicated ADMS. The ORF ADMS highlighted that:

- Atmospheric concentration of airborne pollutants induced by the ORF operation comply with national and WBG/WHO AQS;
- Predicted concentration maxima are localised within a distance of 1.5 km from the ORF and do not affect closest human receptors
- Based on the outcome of the FPSO ADMS, no changes in the significance of onshore impacts are expected as a result of the simultaneous operation of onshore and offshore Project facilities.

The emissions released by the vessels during the Project offshore construction, have been quantified on the base of available project data following the MEET Methodology.
These emissions are mobile and will be released offshore at a distance of more than 60km from the closest permanent human receptors located on the coast. 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.

The impact of the FPSO emissions during the Project offshore operation was quantified by a dedicated ADMS. The FPSO ADMS highlighted that:

- Atmospheric concentration of airborne pollutants induced by the FPSO operation comply with national and international AQS both for its 1st and 2nd development steps;
- Predicted concentration maxima are localised within a distance of 8-10 km from the FPSO and do not affect closest human receptors located on the coast.
- Based on the outcome of the ORF ADMS, no changes in the significance of offshore impacts are expected as a result of the simultaneous operation of offshore and onshore Project facilities.

Regarding the cumulative impacts due to emissions to atmosphere from the various projects planned in the area, both onshore and offshore, they are not considered to affect significantly the local air quality given the dispersion capacity of the surrounding atmosphere and the distances between onshore and offshore facilities. Thus the cumulative impact on the local air quality, and associated impacts on receptors, will be expected to be low.

H.5. References

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ESHIA for GHANA OCTP BLOCK Phase 2

ANNEX I
Noise

ABSTRACT

Annex I provides an assessment of the noise impacts correlated to the onshore Project activities during construction and operation phases by means of modelling calculation tools.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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ACRONYMS

Acronym	Definition
A	Attenuation
a	coefficient of atmospheric attenuation, in dB/km
A_{div}	Attenuation due to geometrical divergence
A_{atm}	Attenuation due to atmospheric absorption;
A_{ground}	Attenuation due to the ground effect
A_{refl}	Attenuation due to reflections from obstacles
A_{screen}	Attenuation due to screen effects
A_{misc}	Attenuation due to other effects
a.g.l.	Above ground level
CE	European Community
D	Directivity
d	Distance between the source and the receiver, calculated in meters
dB(A)	A-Weighted decibel
DGM	Digital Ground Model
EHS	Environmental, health and safety
EPA	Environmental protection agency
ESHIA	Environmental and social impact assessment
FPSO	Floating production storage and offloading
hm	Medium height from the ground of the propagation way
IFC	International Finance Corporation
ISO	International Organization for Standardization
K	Index that considers the emission in a defined solid angle
km	kilometre
l	Wavelength
L_P	Level of sound pressure
L_W	Level of sound power
Leq	Equivalent Continuous Level
log	Logarithm
m	metre
mbar	millibar
µPa	Micropascal
NASA	National Aeronautics and Space Administration
NOAA	US National Oceanic and Atmospheric Administration
OCTP	Offshore Cape Three Points
ORF	Onshore reception facility
SRTM	Shuttle Radar Topography Mission

I.1 INTRODUCTION

The development of the hydrocarbon reserves in the Offshore Cape Three Points (OCTP) has the potential to adversely impact the acoustic climate of the surrounding environment and in particular of the nearest inhabited areas. In order to assess the potential impact on local acoustic climate, a dedicated noise study has been performed. Details about the Project Design Data, relevant assumptions and project information related to the OCTP project are presented in the Chapter 4 of the ESHIA, related to OCTP Phase 2, and Chapter 2 of the ESHIA, related to OCTP Phase 1.

The noise study aimed at predicting the noise levels generated by the Project in the AoI. Since the OCTP Project presents onshore and offshore component the impacts to the environment surrounding the onshore facilities, offshore installations and at the nearest noise sensitive receptors have been evaluated as follows:

- Assessment of the impacts on local acoustic climate arising from the construction phase of the onshore pipeline and the ORF, based on an analysis of the emissions generated by the main equipment in use for construction activities;
- Assessment of the impacts on local acoustic climate arising from the pre-commissioning phase (hydrostatic test) of the sea export pipeline, by means of the SoundPLAN modelling system;
- Assessment of the impacts on local acoustic climate arising from the operation phase of the ORF, by means of the SoundPLAN modelling system.

Human receptors are unlikely to be affected by noise impacts from offshore activities since the coast settlements are located at least at a significant distance of 60 km. Only temporary noise impacts may be generated during the construction of the pipeline in the nearshore, since vessels will be nearer to the coast. However, generally, the residential areas are sufficiently far to not experience any significant disturbance from offshore activities. Thus, the impact on onshore receptors generated by offshore activities have not been further assessed in this Annex. The assessment of the impacts on underwater noise and marine fauna arising from the construction and operation of the offshore facilities (FPSO, wells and sea export pipeline) has been included in Annex G of the ESHIA Study.

Since empirical data suggest that ground vibration from construction and operation is not likely to be perceptible beyond about 100 m, vibration is not expected to be a significant effect of the Project. Therefore, vibration impact has not been considered further in this assessment.

The following Sections present the study methodology, model inputs, assumptions and results compared against applicable noise guidelines for the noise assessments listed above.

Results of Impact Assessment presented in this Annex are based on the methodology and the analysis described in the Annex G of the ESHIA Study. Annex G defines as well applicable mitigation measures, and therefore the impacts hereby presented have to be considered as residual impact, post application of foreseen mitigation measures.

I.2 ONSHORE

I.2.1 NOISE STANDARDS

The noise standards considered in the present study are based on national (Ghana EPA) and international (World Bank Group, WBG) guidelines for noise emissions and noise pollution during construction and operation phase. The Project will need to take these ambient noise level standards into account for the planning of construction and operation phase activities to ensure that these are not exceeded.

I.2.1.1 Construction Phase

Noise pollution generated during construction activities is not directly addressed by neither any relevant national guidance nor the WBG EHS guidelines. It is common practice to class impacts as negligible if the predicted construction noise levels do not exceed the existing ambient noise levels.

In consideration of the construction period, being a period of more than 2 years, it is considered that the IFC guideline levels of 55 dB(A) for the daytime would be appropriate for this Project, as per WBG Guidelines for Ambient Noise Levels, residential areas (see Table I2.2). The night time limit is not taken into account since construction activities are not scheduled to occur during the night. Moreover, the IFC guideline level for day time is the same set by the Ghana EPA for "residential areas with negligible or infrequent transportation".

I.2.1.2 Operation Phase

For noise pollution generated during operation, the Ghana EPA maximum permissible noise levels during day and night time hours are presented in Table I2.1. The national limits applicable to the Project, in consideration of the nature of the sensitive receptors, mainly inhabited areas, are 55 dB(A) for daytime and 48 dB(A) for night time.

Table I2.1 Ghana EPA Ambient Noise Level Standards

Zone	Description of Noise Receptor	Permissible Noise Level [dB(A)]	
		Daytime 06h00 – 22h00	Night time 22h00 – 06h00
A	Residential areas with negligible or infrequent transportation	55	48
B1	Educational (school) and health (hospital clinic) Facilities	55	50
B2	Area with some commercial or light industry	60	55
C1	Area with some light industry, place of entertainment or public assembly and place of worship such as churches and mosques	65	60
C2	Predominantly commercial areas	75	65

Zone	Description of Noise Receptor	Permissible Noise Level [dB(A)]	
		Daytime 06h00 – 22h00	Night time 22h00 – 06h00
D	Light industrial areas	70	60
E	Predominantly heavy industrial areas	70	70

Source: General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels (EPA).

The WBG General Environmental EHS Guidelines (World Bank Group 2007), which implement the "Guidelines for Community Noise" established by the World Health Organization (WHO) in 1999, prescribe the absolute noise levels reported in Table I2.2 for day time and night time to be achieved. In environments where the ambient noise levels already exceed a level of 55 dB(A) daytime and/or 45 dB(A) night time the WBG includes a guideline stating that noise emissions should not cause the ambient noise level in a residential area to rise by 3 dB(A) or more, determined during the noisiest hour of a 24 hour period.

Table I2.2 IFC Guidelines for Ambient Noise Levels

Receptor	Maximum Ambient Noise Level 1-hour Leq [dB(A)]	
	Daytime 07h00-22h00	Night time 22h00-07h00
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

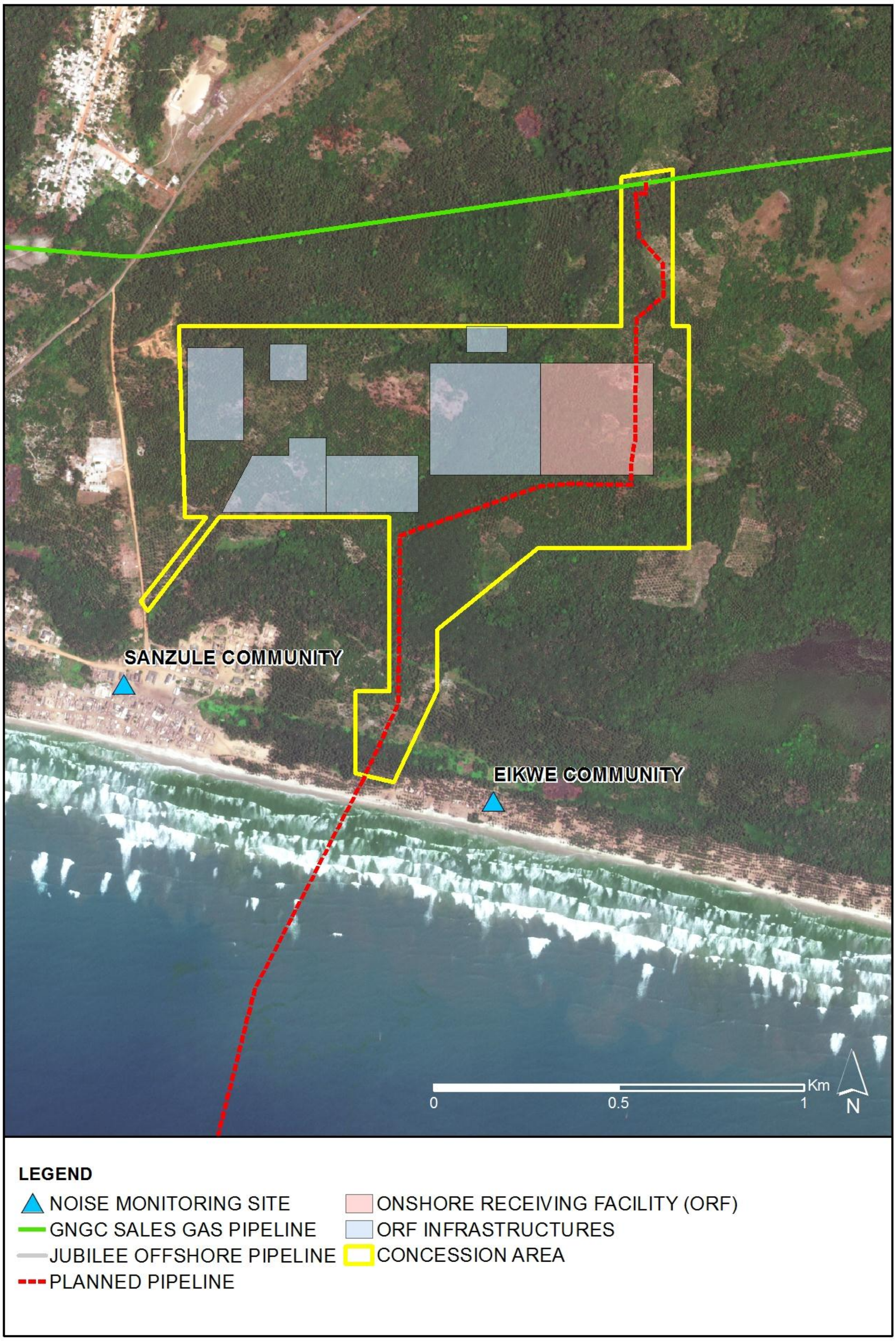
Source: WBG General EHSs Guidelines: Noise (WBG, 2007)

I.2.2 BASELINE NOISE LEVELS

Noise emissions generated during onshore activity, both construction and operation, could affect human receptors present in the AoI with consequence on behavior and health (i.e., annoyance, sleep disturbance, stress).

As described in details in the Chapter 6 of the ESHIA, in March and October 2013 field surveys were performed to identify potential noise sensitive receptors, such as inhabited buildings, along the pipeline and in proximity of the ORF and measure existing ambient noise levels. Two main villages are found and monitored in the surroundings of the Project site, namely Sanzule and Eikwe located at a minimum distance of 700 m and 350 m respectively from the boundary of the Concession Area. The ORF site and the most significant noise sources, planned to be located in the north-east side of the Concession Area, are expected to be located at a distance of above 1000 m from Sanzule and 900 m from Eikwe.

Figure I2.1 Location of Monitored Receptors



Source: ERM, 2015

Both of the monitoring sites can be located in residential areas, thus the monitored values have been compared with the relevant limits set by Ghana EPA for Zone A and by IFC for residential area. Noise monitoring results are reported in Table I2.3. Measured ambient noise levels at the villages, both day-time and night-time, were already generally above Ghana EPA guideline (55 dB(A) daytime, 48 dB(A) night time) and IFC EHS Guidelines (55 dB(A) daytime, 45 dB(A) night time) for noise levels in a residential areas. This was due to significant contribution of noise from routine human activities and natural elements (e.g., sea waves breaking at the beach). Noise originated from non-industrial sources such as domestic activities, fishing activities, beach seine activities and vehicular traffic.

Table I2.3 Ambient Noise Levels

Location	Measured Sound Pressure Level [dBA]					
	Dry Season			Wet Season		
	Average (Leq)	Day Time	Night Time	Average (Leq)	Day Time	Night Time
Sanzule Community	55.19	55.07	55.19	63.70	65.90	64.53
Eikwe Community	59.86	60.48	59.49	61.31	62.02	60.80

Source: eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report (ESL Consulting, 2014) (REF. 1, REF. 2).

I.2.3 METHODOLOGY

In order to estimate the potential noise impacts resulting from construction, hydrostatic testing and operation phases, a quantitative analysis of the noise emissions levels generated has been performed using the noise propagation model SoundPLAN (version 7.2), developed by Braunstein + Berndt GmbH. The main features of the modelling tool are described in Section 1.1I.2.3.1.

All equipment with acoustic characteristics able to influence the current acoustic climate of the AoI were used as input for the model and simulated as noise sources. A description of the emission scenarios simulated in this study for construction, hydrostatic testing and operation phases is reported in Section I.2.4 and is based on the Project Design Data, relevant assumptions and project information presented in the Chapter 4 of the ESHIA, related to OCTP Phase 2, and Chapter 2 of the ESHIA, related to OCTP Phase 1.

I.2.3.1 SoundPLAN Modelling System

SoundPLAN is a recognised noise prediction and presentation tool used extensively throughout the world in order to provide the values of sound pressure level in specific areas.

This software applies the “ray tracing” method. Sources are simulated as surfaces, lines or points: each source propagates sound waves. The resulting acoustic field depends on the absorption and reflection characteristics of all existing obstacles between the source and the receptor. In the area of interest, the acoustic field will be the result of the acoustic energies sum of “n” rays which reach the receiver.

SoundPLAN implements the methods identified within ISO 9613 Acoustics - Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation (see Box I2.1). The noise model will be developed by locating noisy equipment on digital plot plans for the plant. Noise propagation will be estimated according to the nature, type and sound power level of the different noise sources, as well as weather conditions and terrain.

The model needs the following input data to predict noise levels attributable to the noise sources object of the modelling at nearby receivers:

- three-dimensional digital terrain map of site and surrounding area;
- frequency-based sound power level noise source data for equipment operating at the site;
- intervening ground cover;
- shielding by barriers, intervening buildings or topography; and
- atmospheric conditions.

SoundPLAN calculates area-wide and plant-wide noise metrics, and the results will be provided in the form of noise maps of equal loudness and sound pressure values at the receptors identified. The levels in the whole area are indicated by iso-phones with equivalent steps, at a conventional height (e.g. 1.5 metres a.g.l.). The results can be processed by any GIS software, to create iso-concentration maps.

Box I2.1 describes the calculation method implemented by SoundPLAN for the simulation of noise propagation.

Box I2.1 Method of Calculation

The medium level of sound pressure to the receiver in the propagation direction (downwind conditions) is calculated for every source with:

$$L_P = L_W - A$$

The factor A is the attenuation that the sound energy endures during the propagation and it is composed of the following contributors:

$$A = A_{div} + A_{atm} + A_{ground} + A_{refl} + A_{screen} + A_{misc}$$

where:

- A_{div} = attenuation due to geometrical divergence;
- A_{atm} = attenuation due to atmospheric absorption;
- A_{ground} = attenuation due to the ground effect;
- A_{refl} = attenuation due to reflections from obstacles;
- A_{screen} = attenuation due to screen effects;
- A_{misc} = attenuation due to other effects.

The factor *A* can be applied singularly to every contributor or, in a second moment, to the sum calculated for every octave band. The continuous equivalent sound level is the result of the sum of the single pressure levels, obtained for each source in each frequency, if requested.

The resulting sound power level in the direction of propagation depends upon the power level in free field conditions and upon a term that specifies the directivity (*D*).
D quantifies the variation of the radiation towards more directions of one directional source in comparison to the same non-directional one:

$$L_P = L_W + D$$

For a non-directional point source the contribution of *D* is 0 dB. The correction of *D* comes out from the index of directivity of the source, adding a *K* index that considers the emission in a defined solid angle.
For a source with spherical propagation in a free space *K*=0dB; when the source is near to a reflecting surface that is not the ground, *K*=3dB; when the source is in front of two perpendicular reflecting surfaces, one of which is the ground, *K* = 3 dB; if none of them is the ground, *K*=6dB; with sources in front of three perpendicular surfaces, one of which is the ground, *K*=6dB; with sources in front of three reflecting surfaces and none of them is the ground, *K*=9dB.

Geometric Divergence Attenuation
The attenuation for geometric divergence can be evaluated theoretically as:

$$A_{div} = 20 \log (d/d0) + 11$$

where:
- d is the distance between the source and the receiver, calculated in meters;
- d0 is the reference distance, 1 m.

Atmospheric Attenuation
The absorption of the air is defined as:

$$A_{atm} = a*d/1000$$

where:
- d is the distance of propagation, expressed in meters;
- a is the coefficient of atmospheric attenuation, in dB/km.

The coefficient of atmospheric attenuation depends mainly on sound frequency, environmental temperature, relative air humidity and atmospheric pressure.

Ground Effect Attenuation
The attenuation due to the ground effect comes from the interference between the sound reflected from the ground and the sound with direct propagation from the source to the receiver.
For this methodology of calculation, the surface of the land between the source and the receiver has to be flat, horizontal or with one constant slope. In alternative, a breaking line has to be drawn in the model.
There are three main regions of propagation: one of the source, one of the receiver and an intermediate one. Each of these zones can be described with a factor related to the characteristic detailed lists of reflection.
The methodology for the calculation of land attenuations can make use of one more simplified formula,
which considers the distance d receiver-source and the medium height from the ground of the propagation way (hm):

$$A_{ground} = 4.8 - (2\ hm/d)\ (17 + (300/d))$$

Reflection Effect Attenuation
The attenuation by reflection refers to surfaces like facades of buildings, which cause an increase of the sound pressure level to the receiver.
An important term is the attenuation due to the presence of obstacles (a little deep backs, barrier or screen).
The barrier must be considered a close and continuous surface without interruptions. Its perpendicular horizontal dimension to the line source-receiver must be greater than the wavelength l to the frequency of centre band for the considered octave band. According to the standards, the attenuation due to the shielding effect will be given by "insertion loss", that is from the difference between the levels of pressure measured to the receiver in a specific position with and without the barrier.

Mixed Effects Attenuation
The term of mixed attenuation is the result of many effects:
• attenuation due to propagation through leaves;
• attenuation due to the presence of obstacles with big dimensions, for diffraction due to buildings or plants;
• attenuation due to the propagation through an obstacle, for shield effect or house reflection.

Source: SoundPLAN User's Manual

I.2.3.2 Noise Model Input

This Section describes the main data input of the modelling study. The following assumptions applied to all emission scenarios.

Computational Domain

Noise impacts relating to ORF construction, operation and hydrostatic testing are likely to occur within a maximum radius of 1 km from the ORF. Conservatively, the noise study has been performed considering a calculation domain up to 6 km x 7 km with 15 meters resolution centred on the ORF site.
The domain takes into account a geographical area of about 42 km^2 in order to include in the Computational Domain all the Concession Area and the nearest sensitive receptors up to a distance of about 3 km potentially influenced by the Project activities.

Orography
Topographical information for the acoustic model was extracted from 2 m ground contours available in raster format for the area surrounding the Concession Area (Source: NASA SRTM). A 3-D representation of the terrain's surface has been calculated through the generation of a Digital Ground Model (DGM) in SoundPLAN, using a Triangular Irregular Network Algorithm.

The attenuation due to the ground between the noise sources and the receptors, mainly characterised by coastal areas and surfaces covered by vegetation, has been included in the noise model; an absorption coefficient value of 0.6dB has been applied.

Obstacles between source and receptor

The screening effects of buildings and barriers at the ORF site have been included from the acoustic model to represent a more realistic calculation methodology. Obstacles between the source and the receptor result in additional noise reductions depending upon their size, density and location. To reproduce in a more detailed way the plant layout, the following non-emitting buildings have been considered: control room, warehouse/workshop, gate house, electrical substation. Plot plan of the ORF and location of the noise emission sources are reported in Section I.2.4.

Meteorological Data

The climate conditions of the Project site have been characterised through an analysis of the meteorological data acquired during the field surveys performed in the Concession Area and on the basis of available meteorological data from the US National Oceanic and Atmospheric

Administration (NOAA, 2010) database. Further information are presented in the Chapter 6 of the ESHIA, from which relevant data for the purpose of the analysis have been analysed.
Differences in the meteorological parameters values occur between dry and wet season; the noise model took into account an average of these parameters:

- Average Air Temperature 31 °C
- Average Relative Humidity 80%
- Atmospheric Pressure 1013 mbar

As a conservative approach, the noise propagation is carried out under down wind conditions (from source to receptor). Downwind propagation conditions for the method specified in ISO 9613 are:

- Wind direction within an angle of ±45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region, with the wind blowing from source to receiver.

- Wind speed between 1 m/s and 5 m/s, measured at a height of between 3 m to 11 m above the ground.

The meteorological parameters have been set up for the whole calculation domain, to represent as the probable atmospheric conditions of the Project area.

I.2.3.3 Limitation and Assumptions

This study is based on preliminary Project data and it is possible that upgrades in the Project configuration, namely ORF layout and equipment characteristics, will occur. Therefore, worst case scenarios have been assumed for the estimation of noise emissions in order to guarantee a conservative methodological approach in the evaluation of potential noise impacts related to the Project. Assumptions related to each Project phase are reported in the dedicated sections of the emission scenarios characterization.

I.2.4 EMISSION SCENARIOS

I.2.4.1 Construction Phase

Noise associated with construction of the onshore pipeline and ORF will be intermittent, variable in nature and will depend on the particular activities being undertaken as well as the number and type of equipment in operation.

The overall noise produced during the construction phase comes from several types of equipment and from specific activities. During the site preparation, the main equipment used will be soil moving machinery (e.g., excavators, loaders) and trucks. The subsequent construction activities will involve the operation of equipment to move materials (e.g., cranes, side-boom/pipe layer, pipe bending machine) and stationary machinery (e.g., pumps, generators, compressors).

Therefore, the noise impact related to construction phase can be variable and it is difficult to accurately predict construction noise emissions throughout the entire construction period.

Hence, to facilitate the noise assessment, worst case scenarios have been developed throughout SoundPLAN simulations, representative of the main group of scheduled activities.

Considering that construction activities will extend throughout the length of the onshore pipeline and the ORF site, each scenario has been simulated to represent a 'typical' maximum activity with equipment operating in the area closest to noise sensitive receptors. The predicted noise levels from the SoundPLAN model are based on the assumption that all equipment is operating simultaneously and at full load.

The equipment simulated for construction activities and their acoustic performances for each scenario are shown in Table I2.4 and Table I2.5. According to present design stage of the Project, specific equipment noise data sheet are not available. Therefore, the sound power levels for the main equipment used during construction works have been conservatively set according to European Commission Directive 2000/14/CE. As indicated by Directive 2000/14/CE, all noise emitting equipment will be properly maintained to minimize noise impact on the area and should comply with the applicable noise standards for such equipment.

Table I2.4 Noise Emission Scenario for Onshore Pipeline Construction

Activity	Equipment	N.	LW tot [dBA]
Working strip	Excavator	1	108
	Backhoe loader	1	105
	Dozer	1	105
Pipe Stringing/ Bending	Crane	1	98
	Side-boom	1	109
	Pipe Bending Machine	1	94
Pipe Welding	Motor-driven welding machine	1	106
Trench digging	Excavator	1	108
	Truck	1	107
Pipe laying	Side-boom/Pipelayer	1	109
Backfilling and reinstatement	Roller compactor	1	100
	Truck	1	107

Source: ERM, 2015.

Table I2.5 Noise Emission Scenario for ORF Construction

Activity	Equipment	N.	LW tot [dBA]
Site preparation	Excavator	1	108
	Backhoe loader	1	105
	Dozer	1	105
ORF Installation	Crane	1	98
	Side-boom	1	109
	Truck	1	107
	Generator	1	102
	Concrete mixer	1	99
Backfilling and reinstatement	Roller compactor	1	100
	Truck	1	107

Source: ERM, 2015.

I.2.4.2 Pre-commissioning Phase

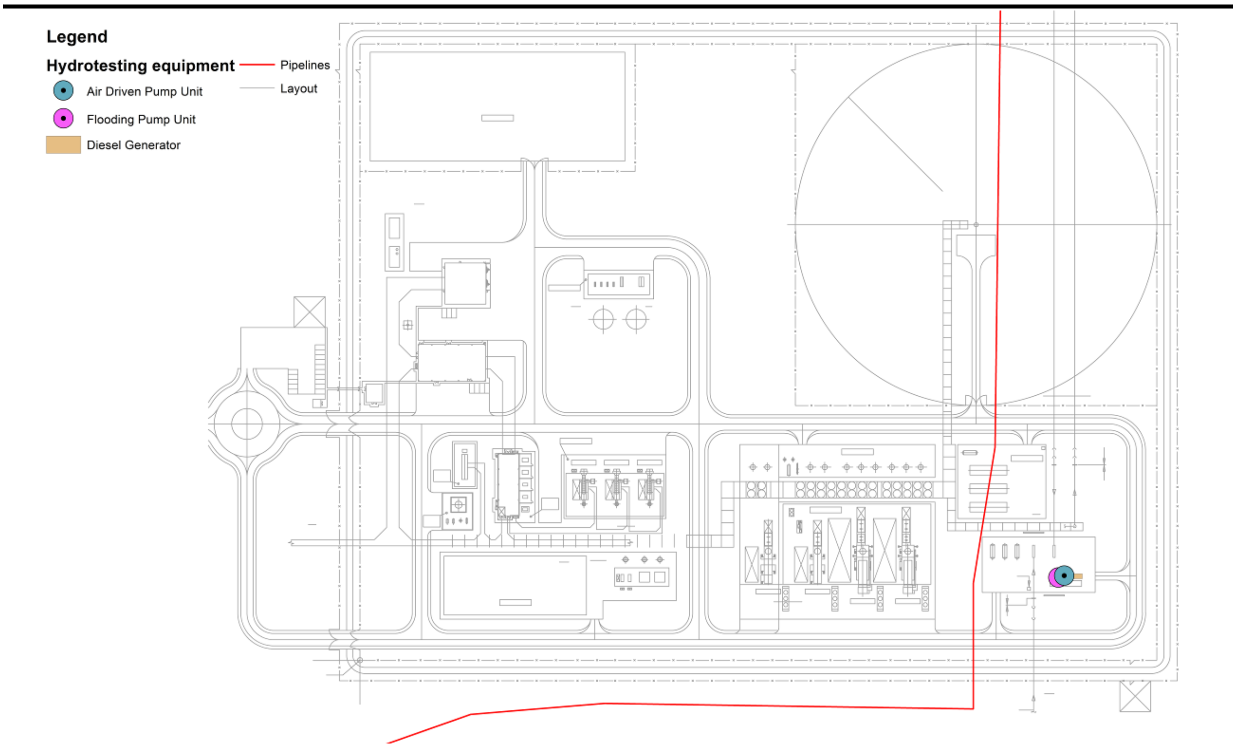
During pre-commissioning phase, once the pipeline has been cleaned and gauged and ORF equipment installed, it will be subjected to a hydrostatic test operation. The most critical aspect is represented by the continuous activity (24 hours per day) of flooding pumps, air driven pumps and generators needed for raising the pressure in the pipeline to the specified test pressure and for cleaning operations.
According to present design stage of the Project, the specific equipment that will be likely to be adapted for the hydrostatic test and therefore simulated in noise modelling study are shown in Table I2.6. Location of the simulated equipment is shown in the next Figure.

Table I2.6 Noise Emission Scenario for Hydrostatic Testing

Equipment	N.	LW tot [dB(A)]
Flooding pump unit	1	93.0
Air driver pump unit	1	90.0
Diesel generator	1	84.6

Source: ERM, 2015.

Figure I2.2 Location Of Equipment For Hydrostatic Test



Source: eni, 2015. Modified by ERM.

I.2.4.3 Operation Phase

ORF operations comprise a few number of processes, activities and equipment that generate noise. All equipment with acoustic characteristics able to influence the global noise levels of the Concession Area have been used as input for the model and simulated as noise sources. In particular, potential impacts on the ambient acoustic levels may be generated by noise emissions from the power generation unit, the compression station and ancillary equipment. Emission inventory is based on the Project Design Data, relevant assumptions and project information presented in the Chapter 4 of the ESHIA, related to OCTP Phase 2, and Chapter 2 of the ESHIA, related to OCTP Phase 1.

It is anticipated that the operational life of the facility will be 20 years and the ORF will run 24 hours a day, 7 days a week. Thus, to predict noise emissions from plant processing operations, a typical worst case activity has been assumed based on the assumption that equipment are operating simultaneously and at full load for 24h/day.

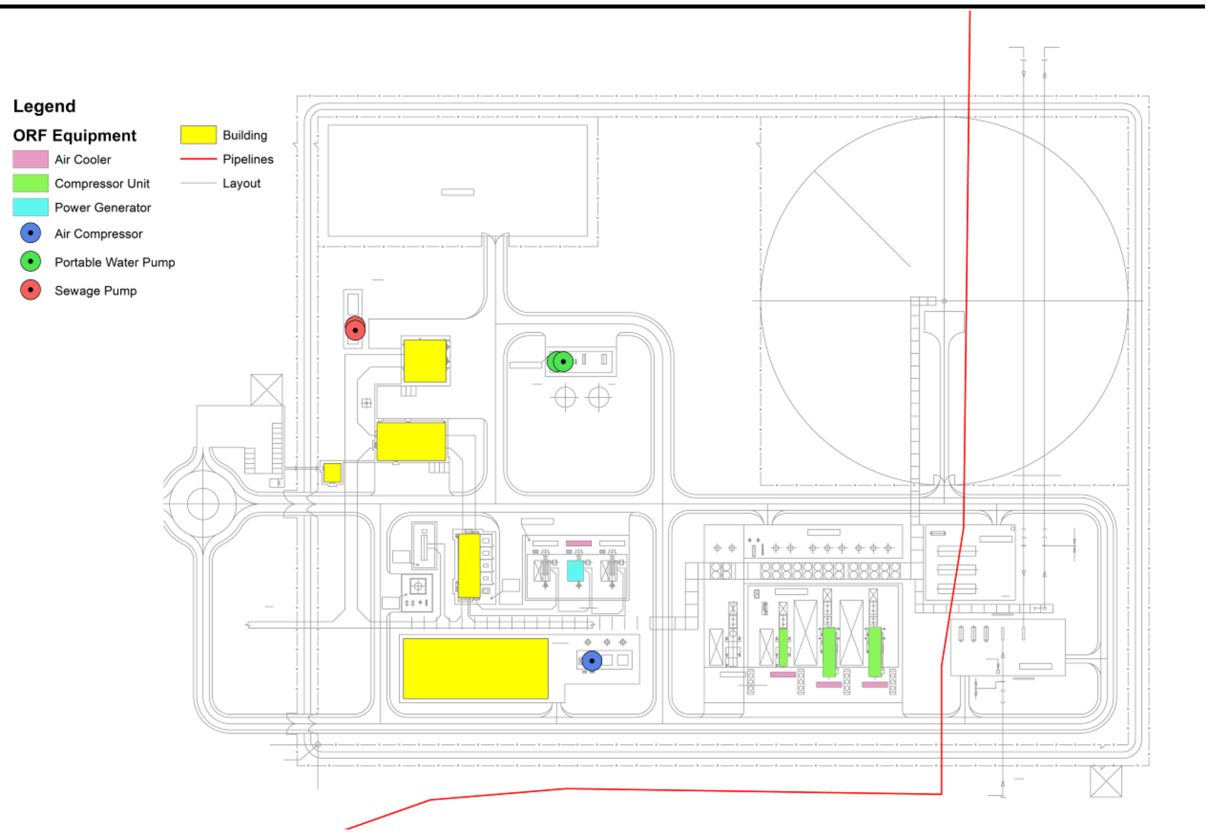
The equipment simulated for ORF operation and their acoustic performances are shown in Table I2.7. All the noise sources have been simulated considering a Sound Pressure Level of 85 dB(A) measured at the distance of 1 meter, corresponding to the individual employee's upper daily noise exposure level (Source: OSHA), as requested by eni Technical Specifications for Noise and Vibration Management. Location of the simulated equipment is shown in Figure I2.3.

Table I2.7 Noise Emission Scenario for ORF Operation

Equipment	N.	Lp@1m [dB(A)]
Power Generator Unit - Gas turbine - Diesel generator	 1 1	 85 85
Diesel power generator	1	85
Compressor unit	3	85
Air cooler	4	85
Air compressor	1	85
Potable water pump	2	85
Sewage pump	2	85

Source: ERM, 2015.

Figure I2.3 Location Of Equipment for ORF Operation



Source: eni, 2015. Modified by ERM.

I.2.5 NOISE MODELLING RESULTS

I.2.5.1 Construction Phase

The noise emission levels generated by the equipment involved in the construction activities of the onshore pipeline and ORF can be estimated considering each piece of machinery as a single point source located in the centre of the construction site. The noise propagation from the source (the piece of equipment) to the receptor has been estimated considering the noise emission scenarios reported in Section I.2.4.1.

During the construction phase, each single activity entails the use of several types of machinery; therefore the noise impact will be the result of the cumulative noise effect of all the equipment working simultaneously in the same area. Moreover, the vehicles and equipment will move along the pipeline route and around the ORF construction site, with a consequent variations of the noise emission levels affecting the receptors based on the distance between the noise source and the receptor. For this reason the modelling assessment, performed by means of SoundPLAN model, has been conservatively carried out considering the single contributions of the pipeline and ORF construction activities and a cumulative assessment as well (pipeline + ORF construction).

In particular for assessing noise contribution of the Pipeline's construction phase a noise impact buffer at fixed distance from the Pipeline route has been evaluate throughout SoundPLAN calculation, as shown in Table I2.8.

The detail of the predicted noise levels at sensitive receptors identified near the Concession Area is shown in Table I2.9 and Table I2.10.

Table I2.8 Predicted Sound Pressure Levels at Fixed Distances during Pipeline Construction

Construction Activity	Sound Pressure Level [dB(A)] at						
	100 m	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**2000 m**
All the equipment (working in the same time and area)	64.6	58.0	54.0	49.0	45.4	42.4	33.8

Source: ERM, 2015

Table I2.9 Predicted Sound Pressure Levels at Receptors during the most critical working activity in Pipeline Construction

Receptor	Construction Phase Contribution [dB(A)]	Ghana EPA Noise Limits [dB(A)]		IFC Noise Limit [dB(A)]	
		Day	**Night**	**Day**	**Night**
Sanzule Community	46.1	55	48	55	45
Eikwe Community	52.9	55	48	55	45
Location of the receptors: (ref. Figure I2.1) - Sanzule Community:700 m minimum distance far from pipeline - - Eikwe Community:300 m minimum distance far from pipeline					

Source: ERM, 2015

Table I2.10 Predicted Sound Pressure Levels at Receptors during ORF Construction

Receptor	Construction Phase Contribution [dB(A)]	Ghana EPA Noise Limits [dB(A)]		IFC Noise Limit [dB(A)]	
		Day	Night	Day	Night
Sanzule Community	36.4	55	48	55	45
Eikwe Community	39.8	55	48	55	45

Location of the receptors (ref. Figure I2.1)
- Sanzule Community:1000 m minimum distance far from ORF construction area
- Eikwe Community:900 m minimum distance far from ORF construction area

Source: ERM, 2015

Furthermore, Table I2.11 shows cumulative assessment performed by means of Soundplan considering the most critical scenario in terms of noise emissions, namely the preparation of the working strip for pipeline construction and the civil and installation works for ORF construction, and the minimum distance between each receptor and the pipeline work site.

Table I2.11 Predicted cumulative Sound Pressure Levels at Receptors during both Pipeline and ORF Construction

Receptor	Construction Phase Contribution (pipeline + ORF) [dB(A)]	Background Noise Level [dB(A)] (1)		Cumulative Noise Level [dB(A)]		Ghana EPA Noise Limits [dB(A)]		IFC Noise Limit [dB(A)]	
		Day	Night	Day	Night(2)	Day	Night	Day	Night
Dry Season									
Sanzule Community	46.5	55.1	55.2	55.7	-	55	48	55	45
Eikwe Community	53.1	60.5	59.5	61.2	-	55	48	55	45
Wet Season									
Sanzule Community	46.5	65.9	64.5	66.0	-	55	48	55	45
Eikwe Community	53.1	62.0	60.8	62.5	-	55	48	55	45

Notes:
(1) Measured during the field surveys performed in March 2014 and in October 2014
(2) Construction works are planned to be undertaken only during daytime, thus there will not be any Project noise emissions during night time.
Location of the receptors (ref. Figure I2.1)

Source: ERM, 2015

Construction works are planned to be undertaken only during daytime, so the noise limit in force to identify impacts at noise sensitive receptors is 55 dB(A), both for Ghana EPA and WBG standards.

Comparing the project sound pressure levels with the day time noise limit it is observed that:

- During pipeline construction, the noise limit of 55 dB(A) for day time is respected at a distance of about 280 m from the pipeline centreline;

- At the village of Sanzule, the maximum predicted noise level generated by the Project is 46.5 dB(A), occurring during the construction of the closest pipeline segment, mainly due to its proximity to the work areas (about 700 m). The cumulative noise levels exceed the Ghana EPA and IFC noise limit, but this is only due to the high values of the monitored background levels. Project contribution, in fact, is well below the daytime limit of 55 dB(A) during all construction activities and will not increase significantly the existing background noise (a maximum increase of 0.8 dB(A) is predicted);

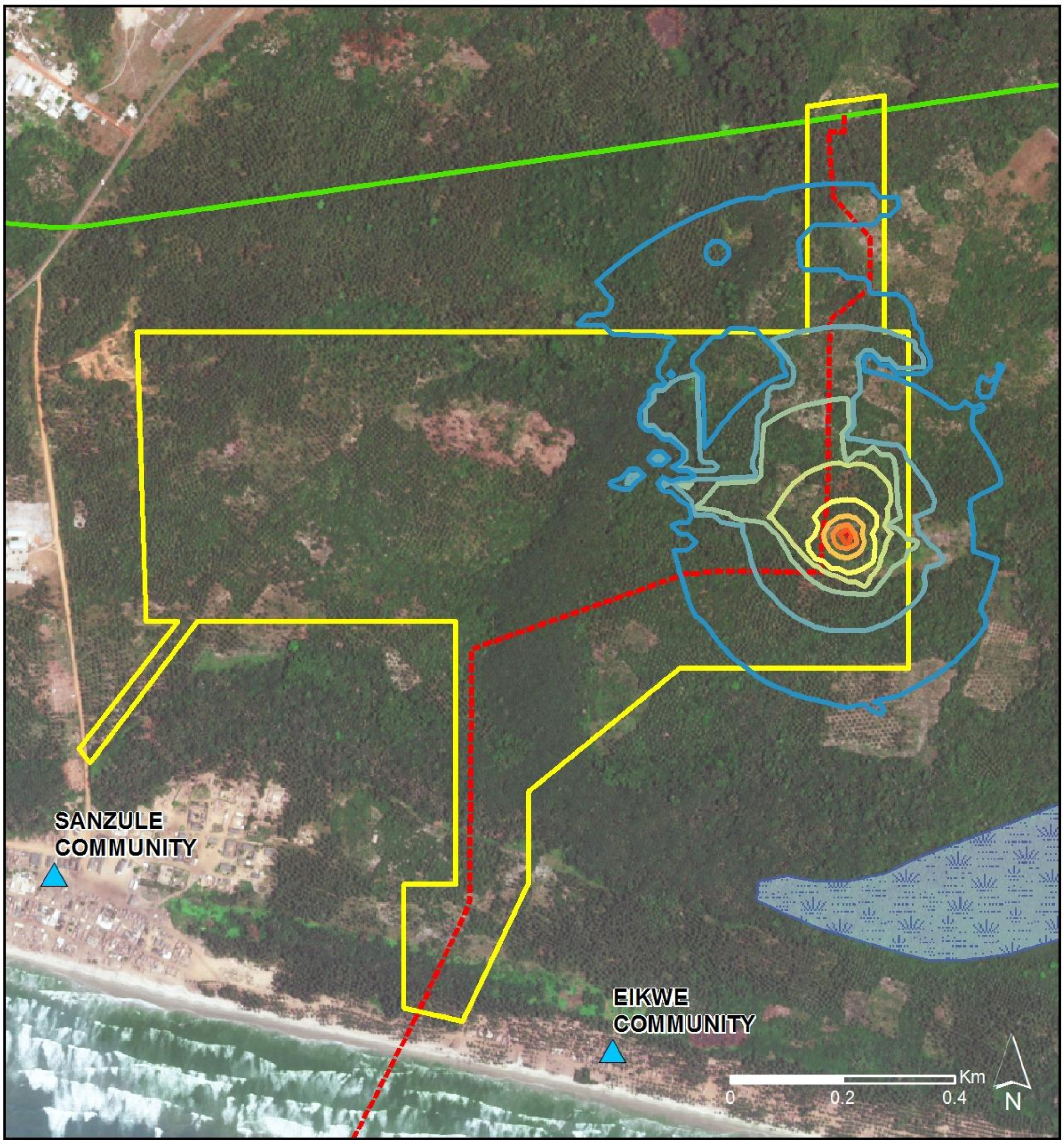
- At the village of Eikwe, the maximum predicted noise level generated by the Project is 53.1 dB(A), occurring during the construction of the closest pipeline segment. The noise level at this village is higher than the level predicted for Sanzule, as a consequence of its proximity to the pipeline route (only 300 m). The cumulative noise levels exceed the Ghana EPA noise limit and IFC noise guideline, but this is only due to the high values of the monitored background levels. Project contribution, in fact, is well below the daytime limit of 55 dB(A) during all construction activities and will not increase the existing background noise (a maximum increase of 0.7 dB(A) is predicted).

I.2.5.2 Pre-commissioning Phase

The noise emission levels generated by the equipment involved in the hydrostatic testing has been estimated using SoundPLAN modelling system and considering the noise emission scenario reported in Section I.2.4.2.

Predicted noise emission levels from hydrostatic testing operations in the area surrounding the Concession Area are shown in the noise map in Figure I2.4. Table I2.12 reports the Project contribution at the monitored sensitive receptors, the estimated cumulative noise levels and the comparison with Ghana EPA and IFC standards.

Figure I2.4 Predicted Sound Pressure Levels during Hydrostatic Testing



LEGEND

NOISE MONITORING SITE

WETLAND

HYDROSTATIC TEST

Value (dBA)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70

Receptor	Background Noise Level [dB(A)]		Ghana EPA Noise Limits [dB(A)]		IFC Noise Limit [dB(A)]	
	Day	Night	Day	Night	Day	Night
Dry Season						
Sanzule Community	55.1	55.2	55	48	55	45
Eikwe Community	60.5	59.5	55	48	55	45
Wet Season						
Sanzule Community	65.9	64.5	55	48	55	45
Eikwe Community	62.0	60.8	55	48	55	45

Source: ERM, 2015

Table I2.12 Predicted Sound Pressure Levels at Discrete Receptors during Hydrostatic Testing

Receptor	Hydrostatic Testing Contribution [dB(A)]	Background Noise Level [dB(A)] (1)		Cumulative Noise Level [dB(A)]		Ghana EPA Noise Limits [dB(A)]		IFC Noise Limit [dB(A)]	
		Day	Night	Day	Night	Day	Night	Day	Night
Dry Season									
Sanzule Community	**14.5**	55.1	55.2	**55.1**	**55.2**	55	48	55	45
Eikwe Community	**18.5**	60.5	59.5	**60.5**	**59.5**	55	48	55	45
Wet Season									
Sanzule Community	**14.5**	65.9	64.5	**65.9**	**64.5**	55	48	55	45
Eikwe Community	**18.5**	62.0	60.8	**62.0**	**60.8**	55	48	55	45

Source: ERM, 2015

Hydrostatic Testing is planned to be undertaken only few days but continuously throughout the entire day (24/day), so the noise limits in force to identify impacts at noise sensitive receptors are: 55 dB(A) during day time, both for Ghana EPA and IFC standards; 45 dB(A) during night time for IFC standard; 48 dB(A) night time for Ghana EPA regulation.

Comparing the project sound pressure levels with the day time noise limit it is observed that:

- The Project contribution respects the Ghana EPA noise limits and WBG guidelines both during day time and night time. Noise levels at receptors are, in fact, very low as below 20 dB(A). Thus, the noise produced during hydrostatic testing is unlikely to be perceived by the human settlements in the area.

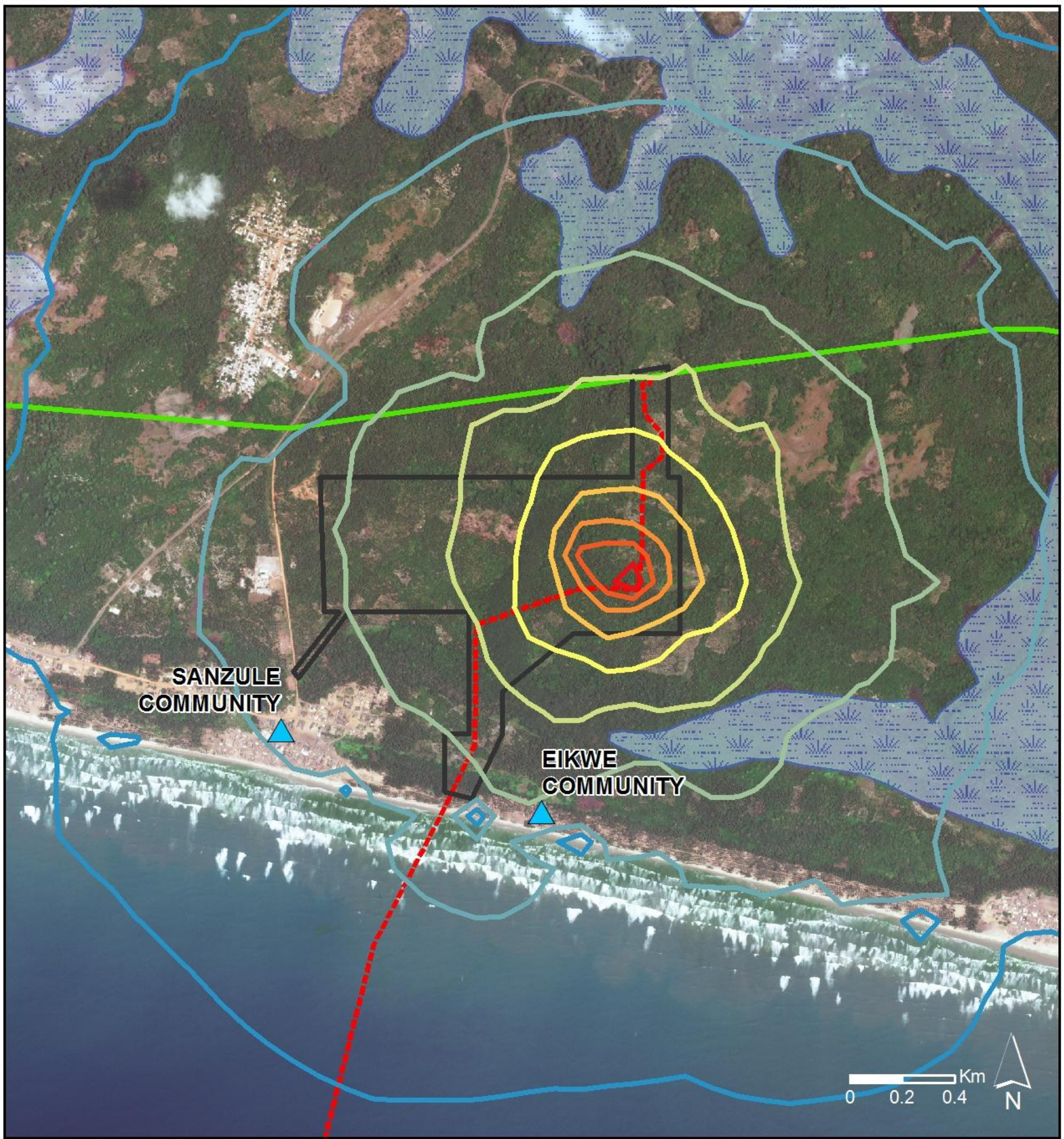
- Cumulative noise levels, calculated as the logarithmic sum of monitored background noise and Project contribution, are well above the noise limits both for day and night time. The exceedances are only due to the high levels of the current background noise monitored during the field surveys; the project contribution, in fact, is well below the noise limits and it is so low to not cause any increase of the background noise level at receptors.

I.2.5.3 Operation Phase

The noise emission levels generated by the equipment involved in operation has been estimated using SoundPLAN modelling system and considering the noise emission scenario reported in Section I.2.4.3.

Predicted noise emission levels from ORF operation phase in the area surrounding the Concession Area are shown in the noise map in Figure I2.5. The ORF is planned to operate 24 hours/day, therefore the predicted noise emission levels are the same both during day and night time. Table I2.13 reports the Project contribution at the monitored sensitive receptors, the estimated cumulative noise levels and the comparison with Ghana EPA and IFC standards.

Figure I2.5 Predicted Sound Pressure Levels during ORF Operation Phase



LEGEND

NOISE MONITORING SITE

WETLAND

OPERATIONAL ORF TEST

Value (dBA)

- 30
- 35
- 40
- 45
- 50
- 55
- 60
- 65
- 70

Receptor	Background Noise Level [dB(A)]		Ghana EPA Noise Limits [dB(A)]		IFC Noise Limit [dB(A)]	
	Day	Night	Day	Night	Day	Night
Dry Season						
Sanzule Community	55.1	55.2	55	48	55	45
Eikwe Community	60.5	59.5	55	48	55	45
Wet Season						
Sanzule Community	65.9	64.5	55	48	55	45
Eikwe Community	62.0	60.8	55	48	55	45

Source: ERM, 2015

Table I2.13 Predicted Sound Pressure Levels at Discrete Receptors during ORF Operation Phase

Receptor	ORF Operation Contribution [dB(A)]	Background Noise Level [dB(A)] (1)		Cumulative Noise Level [dB(A)]		Ghana EPA Noise Limits [dB(A)]		IFC Noise Limit [dB(A)]	
		Day	Night	Day	Night	Day	Night	Day	Night
Dry Season									
Sanzule Community	35.6	55.1	55.2	55.1	55.2	55	48	55	45
Eikwe Community	39.5	60.5	59.5	60.5	59.5	55	48	55	45
Wet Season									
Sanzule Community	35.6	65.9	64.5	65.9	64.5	55	48	55	45
Eikwe Community	39.5	62.0	60.8	62.0	60.8	55	48	55	45

Source: ERM, 2015

ORF operation is planned to be undertaken continuously 24 hours per day, so the noise limits in force to identify impacts at noise sensitive receptors are: 55 dB(A) during day time, both for Ghana EPA standards and WBG guideline value; 45 dB(A) during night time for WBG guideline value; 48 dB(A) night time for Ghana EPA regulation.

Comparing the Project sound pressure levels with the day time noise limit it is observed that:

- The Project contribution respects the WBG and Ghana EPA noise limits both during day time and night time. During day time, noise levels at receptors are about 20 dB(A) below the limit (IFC and Ghana EPA) at Sanzule and about 15 dB(A) below at Eikwe. During night time, predicted noise level at Sanzule is 10 dB(A) below WBG guideline value and 13 dB(A) below Ghana EPA noise limit; at Eikwe, 5 dB(A) below WBG guideline value and 8 dB(A) below Ghana EPA noise limit. Thus, the increase of the noise background generated by the Project during ORF operation, is below the 3 dB(A) incremental criterion set by WBG Guidelines, stating that "the ambient noise level in a residential area to rise by 3 dB(A) or more, determined during the noisiest hour of a 24 hour period".

- Cumulative noise levels, calculated as the logarithmic sum of monitored background noise and Project contribution, are above the noise limits both for day and night time. The exceedance is due to the high levels of the current background noise monitored during the field surveys; the project contribution, in fact, is below the noise limits. Moreover, also in this case, the Project complies with the IFC incremental criterion which requires that there not be an increase above ambient of more than 3 dB(A) generated by project contribution. Considering the high existing background noise levels, the noise produced during ORF operation is unlikely to be perceived by the human settlements in the area.

I.3 ASSESSMENT OF IMPACTS AND CONCLUSIONS

A dedicated noise study was performed to assess the potential noise impacts generated during the construction of the onshore pipeline and ORF, the hydrostatic testing and the ORF operation. The assessment was carried out by means of modelling simulations of the three different Project phases, in order to predict the noise levels in the area surrounding the Concession Area where Project facilities will be installed, at a discrete sensitive receptors, namely Sanzule and Eikwe communities.

The results of the study highlighted the following:

- During construction phase, noise emission levels are in compliance with both IFC and Ghana EPA standards.
- During hydrostatic testing, a fully compliance of Project noise emissions with the IFC and Ghana EPA standards, both for daytime and night time at Sanzule and Eikwe.
- During ORF operation, a fully compliance of Project noise emissions with the IFC and Ghana EPA standards, both for daytime and night time at Sanzule and Eikwe.

The cumulative noise levels, calculated as the logarithmic sum of monitored background noise and Project contribution, instead, shows an exceedance of the noise standards. The non-compliance with the noise limits was exclusively due to the high existing background noise, monitored at Sanzule and Eikwe. The monitored noise levels, in fact, already well exceeded the IFC and Ghana EPA permissible noise levels.

In conclusion the impact on the ambient acoustic conditions due to construction and pre-commissioning will be limited in time and in each specific location along the pipelines and in the ORF work site. Considering the mitigation measures described in Annex G (e.g., regular maintenance of the equipment, construction activities properly planned only during day time, application of speed limit to all vehicles), the impacts magnitude on the ambient acoustic conditions associated with the construction phase is ranked negligible to low

The impact on the ambient acoustic conditions due to the operation of the ORF and pipeline maintenance will occur for the entire Project life. The noise emissions levels generated by the Project operation are all well below the IFC and Ghana EPA noise limits and comply with the IFC 3 dB(A) incremental criterion, and negligible in term of impact magnitude.

Even if negligible magnitude impacts are expected to occur during operation it is recommended to:

- Carry out a pre-construction survey in order to collect more detailed baseline data at the sensitive receptors located near the onshore facilities.
- Perform a new modelling study when detailed design information are available.
- Implement a noise monitoring program during the construction and operation phases
- Define seasonal constrains for construction activities in relation to the local fauna sensitivity (e.g., avoiding reproduction period of turtles, birds migration routes).

The assessment of impacts significance in accordance with the adopted assessment methodology for the ESHIA is reported in Annex G.

I.4 REFERENCES

eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Dry season (ESL Consulting, 2014)

eni Ghana Offshore Cape Three Points Baseline Studies, Sanzule-Bakanta. Air Quality Technical Report – Wet season (ESL Consulting, 2014)

General EHSs Guidelines: Noise (IFC, 2007)

General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels (Ghana EPA)

Guidelines for Community Noise (WHO, 1999)

SoundPLAN International LLC/Braunstein + Berndt GmbH (February 2014). SoundPLAN User's Manual.

ESHIA for GHANA OCTP BLOCK Phase 2

ANNEX J
Visual Impact Assessment

ABSTRACT

Annex J provides an assessment of the noise impacts correlated to the onshore Project activities during construction and operation phases by means of modelling calculation tools.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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ACRONYMS

Acronym	Definition
DEM	Digital Elevation Model
ESHIA	Environmental Social and Health Impact Assessment
IFC	International Finance Corporation
OCTP	Offshore Cape Three Points
ORF	Onshore Receiving Facilities
VSR	Visual Sensitive Receptor
ZVI	Zone of Visual Interference

J.1. Introduction

The development of the hydrocarbon reserves in the Offshore Cape Three Points (OCTP), and particularly the realization of the ORF (Onshore Receiving Facilities), has the potential to adversely impact the landscape of the surroundings. In order to assess the potential impact on landscape and visual amenity, a dedicated visual study has been performed. Details about the Project Design Data, relevant assumptions and project information related to the OCTP project are presented in the Chapter 4 of the ESHIA, related to OCTP Phase 2.

The visual study aimed at analysing Landscape Changes and Visual Impacts due to Construction of the ORF and Associated Facilities. As stated in the ESHIA, given the significant distance (about 50 km) of the offshore installations to the sensitive receptors located on the coast, the visual impacts related to Project offshore facilities (FPSO) has been considered Negligible.

The following Sections present the study methodology and inputs, assumptions and results. In absence of specific guidelines for assessment of impacts in Ghana on visual amenity a standard international approach based on ERM’s experience and internal guidance (in compliance with IFC Standards) has been implemented.

This Annex presents the modelling estimation activities carried out to support of the assessment of visual impacts performed for the Phase 2 ESHIA and presented in Annex G.

J.2. Analysis of the Study Area (ZVI) and Potential Receptors

Analysis of landscape and visual amenity and related impact assessment requires an in depth analysis of the main features characterizing the local environmental and social context within a defined study area. Based on that, a key element to be considered in deploying an assessment of landscape and visual amenity impacts is represented by the identification of the Zone of Visual Interference (ZVI) and the potential areas prone to be affected by the presence of the proposed development (potential visual sensitive receptors, VSRs).

The selected approach (described in the following sections) has been developed according to the following methodological steps:

- Definition of the ZVI: visual impact assessment is informed by an understanding of the existing visual qualities within the region that can be visually affected by a development. For the purpose of the Visual Impact Assessment the Study Area is referred to as Zone of Visual Interference "ZVI", as described below;
- Viewshed analysis and calculation of the potential range of visibility;
- Identification of Potential Visual Sensitive Receptors located within the ZVI.

This approach is based on a desktop research, GIS viewshed analysis and reconnaissance surveys using survey maps, topographical data and aerial photographs. This information was used to identify and understand the topographical features and landscape patterns as well as the view catchment area (i.e. places from where the development might be seen).

J.2.1. IDENTIFYING THE EXTENT OF VISIBILITY

Defining an appropriate ZVI is the starting point to understand the visual impacts of a development as this area will vary depending on the nature and scale of the proposed development. The larger and/or higher a development the greater the ZVI as it may be visually apparent for a greater distance. Once the ZVI is established, locations can be identified that are either particularly sensitive or indicative of the visual impact.

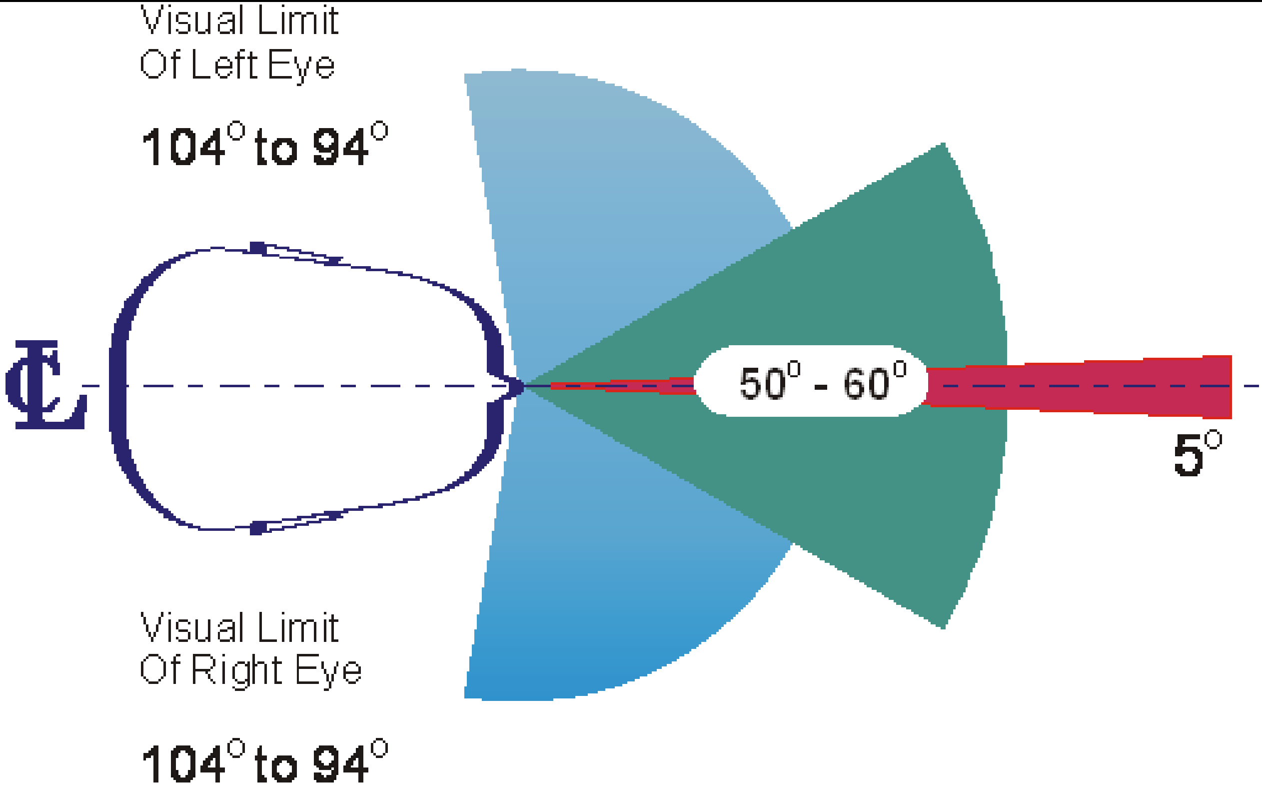
The ZVI is therefore the area that is most likely to be visually impacted.

The visual impact of a development can be quantified by reference to the degree of influence on a person's field of vision. So in order to draw the potential viewshed, the analysis has been based on the concept of "*Horizontal Field of View*" and "*Vertical Field of View*", representing typical parameters of human vision based on anthropometric data (*Human Dimensions & Interior Space – A Source Book of Design reference Standards, Julius Panero and Martin Zelnik, The Architectural Press Ltd. London, 1979*).

J.2.1.1. Horizontal Field of View

For most people, the horizontal central field of vision covers an angle of between 50° to 60° (Figure J1). Within this angle, both eyes observe an object simultaneously but from a slightly different angle. This creates a central field of greater magnitude than that possible by each eye separately. This central horizontal field of vision is termed the 'binocular field' (see green zone). Within this field images are sharp, depth perception occurs and colour discrimination is possible. Research suggests that the visual impact of a Project component will vary according to the proportion the binocular field it occupies. Project components which occupy 5% or 2.5° or less of the horizontal central binocular field of vision are usually perceived as insignificant objects, whereas components which occupy 30° are considered to be visually dominating.

Figure J1 Horizontal Field of View

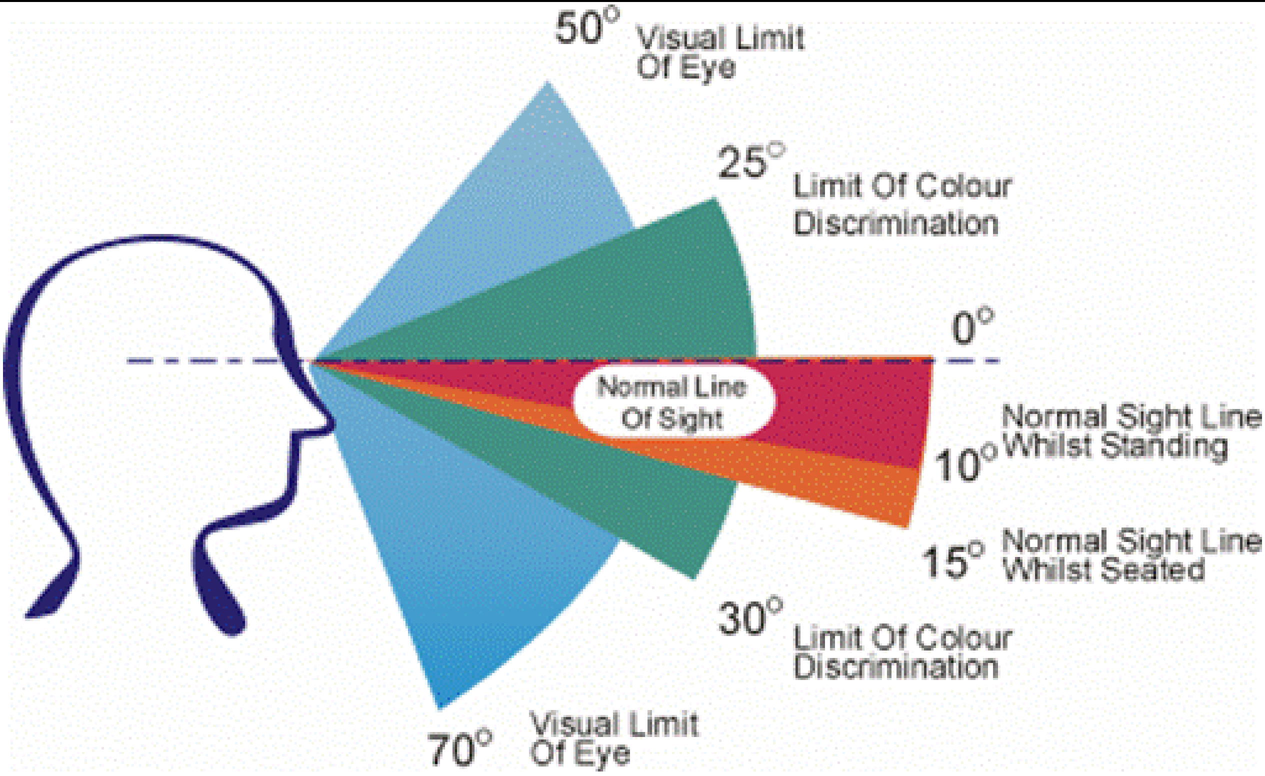


Based on the above description and considering the foreseen width, calculations suggest that the distance at which the stack and the buildings will have an insignificant impact will be 3.2 kilometers far from the site.

J.2.1.2. Vertical Field of View

A similar analysis can be undertaken based upon the vertical field of view for human vision. As can be seen in Figure J2, the typical line of sight is considered horizontal or 0°. A person's natural or normal line of sight is normally a 10° cone of view below the horizontal, and if sitting, approximately 15°. Objects which take up 5% of this cone of view (5% of 10° = 0.5°) would only take up a small proportion of the vertical field of view, and are only visible when one focuses on them directly. Objects that take up such a small proportion of the vertical view cone are not dominant, nor do they create a significant change to the existing environment when such short objects are placed within a disturbed or man-modified landscape.

Figure J2 Vertical Field of View



The proposed ORF facilities within the Project (Figure J3) will include a 75 m stack, 5 m tanks and 5 to 17 m main buildings will be constructed in the north east of the concession area (Figure J4) Details about the Project Design Data, relevant assumptions and project information related to the OCTP project are presented in the Chapter 4 of the ESHIA, related to OCTP Phase 2.

Based on the extent of visibility analysis and considering the foreseen heights, calculations suggest that the distance at which the stack will have an insignificant impact will be about 8.6 km while for buildings and tanks the distance will be about 1.1 km.

Figure J3 ORF Location

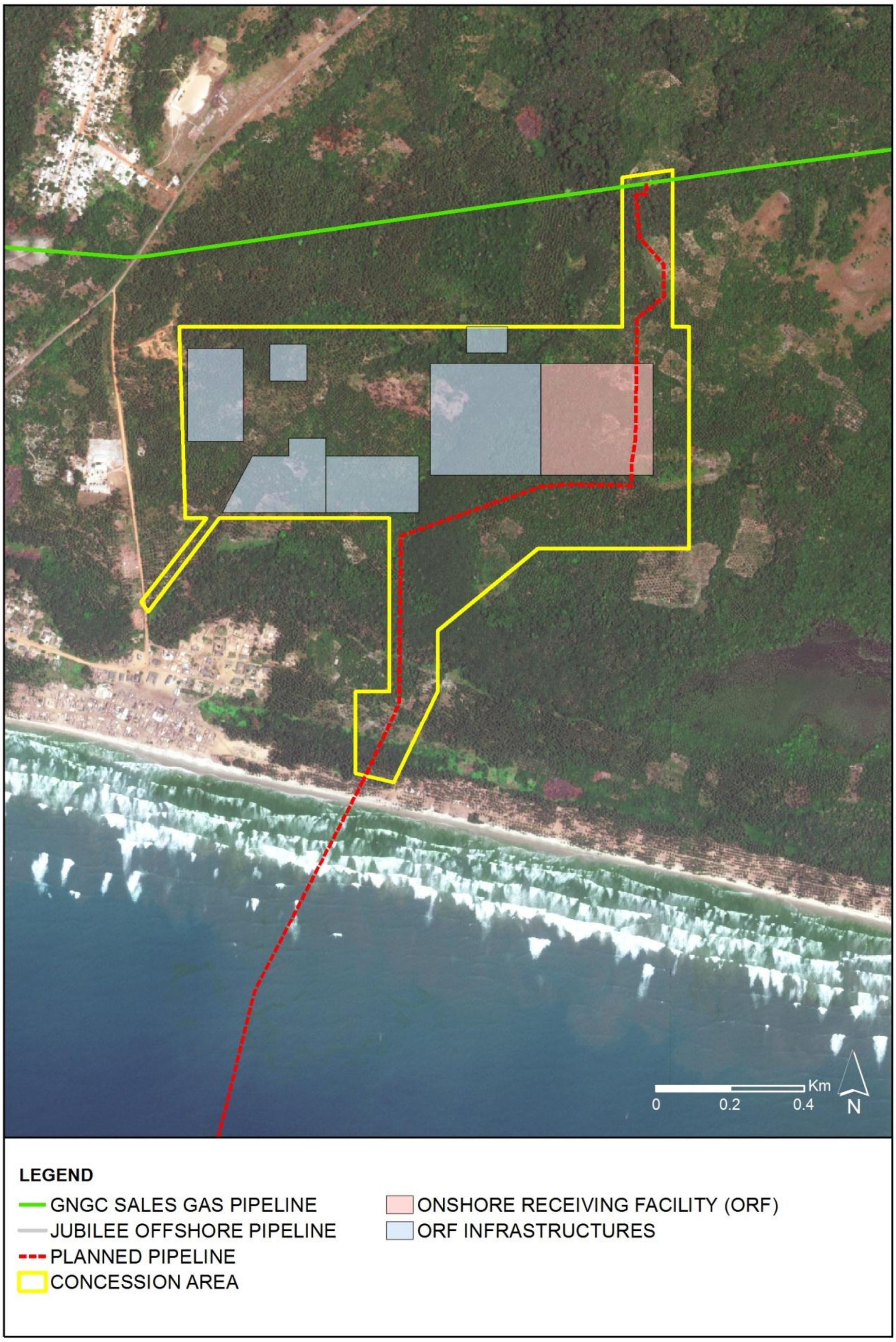
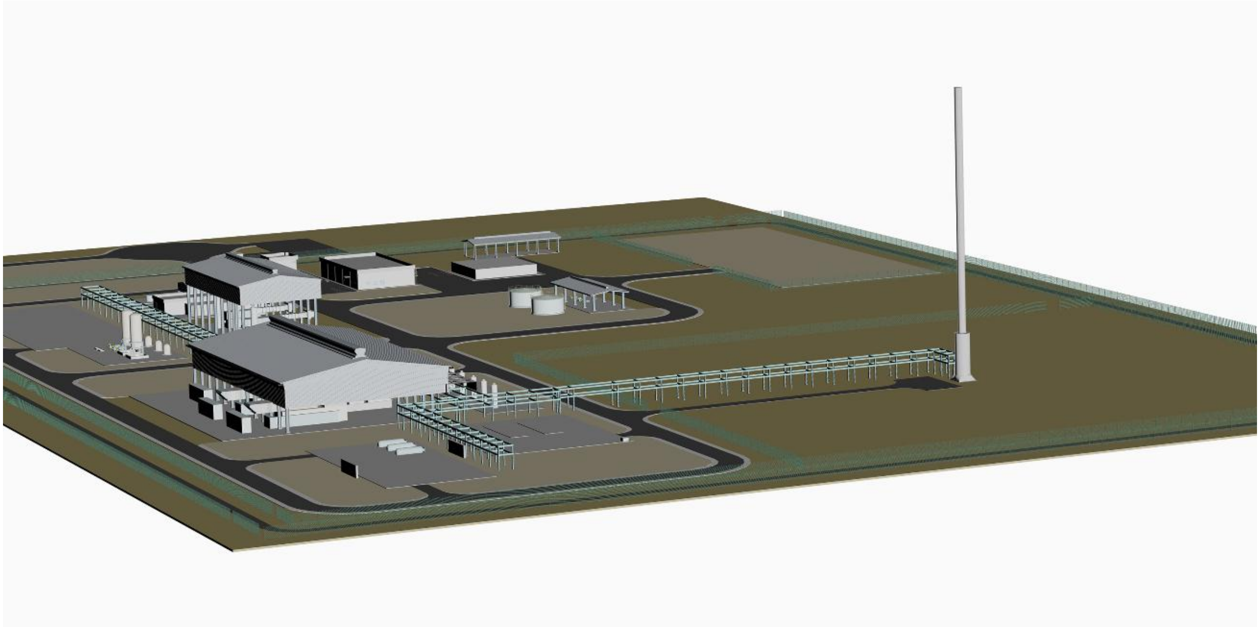


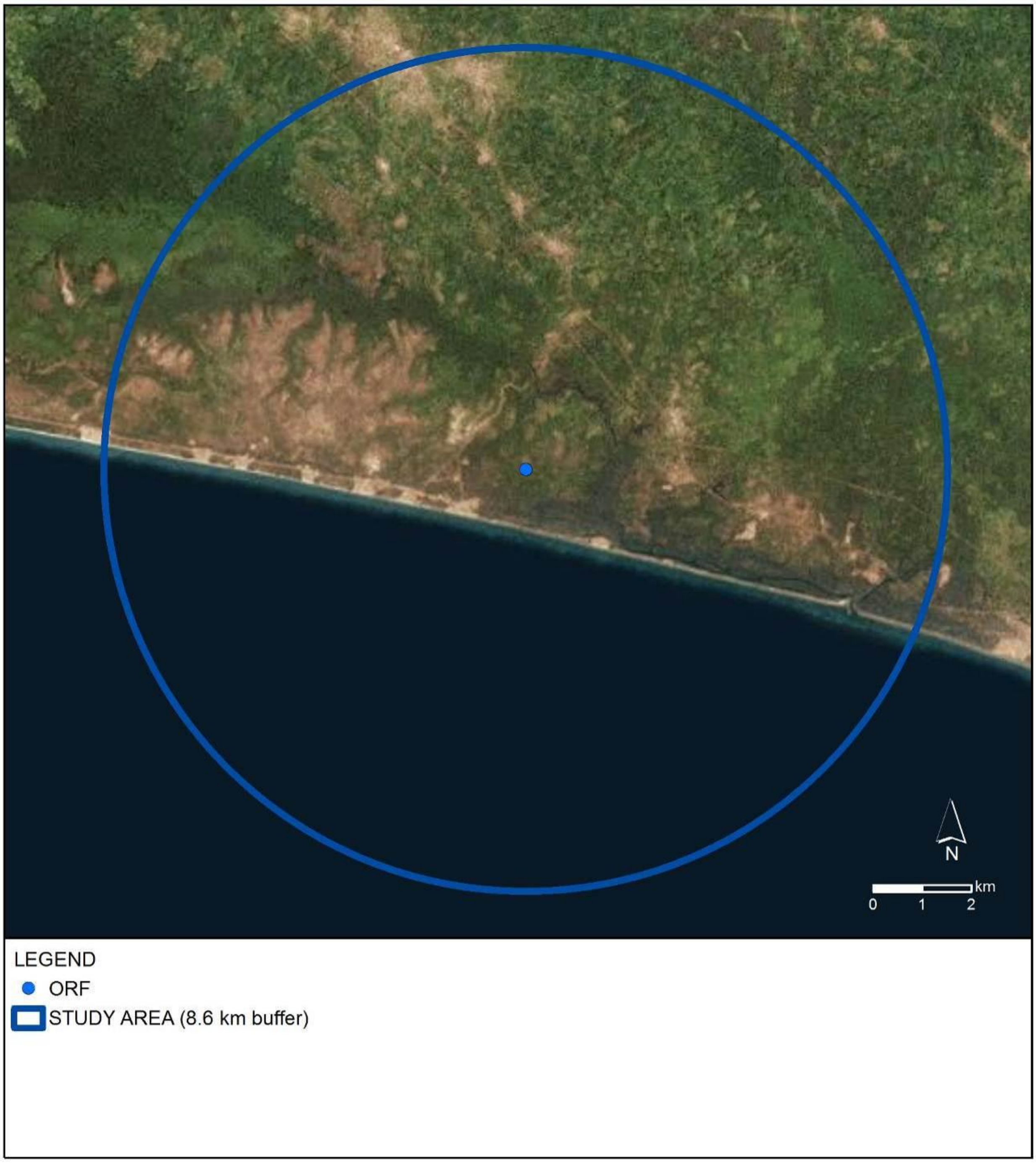
Figure J4 ORF 3D Model - South East View



J.2.1.3. Final ZVI Identification

Generally, the more conservative, or worst-case distances form the basis for the assessment of visual impacts. Therefore for this development the greater impacts would be associated with the vertical field of view. Based on this, it would be reasonable using the vertical field of view and extend the viewshed to 8.6 km (Figure J5).

Figure J5 Study Area



J.2.2. LANDSCAPE SENSITIVITY

As better described in Chapter 6 of the ESHIA, the onshore Project area is a flat area of low altitude (0-10 m) with very few headlands or rocky outcrops. as reported in the ESHIA baseline chapter the concession area is mainly characterized by modified habitats with a large proportion of the area covered by degraded coconut palm plantations, degraded vegetation and wet evergreen forest with palms. The coastal areas are dominated by regenerating vegetation comprising of palm trees and thorny shrubs.

The ground elevation increases from the sea for several meters within the beach up to around 4 m high when it decreases again below 2 m high resulting on the generation of flat and low-lying area that occupies the central section of the ORF site. The higher grounds are located at the north-western most corner of the ORF site with 8.9 m elevation, while the site generally varies between 3.9 and 4.6 m. The current land use and activities on the Study Area are farming and aquaculture. The ORF will be constructed in the north east of the concession area which is at elevated portion of the site. Therefore, the levelling of the site will not require major excavation (in terms of levelling). The base camp and helipad are located on the slightly more elevated section of the concession area and therefore require increased levelling (although to the general low lying nature of the site this will not require major excavation. The construction of the ORF and associated infrastructure will alter the landscape permanently.

Figure J6 Height of ORF

J.2.3. VIEWSHED ANALYSIS

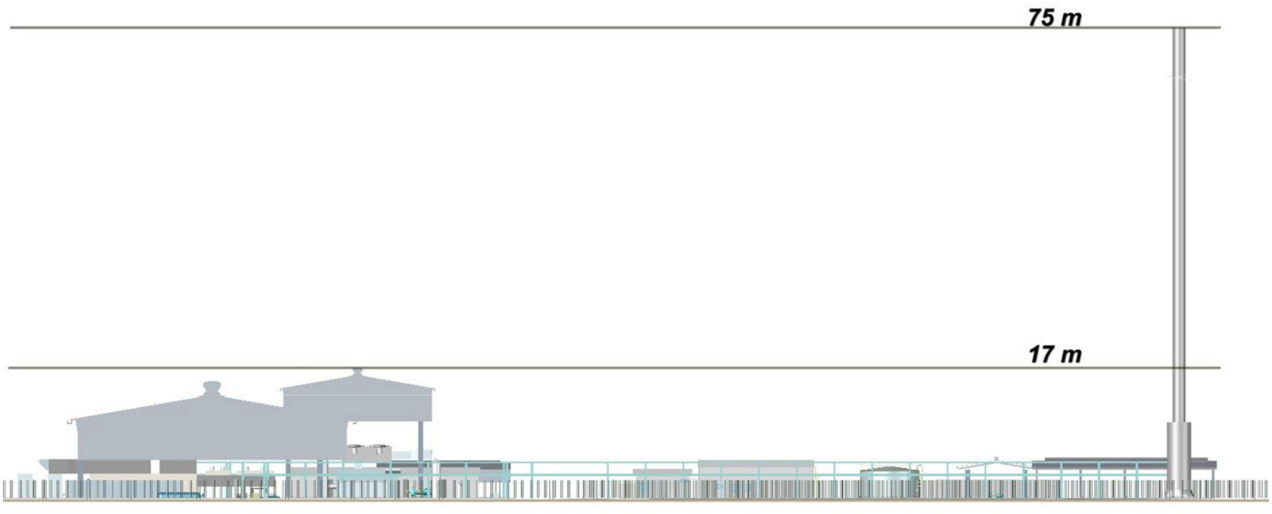
Due to the gently rolling landform, with different flat areas in the immediate area around the site and the proposed height and scale of project components (particularly the stack, main plant buildings and tanks), the ORF is likely to be visible from the nearby rural settlements located along the sea. As per the landscape baseline assessment previously described, the presence of vegetation patches along the coast has a relevant role in determining the potential visual influence of the ORF.

The viewshed analysis has been performed by using ESRI ArcGIS 10.2. Such analysis has been based on topography and vegetation, and defines those areas where the ORF would be visible. In order to perform the analysis, a key feature is represented by the Digital Elevation Model (DEM). For this specific assessment, ASTER Global Digital Elevation Model 30 m Version October 2011 has been used as a reference layer. Based on a preliminary assessment of the quality of the input data, it should be noted that the elevation raw data take into account not only the ground elevation, but also the presence of vegetated areas where the patches are thick like along the coast as well as small variations in topography.

In order to characterize the visual interference of the proposed development, a cumulative approach has been proposed by performing a viewshed analysis considering different heights as follows (Figure J7):

- Range 1 : main buildings from 0 to 17 m
- Range 2 : only the stack section from 17 to 75 m

Figure J7 Height of ORF



The result of the viewshed analysis is presented in Figure J8 and Figure J9 revealing that the most sensitive areas are located nearby the ORF and about 1.4 km far from the sea. It is also evident that the presence of dense and high vegetation characterizing the coastline is acting as a natural barrier that reduces the visibility of the proposed development. Indeed, based on the outcomes of the field surveys performed in March 2015, as presented in the following figures there are relevant section along the coastline where the vegetation is dense. However, moving east and west along the coasts there are also areas where the vegetation is sparser allowing for an increasing of the visibility (Figure J10 and Figure J11).

Regarding the areas located in the inland, it should be noted that the potentially affected areas are composed by gentle rolling conditions characterizing the local topography and the presence of patches of degraded coconut palm plantations and generally speaking by degraded vegetation.

In case of ships/boats in transit near the coast, the visual interference related to the onshore facilities is based on the ship's distance and its relative position with respect to the coast, as showed in Figure J8 and Figure J9. The analysis carried out, that is more focused on the visibility from onshore receptors is not fully considering the limitation of visibility determined by the presence of physical obstacles (such as trees).

Figure J8 Zones of Visual Interference (ZVI) Main buildings

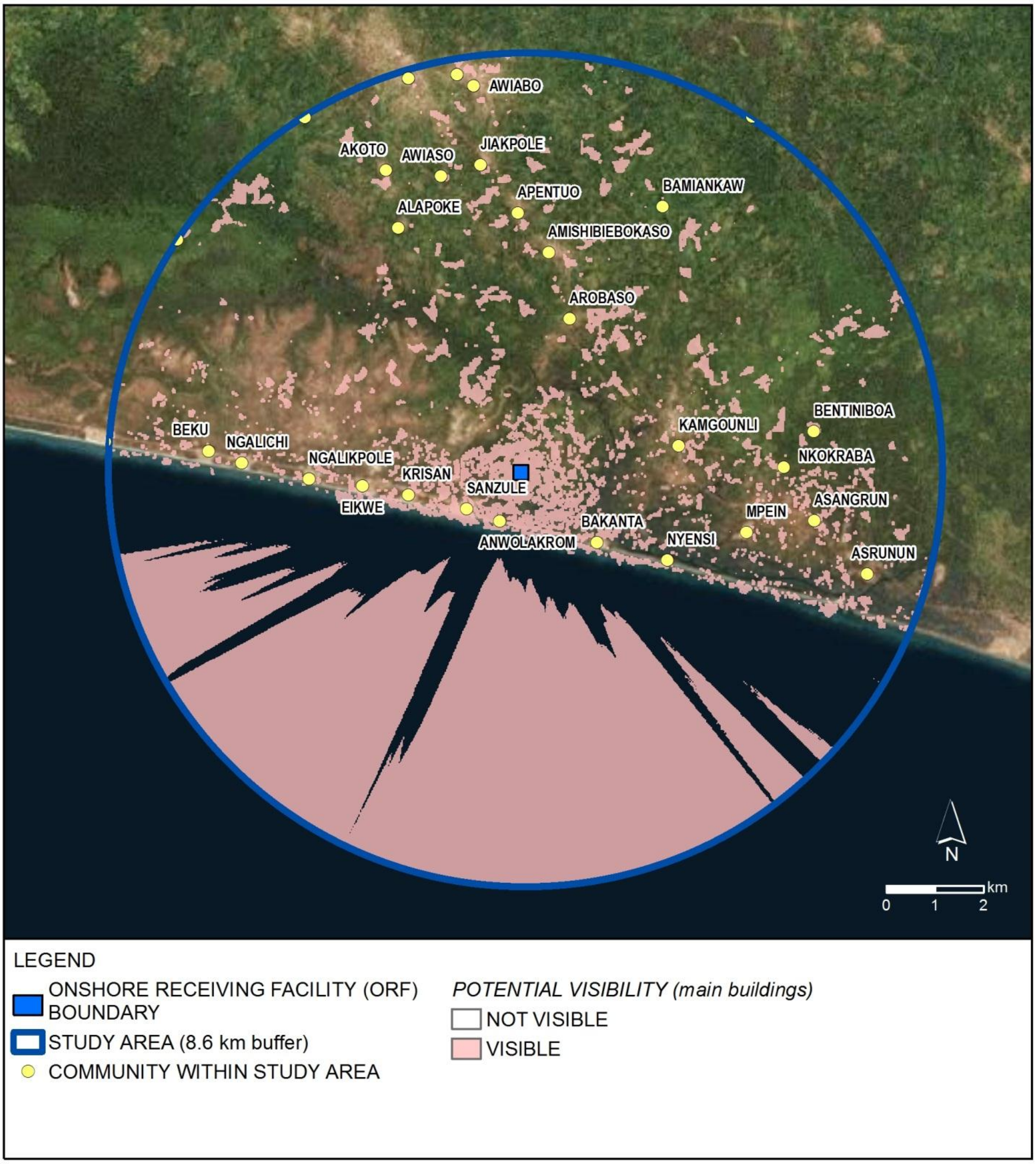


Figure J9 Zones of Visual Interference (ZVI) Stack

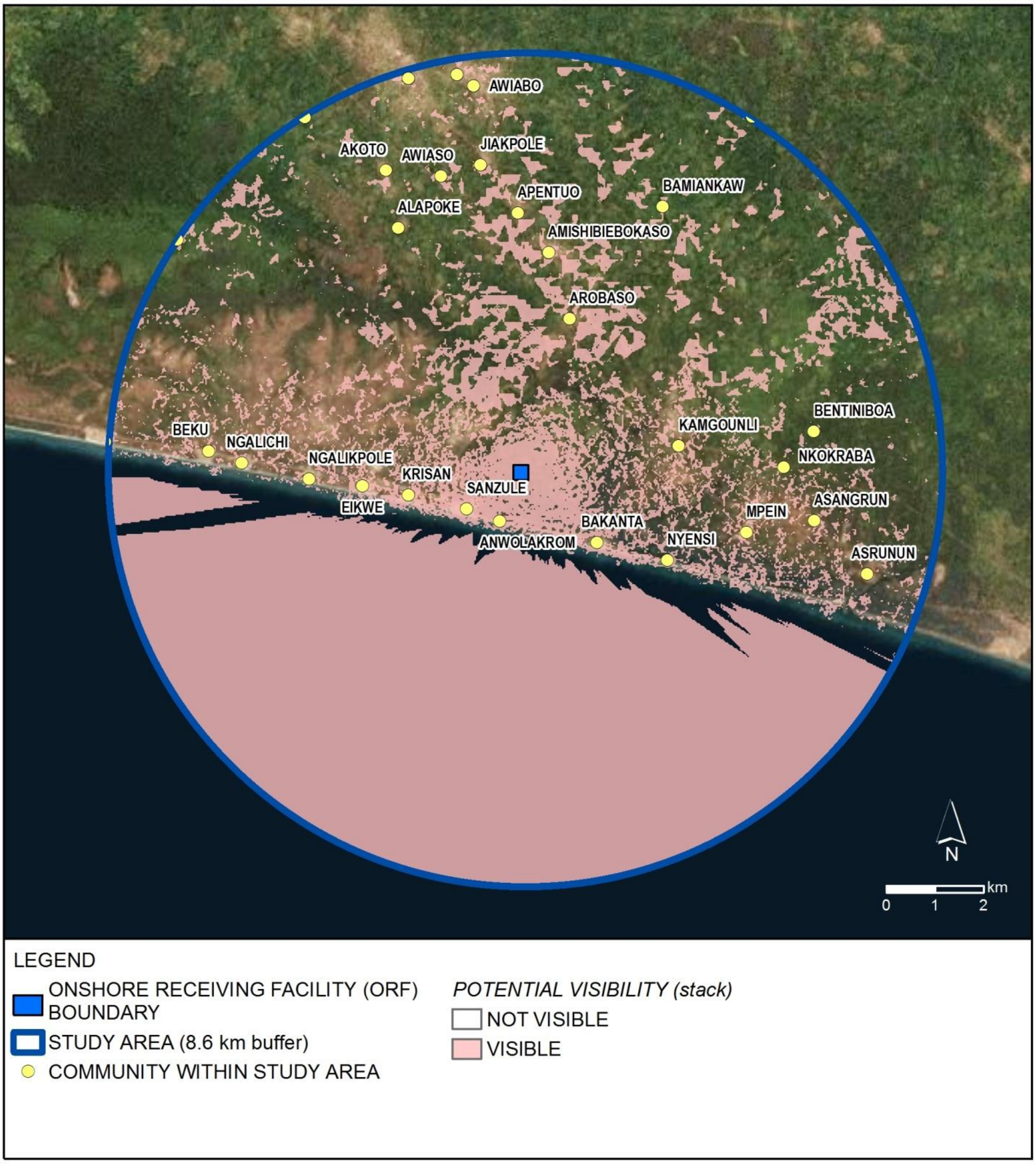


Figure J10 Dense vegetation acting as a natural barrier along the coast

Figure J11 Sparse vegetation along the coast

Based on the interpretation of available satellite images (Microsoft Bing Maps embedded into ESRI ArcGIS), available secondary data and outcomes from the field survey, a significant number of potential VSRs have been mapped Table J1,Figure J8 and Figure J9 show the locations of theVSRs (corresponding to ocal communities within the study area) where the perception of the local population can be affected by the presence of the Project.

Table J1 Communities within the Study Area

Community	Distance from project
Aiyinasi	8.2 km
Akoto	6.6 km
Alapoke	5.4 km
Amishibiebokaso	4.4 km
Anwolakrom	1.0 km
Apentuo	5.2 km
Arobaso	3.0 km
Asangrun	5.9 km
Asrunun	7.2 km
Auraso	8.6 km
Awiabo	7.9 km
Awiaso	6.1 km
Bakanta	1.9 km

Community	Distance from project
Bamiankaw	6.0 km
Basaka	8.2 km
Beku	6.3 km
Bentiniboa	5.9 km
Eikwe	3.3 km
Jiakpole	6.2 km
Kabensiri	8.6 km
Kamgounli	2.8 km
Krisan	2.1 km
Mambuen	8.6 km
Mpein	4.6 km
Ngalichi	5.6 km
Ngalikpole	4.2 km
Nkokraba	5.2 km
Nyensi	3.4 km
Sanzule	1.1 km

The closer VSR are Sanzule and Anwolakrom Communities and as evident in Figure J12, Figure J13 and Figure J14 the surroundings of the communities are characterized by the presence of high dense vegetation and sparse vegetated patches acting as a natural visual mitigation barrier. Generally speaking, also the other settlements located within the ZVI are characterize the presence of the same patches of vegetation like for example Bakanta Community (Figure J13) and Krisan Community (Figure J15).

Figure J12 Sanzule community aerial photo

Figure J13 Anwolakrom community aerial photo

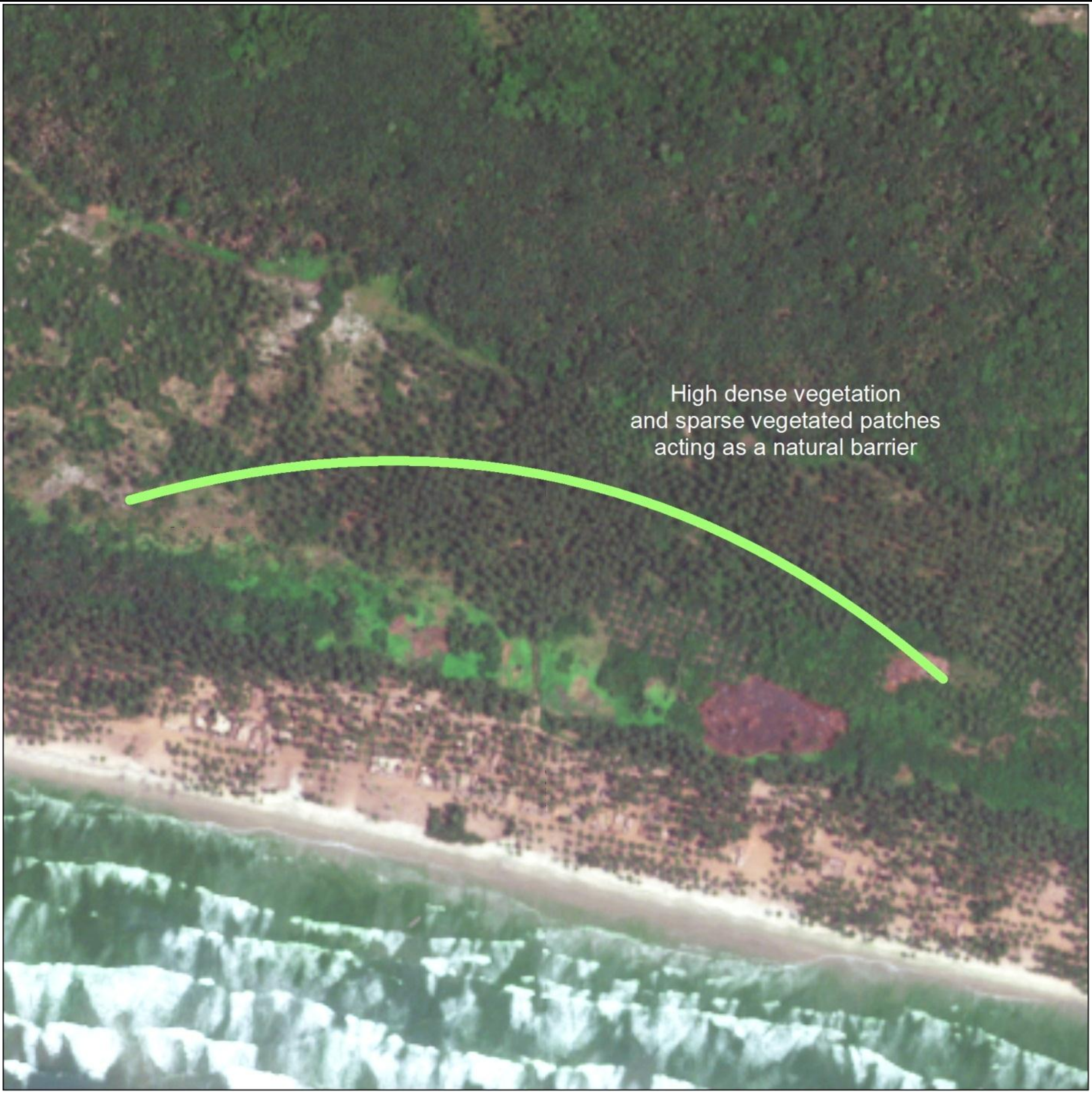


Figure J14 Bakanta community aerial photo

Figure J15 Krisan community aerial photo

Based on the outcomes of the previous analysis, it is reasonable to assume that the main buildings will not be perceived from the local communities. The stack will be visible from the communities, along the coastline and from the sea.

It is reasonable to assume that the onshore facilities will become visible by offshore receptors (e.g., ships in transit along the coastline) at a distance of approximately 1.0 km from the coast. Up to about 1.0 km from the coast, only the highest structures (e.g., stack) will be visible.

The analysis carried out is not fully considering the limitation of visibility determined by the physical characteristic of obstacles (such as trees) that form a natural barrier..

J.3. Visual Impact Assessment

J.3.1. METHODOLOGY

Impacts on the perception and fruition of the landscape occurs when new elements are introduced into an environment or existing elements are altered or removed leading to a change in the way stakeholders access, perceive or experience landscape resources. In each case the impact may be perceived as either adverse or beneficial, depending on the nature and degree of change and the attitudes of people to the existing and new landscape.

It is acknowledged that the implementation of the ORF will introduce some degree of changes into the existing landscape and views.

The two main sources of visual impacts are the height and bulk of the proposed structures. Key potential impacts which arise from the proposed development are summarized as follow:

- long term visual impacts will result at the main Project site due to new buildings, in particular the installation of stack which is approximately 75 m in height and will be visible over the site boundary; and
- the installation of buildings, tanks as well as the gas compression and main power generator (approximately 6 -17 m high).

The present section has been developed according to best practices and also incorporates the assessment methodology as described in the Guidelines for Landscape and Visual Impact Assessment (*Guidelines for Landscape and Visual Impact Assessment:2nd Edition; The Landscape Institute and Institute of Environmental Management and Assessment; 2002*) produced jointly by the British Landscape Institute and the British Institute of Environmental Management and Assessment (IEMA). This methodology is applicable both to the assessment of short term impacts during the construction of the Project, and to long term impacts during its operation.

Landscape character and resources should be considered to be of importance in their own right, and as an aspect of ecosystem services, and valued for their intrinsic qualities regardless of whether they are seen by people. Impacts on visual amenity as perceived by people are therefore clearly distinguished from, although closely linked to, impacts on landscape character and resources.

J.2.1.4. Significance Criteria

The significance of visual impact is based and evaluated on two main factors, sensitivity of the landscape or viewer to change, and magnitude of change.

<u>Sensitivity of the landscape or viewer to change</u>

The sensitivity of viewers depends upon the duration of their exposure to perceptible views of the site, the frequency of opportunities for them to visually perceive the site. Hence, a resident with a permanent view is considered to be of higher sensitivity than a worker or traveler with a transient viewing opportunity. The sensitivity of the receptor is described as low, moderate or high.

Magnitude of change

The magnitude of change in view depends on a number of factors:

- the mass and scale of the new or altered elements in the view;
- the likelihood that the new elements will be screened by intervening features such as vegetation, hills, buildings;
- the perception of change, that is, how far away they are from the project, if the project can be seen in the foreground, middle ground and background, or seen above or below a person's normal line of sight (factors affecting human perception and visibility are outlined in box on the next page);
- compatibility of the project components with the existing landscape character, taking into account whether the landscape is natural, modified or built, the characteristics of the landscape and the importance of each to its value, how well the project components fit with these characteristics with regard to size, form, colour, material; and
- the capacity or ability of the foreground, middle ground and background of the landscape to accommodate the change.

The magnitude of impact is described as being imperceptible, small, medium or large.

J.2.1.5. Evaluation of Impact Significance

Impact significance is determined by cross-referencing the sensitivity of the landscape or viewer, with the magnitude of change expected as a consequence of the development. Thus an impact of major significance will usually occur where the sensitivity of the landscape or viewer is high and the magnitude of the impact is large. The assessment of impact significance also requires the application of professional judgement and experience as significance can be subjective. Each example is therefore assessed on a case-by case-basis.

The following definitions, as described Table J2 and are used in this assessment.

Table J2 Levels of Significance of Visual Impacts

	Magnitude of Change in View caused by Proposed Development			
	Imperceptible	**Small**	**Medium**	**Large**
	Change which is barely visible, at very long distances, or visible for a very short duration, perhaps at an oblique angle, or which blends with the existing view.	Minor changes in views, at long distances, or visible for a short duration, perhaps at an oblique angle, or which blends to an extent with the existing view.	Clearly perceptible changes in views at intermediate distances, resulting in either a distinct new element in a significant part of the view, or a more wide- ranging, less concentrated change across a wider area.	Major changes in view at close distances, affecting a substantial part of the view, continuously visible for a long duration, or obstructing a substantial part or important elements of view.

Sensitivity of Landscape		Imperceptible	Small	Medium	Large
		Magnitude of Change in View caused by Proposed Development			
Low	Small numbers of visitors with interest in their surroundings. Viewers with a passing interest not specifically focused on the landscape e.g. workers, commuters. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being low	Not Significant	Not Significant	Minor	Minor to moderate
Medium	Small numbers of residents and moderate numbers of visitors with a interest in their environment. Larger numbers of recreational road users. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being medium	Not Significant	Minor	Moderate	Moderate to major
High	Larger numbers of viewers and/or those with proprietary interest and prolonged viewing opportunities such as residents and users of attractive and well-used recreational facilities. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being high	Not Significant	Minor to moderate	Moderate to major	Major

J.3.2. CONSTRUCTION PHASE

During onshore construction activities, the presence of machinery, construction vehicles, temporary facilities and the removal of vegetation will generate a temporary and permanent visual impact. Regarding the construction phase of the ORF, the following sources of impact have been identified:

- Clearing and levelling of the ORF site (3 m above surrounding area),
- Presence of construction/work sites, machinery, vehicles and storage of materials,
- Subsoil excavation and vegetation removal,
- Lighting of the working sites.

The construction of the ORF and associated infrastructure within the concession area will result in a permanent impact on the landscape and visual amenity regarding loss vegetation. This impact affects also the characteristic of the concession area permanently and changes the sense of place as currently the area is rural in nature and with no industrial facilities. It has to be considered that the Project will implement mitigation measures during construction such as:

- Worksite facilities will be constructed a at minimal height
- Worksites will only be temporary as machinery and construction equipment will be dismantled and removed.
- Soil stockpiles will be re-vegetated with indigenous species as soon after construction

It has to be considered that the Project will implement mitigation measure during construction phase to reduce the light impact, such as:

- Use of directed downward lighting which will be sufficient to enhance the night time visibility required for safety and security but minimise impacts;
- Use of specifically designed lighting equipment that minimises the upward spread of light near to and above the horizontal.

Table J3 assesses visual impacts derived from the ORF construction at selected locations within the ZVI.

Table J3 Construction Phase - Visual Impacts at selected VSRs

VSR	Viewpoint Sensitivity	Magnitude of Change	Significance of Impact.
Aiyinasi	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Akoto	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Alapoke	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Amishibiebokaso	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Anwolakrom	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Apentuo	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Arobaso	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Asangrun	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**

VSR	Viewpoint Sensitivity	Magnitude of Change	Significance of Impact.
Asrunun	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Auraso	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Awiabo	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Awiaso			
Bakanta	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Bamiankaw	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Basaka	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Beku	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Bentiniboa	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Eikwe	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Jiakpole	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Kabensiri	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Kamgounli	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Small* given the distance	**Minor**
Krisan	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Mambuen	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Mpein	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Ngalichi	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Ngalikpole	The sensitivityis considered to be *Medium* given the distance	The magnitude of change is considered to be *Small* given the distance	**Minor**

VSR	Viewpoint Sensitivity	Magnitude of Change	Significance of Impact.
Nkokraba	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Nyensi	The sensitivity is considered to be *Small* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Sanzule	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**

J.3.3. Operational and Maintenance Phase

Regarding the operational phase of the Project, the following sources of impact have been identified:

- Permanent presence of the ORF and related facilities (i.e. helipad and base camp),
- All facilities will include security lighting at night with possible light spill to the surroundings. The ORF will operate 24hrs a day, and will be lit during the night time.

The presence of the ORF will constitute a visual obstruction only at specific viewpoints and is largely expected to be concealed by vegetation including tall trees and surrounding palm plantations as previously described. However, mitigation measures are expected to be considered by the Project as vegetation restoration and the use of specifically designed lighting equipment.

It has to be considered that some appropriate measures will be applied to reduce the light impact during the operational and maintenance phase, as follow:

- use a lower level of lighting; it will be sufficient to enhance the night time visibility required for safety and security; and
- use specifically designed lighting equipment that minimises the upward spread of light near to and above the horizontal.

Table J4 assesses visual impacts of the ORF at selected locations within the ZVI.

Table J4 Operational and Maintenance Phase - Visual Impacts at selected VSRs

VSR	Project Visibility	Viewpoint Sensitivity	Magnitude of Change	Significance of Impact.
Aiyinasi	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Akoto	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Alapoke	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**

VSR	Project Visibility	Viewpoint Sensitivity	Magnitude of Change	Significance of Impact.
Amishibiebokaso	Stock is visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Anwolakrom	Stack and main building are visible	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Apentuo	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Arobaso	Stack is visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Asangrun	Stock is visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Asrunun	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Auraso	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Awiabo	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Awiaso	Stock is visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Bakanta	Main building and stack are visible	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Bamiankaw	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Basaka	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Beku	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Bentiniboa	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Eikwe	Main building and stack are visible	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Jiakpole	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**

VSR	Project Visibility	Viewpoint Sensitivity	Magnitude of Change	Significance of Impact.
Kabensiri	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Kamgounli	Stack is visible	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Small* given the distance	**Minor**
Krisan	Stack is visible	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**
Mambuen	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Mpein	Not visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Ngalichi	Stack is visible	The sensitivity is considered to be *Low* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Ngalikpole	Stack is visible	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Small* given the distance	**Minor**
Nkokraba	Not visible	The sensitivity is considered to be *Small* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Nyensi	Stack is visible	The sensitivity is considered to be *Small* given the distance	The magnitude of change is considered to be *Small* given the distance	**Not Significant**
Sanzule	Stack and main building are visible	The sensitivity is considered to be *Medium* given the distance	The magnitude of change is considered to be *Medium* given the distance	**Moderate**

J.4. Conclusions

A viewshed analysis was performed to assess the potential visual impact generated during construction an operational phase of the ORF.

The result of the study highlighted that main buildings and stack will be visible by the closest communities and the impact will be not significant for the other communities.

Considering the expected mitigation measures and the evaluation presented in the previous sections, the potential impacts significant on visual amenity, based on modeling results, will be expected to be minor to moderate.

J.5. References

IEMA, Guidelines for Landscape and Visual Impact Assessment:2nd Edition; The Landscape Institute and Institute of Environmental Management and Assessment; 2002

IFC - International Finance Corporation, Environmental, Health, and Safety General Guidelines, 2007

ESHIA for GHANA OCTP BLOCK Phase 2

ANNEX K

Drill Cuttings Modeling Report

ABSTRACT

This Annex provides an overview of the modeling performed to assess potential environmental impacts that may occur as a result of the release of drill cuttings and muds.

July 2015	06	Final version	ERM	HSE & CI Manager Juan Deffis HSE Project Manager Giuseppe Nicotra	Development Project Manager Ezio Miguel Lago
Date	**Revision**	**Revision Description**	**Prepared**	**Checked**	**Approved**

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ACRONYMS

Acronym	Definition
bfroc	base fluid retention on cuttings
GEBCO	General Bathymetric Chart of the Oceans
GEMSS	Generalized Environmental Modelling System for Surfacewaters
GIFT	Generalized Integrated Fate and Transport
HYCOM	HYbrid Coordinate Ocean Model
HV	High Viscosity
ESHIA	Environmental and social impact assessment
msl	mean sea level
NABF	Non Aqueous Base Fluids

K. DRILL CUTTING MODELING

K.1 Introduction and Approach

Modelling was performed to assess potential environmental impacts that may occur as a result of the release of drill cuttings and muds.

All the project description data necessary to run the model and the discharge scenarios originate from and are described in detail in Sections 4.6.1 Wells Drilling and Completion and 4.9.9 Waste Handling and Disposal of this ESHIA, which in turn originate from the current project design.

Following the above mentioned origin of data, it was assumed that there will be a direct discharge of cuttings during drilling of the riserless open hole section followed by discharge of cuttings with adhered Non Aqueous Base Fluids (NABF) below the water surface after treatment of the cuttings on the drillship.

For the impact assessment, the modelling was performed to determine three key endpoints:

- The amount of suspended sediment concentrations added to the water column background concentrations;
- The seabed accumulation (thickness) of the adhered muds and drill cuttings over an area of seafloor (the footprint) for the assessment of impacts to benthic organisms; and
- The amount of hydrocarbons settled upon the seafloor.

K.1.1 Simulation Design

The potential dispersion and deposition of released drill cuttings has been quantified using hydrodynamic computer modelling techniques. Released material will pass vertically through the water column, because cuttings and muds are denser than the receiving water. Cuttings and muds dispersion is fundamentally a three-dimensional (3-D) phenomenon.

The model simulated drill cuttings discharges based on the origin of drill cuttings, as follow:

- Scenario 1 - riserless sections cuttings, which are directly discharged to the sea from the seabed; as they are drilled riserless (without a riser) they obviously discharged directly to the seabed and thus cannot be taken onshore to treat. This is common to all offshore drilling operations, and that is why they are drilled with sea water and High Viscosity (HV) pills/sweeps, a type of WBDF (Water Based Drilling Fluid) made mostly of inert materials of extremely low toxicity

- Scenario 2 – drill cuttings from the riser sections drilled with NADF discharged from the drilling unit after treatment, below the sea surface.

In both Scenario 1 and Scenario 2, the subsea wellbore selected for the modelling was the SANK-D well , which will be located at a water depth of approximately 1,100 meters. The top hole will be drilled with seawater and HV Pills to a depth of 70 to 90 m below the mud line (BML). It is assumed that the HV Pills will be a gel or polymer which will not contribute significantly to the depositions upon the seafloor due to the low density. The subsequent section, with a 26" in hole, will be extended approximately 500 meters below the top hole and will be drilled riserless with sea water and HV pills. Scenario 1 ends after the cuttings from these top two sections settle to the sea floor. Scenario 2 continues, including simulations of the releases from the remaining well sections (with hole diameters sizes 17.5" and 12.25"), to be drilled with NADF. The discharge pipe from the drillship will release treated cuttings at 50[1] m below mean sea level (MSL) in this scenario. In both scenarios, the model is designed to run for three days following the final release as described above.

The coordinates for the SANK-D well offshore of Ghana are 546,627.5 E, 493,271.72 N UTM Zone 30N in meters.

The final design may vary slightly from the scenario described in this report. Table K.1 provides a summary of the proposed well profile.

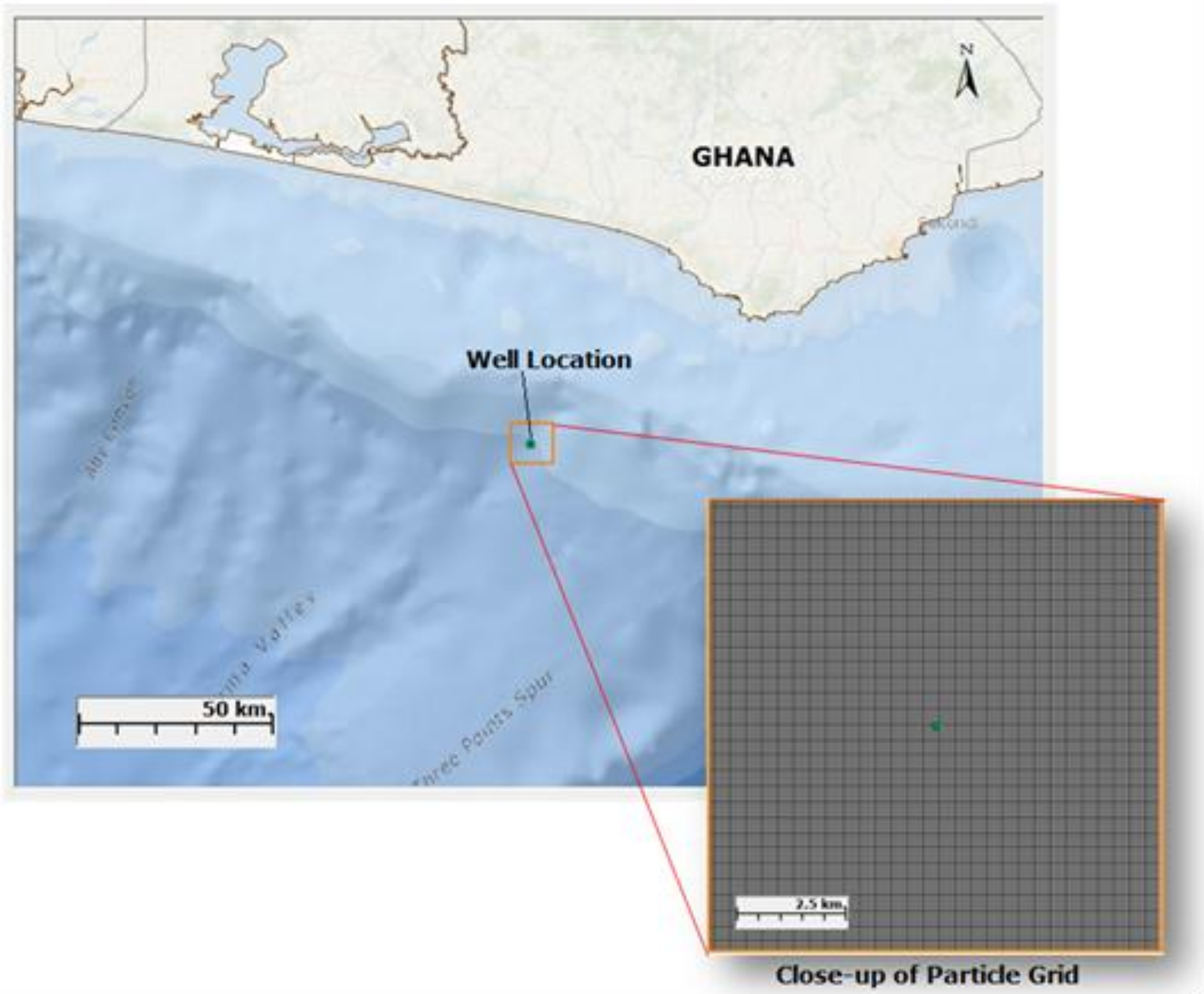
The model was run using three grids: a particle grid, a depositional grid, and a concentration grid. The movement of the discharged cuttings and muds using Lagrangian particles was computed within the particle grid (Figure K.1). This grid is square 20 km on each side, with each cell approximately 100 m by 100 m in length and width. Each grid cell contains an interpolated depth value derived from the bathymetry data from the General Bathymetric Chart of the Oceans (GEBCO) described in Section 1.3.1. Particles are free to move horizontally and vertically within this grid's domain, independently of the grid except for movement past the grid boundaries on the seafloor (as defined by the bathymetry) and shorelines. For computations of the mass deposition on the seafloor, the model used a smaller and finer square two-dimensional (2-D) deposition grid, also centered on the well. The deposition grid is 9.9 km in length with 198 cells on each side, each cell 50 m in length and width (Figure K.1). The deposition grid dimensions were applied to estimate the concentrations of suspended solids in the vicinity of the discharge. Vertically, the cells are 10 m in height at the surface and subsurface regions where the maximum suspended solids are predicted in the vicinities of the discharge locations. The cell heights expand in size towards the middle of the water column region.

Table K.1 Well profile

Section Diameter (inches)	Well Interval (m)	Drilling Fluid	Drill cutting volume (m3)
Top hole, jet	70 - 90	Sea water-HV pills	80
Top hole, drill, 26	500	Sea water-HV pills	320
17 1/2	1,700	NADF	200
12 1/4	1,100	NADF	200

[1]The model was run with a depth of discharge of 12 meters b.s.l. According to updated data the discharge outlet will be 50 meters b.s.l.. However, given the depth of water below the discharge (more than 1000 m), the model results are expected to be the same for the purposes of the assessment.

Figure K.1 Particle grid



Source: ERM data 2015

K.1.2 Drill Cuttings and Mud Deposition Software

Modelling was performed using GEMSS® (Generalized Environmental Modelling System for Surfacewaters) and its drill cuttings and muds discharge module, GIFT (Generalized Integrated Fate and Transport). GIFT simulates the fate of dissolved and particulate material discharged from dredging barges, mine tailings, drill cuttings and muds, and produced water. This three-dimensional particle-based model uses Lagrangian algorithms in conjunction with currents, specified mass load rates, release times and locations, particle sizes, settling velocities, and shear stress values.

The modelling methodology is based on a deterministic mode of simulation. In deterministic single event simulations, the starting date and current speed and direction at each time step are chosen from a database of properties in the selected periods.

Drill cuttings and muds were modelled as particles. Movement in the vertical direction resulted in the settling and deposition of cuttings on the seabed. The combined action of erosion and deposition, based on particle size distribution and the intensity of release, resulted in the net accumulation of drill cuttings on the seabed.

Modelling data requirements included:

- Drill section sizes and schedule;
- Drill mud types;
- Cuttings and mud gran size distribution;
- Mud and cuttings densities; and
- Mud and cuttings release rates, durations, and discharge depths.

K.1.3 Environmental Data

Model inputs were gathered and formatted for use with GIFT. The environmental data used by the model include bathymetric data, ocean current, water temperature and salinity data.

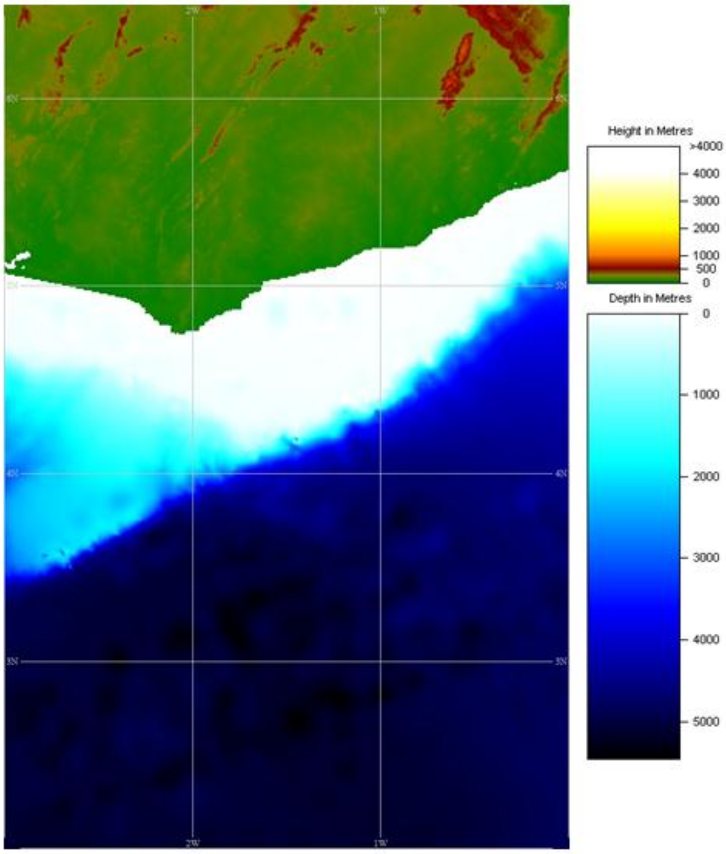
This modelling study used meteorological and oceanic (metocean) data obtained from publically available records. Spatially and temporally varying data were collected to characterize this area and determine appropriate simulation periods.

K.1.3.1 Spatially Varying Data

Bathymetric data

The primary spatial dataset is the bathymetric data, used to describe the depth and shape of the seafloor. Bathymetric data are used to develop the lower boundary of the modelling grids. GEBCO, a publicly-available source, was used to extract seafloor bathymetry at the study site (IOC et al., 2003). The database used for this study is the GEBCO_08 Grid which has a 30 arc-second resolution. GEBCO bathymetry offshore Ghana is shown in Figure K.2.

Figure K.2 GEBCO Bathymetry Data in the Study Region



Accurate and consistent mapping are possible because all spatial data used by the model and produced in the course of modelling are geo-referenced. In addition, a polyline shapefile of the Ghana coastline act as boundary in the model domain between land and water. The coastlines were obtained from Esri's World Boundaries and Places Alternate product.

K.1.3.2 Time Varying Data: Ocean Current, Temperature and Salinity Data

The time-varying data for the drill cuttings deposition modelling include ocean current speed and direction, water temperature, and salinity. Deposition modeling requires time-varying currents on a three-dimensional grid. Hourly depth-varying and spatially-varying currents were obtained from HYCOM (HYbrid Coordinate Ocean Model), which is a data assimilative hybrid isopycnal-sigma-pressure (generalized) coordinate ocean model (Bleck, 2002).

Temperature and salinity from HYCOM were obtained at a daily output frequency. Vertically, values of salinity and temperature are available every 10 m for depths 0–30 m, 25 m for 50–150 m, 50 m for 200–300 m, 100 m for 400–1500 m, and continue with increased spacing to 5500 m (where available).

Based on local meteocean studies (eni, 2014) and an analysis of 2014 HYCOM data, May was selected for modelling since it represents the month with the slowest currents at the well. Released cuttings and muds will disperse less with slow currents, resulting in a higher TSS concentration and larger depositional thickness. The currents, temperature and salinity were obtained for the region offshore of Ghana using data simulating May 2014. This data includes ocean circulation patterns that persist interannually, as well as seasonal circulation variability and eddies.

K.1.4 Discharge Schedule

Estimated quantities of anticipated drill cuttings and muds to be discharged during drilling are provided in Table K.2 and in Table K.3.

The estimated times to drill each section were provided by eni. For the top hole sections, only HV Pills are planned to be used; no non-aqueous drilling muds are to be discharged. In Scenario 2, in the subsequent sections with a riser, the cuttings with adhered non-aqueous muds will be disposed at 12 m below sea level.

Table K.2 Discharge description (Scenario 1)

Hole Diameter (inches)	Volume of Cuttings Discharged (m^3)	Volume of Mud Discharged (m^3)	Type of Mud	Estimated Drilling Duration (days)
Top hole, jet	80	0 (1)	HV Pills (2)	2
Top hole, 26	320	0 (1)	HV Pills (2)	7
17 ½	200	0	NADF	14
12 ¼	200	0	NADF	7
TOTAL	**800**	0	**-**	**30**

Notes:

(1) Seawater and HV Pill not simulated in deposition model.

(2) High Viscosity (HV) pills, made mostly of inert materials of extremely low toxicity.

Table K.3 Discharge description (Scenario 2)

Hole Diameter (inches)	Volume of Cuttings Discharged (m^3)	Volume of Mud Discharged (m^3)	Type of Mud	Estimated Drilling Duration (days)
Top hole, jet	80	0 [(1)]	HV Pill	2
Top hole, 26	320	0 [(1)]	HV Pill	7
17 ½	266	5.32	NADF	14
12 ¼	133	2.66	NADF	7
TOTAL	**799**	**7.98**	**-**	**30**

Notes:

[(1)] Seawater and HV Pill not simulated in deposition model

The model simulation of the releases to the sea was run for 9 days for Scenario 1 and 30 days for Scenario 2, assuming continuous drilling and discharge for a conservative estimate of TSS, and model performance efficiency. The simulations were each extended an additional three days (12 days total for Scenario 1 and 33 days total for Scenario 2) after the last release to ensure time for the final depositions of all particles released.

K.1.5 Cuttings and mud volumes and properties

The grain size properties of the drill cuttings during riserless jetting and drilling (Southwest Research Institute, 2003) and the treated cuttings with NABF used in this study are listed in Table K.4. The adhesion of NADF to cuttings was assumed to add negligible thickness to the diameter of the cuttings. Cuttings density was specified as 2.50 g/mL for top hole drilling. The density of the cuttings with adhered NABF was assumed to be 2.472 g/mL based on a similar but confidential project at another location.

Table K.4 Drill cuttings grain size distribution – top hole sections

Class	Particle Size (µm)	Percent Volume (%)
1	125	34
2	1200	33
3	3000	33

K.2 DISCUSSION

K.2.1 Deposition Thickness

Drill cuttings discharges will create a footprint on the seabed. The deposition of cuttings and adhered muds may result in physical damage and habitat loss or disruption over a defined area of the seabed. The discharge of muds and cuttings may affect seabed habitats through physical smothering and hydrocarbon contamination.

Burial by drilling muds and cuttings may cause physical impacts upon benthic communities. The specific thickness of burial which may cause an impact can vary depending on the benthic species and the amount of oxygen depletion which may occur, causing anoxic conditions beneath the depositional layer.

The severity of burial impacts depends on the sensitivity of the benthic organism, the thickness of deposition, the amount of oxygen depleting material, and the duration of the burial. Thickness thresholds vary by species and sediment impermeability. A suggested threshold thickness value of 5 cm above a substratum for a month deposition impacting benthic communities is recommended based on publications by Ellis and Heim (1985) and Marlin (2011). Smaller threshold values as low as 1 mm have been reported (e.g., Smit et al., 2006), however they are associated with instantaneous burials on benthic species, not gradual smothering effects.

K.2.2 Total Suspended Solids

Increases in concentration of total suspended solids (TSS) will occur due to discharges of drill cuttings and mud. The highest concentration increases will exist at the point of discharge from the drillship or at the seafloor during upper well section drilling, and decrease over time and distance as the suspended solids plume dissipates and settles. 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. Impacts related to elevated TSS may occur if light penetration is impeded significantly for long periods of time reducing the ability of plants and phytoplankton to photosynthesize. Increases in TSS may also decrease water clarity and clog fish gills. A guidance value for TSS provided by the

WBG is 35 mg/L for effluent discharges of hydrotest water at LNG Facilities (WBG, 2007) and has been used as reference in this study.

K.2.3 Adhered Oil

Discharges of cuttings after use of NADF must be treated through the on-board systems (shakers and dryers). The NABF portion of the NADF that remains will be reduced to 2% base fluid retention on cuttings (bfroc) by mass (according to GHANA EPA standards). These hydrocarbons, once settled to the seafloor, can degrade over time, and may enter the pore water within the sediments or become dissolved in the water column, depending on each specific hydrocarbon's tendency to remain partitioned to the solids.

K.3 CONCLUSIONS

The results of the modelling are illustrated in the following sections as contour plots. The plots presented indicate the location of the drill cuttings release point, taken at or above the well. The results are presented for the following parameters:

- Bottom thickness at the end of the simulation;
- Maximum TSS at any time in the simulation; and
- Mass of hydrocarbons per unit area deposited on the seafloor (Scenario 2 only).

Based on the above parameters, the following set of threshold criteria has been applied in this analysis:

- Criterion 1 – The maximum allowable increase in total suspended solids should be no greater then 35 mg/L above ambient; and
- Criterion 2 – The maximum allowable thickness deposited should not exceed 5 cm for the duration of one month.

There are no available criteria applicable for the mass of hydrocarbons deposited on the seafloor. A minimum hydrocarbon concentration of 5 g/m² was applied as a lower bound for quantification of the area affected and illustration purposes. This concentration value corresponded approximately with the region above the 0.1 mm thickness, used on the thickness figures as a lower bound.

K.3.1 Depositional Thickness

When the first two sections are jetted and drilled before the riser is installed, cuttings are discharged directly to the seabed resulting in mound of material deposited around the well.

The material discharged at the seabed is deposited in the area directly adjacent to the well head and results in the thickest layers of deposited material, which can be described as a footprint of cuttings above 1 mm thick within a 300 m radius from the well. No area exceeded the depositional thickness threshold value of 50 mm (5 cm) within a month. At the end of Scenario 2 (33 days), the top mound slumped slightly from its state seen at the end of top hole drilling (Scenario 1), but includes a greater amount of thin particles in a 1 km radius settled surrounding the well head from the surface releases.

Figure K.3 shows the expected thicknesses of the cuttings on the seabed as a result of the drilling activities at the end of Scenario 1 from the bottom releases.

Figure K.4 shows the thickness of the deposits at the end of Scenario 2, including both the top hole and surface discharges.

Jetting and top hole drilling deposited a mound with a maximum height of 33.5 mm in Scenario 1 after nine days of drilling a three days allowed for settling. The total of all depositions after 33 days in Scenario 2 resulted in a maximum mound height of 34.9 mm.

Figure K.3 Maximum Depositional Thckness – Scenario 1 (Day 12)

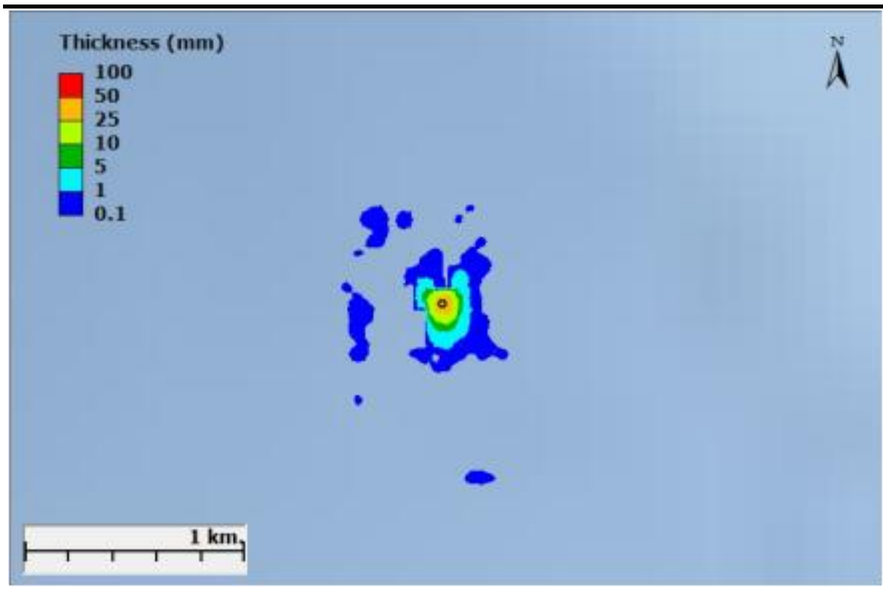
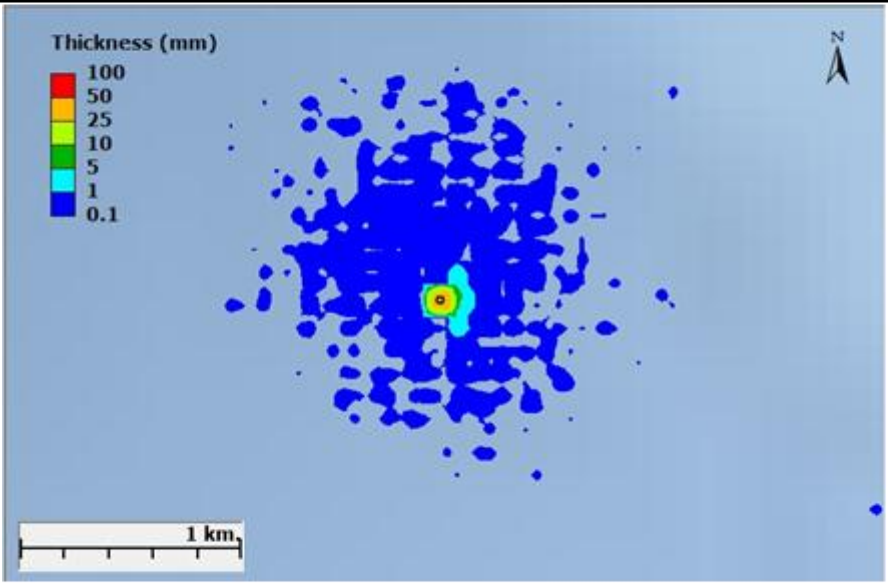


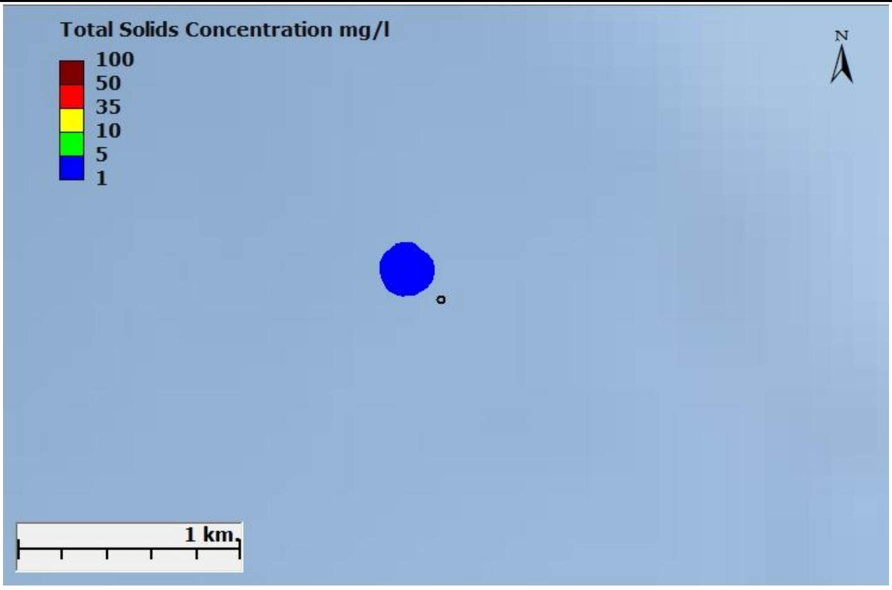
Figure K.4 Maximum Depositional Thckness – Scenario 2 (Day 33)



K.3.2 Total Suspended Solids

The maximum TSS concentration added above ambient concentrations as a result of jetting and top hole drilling near the seafloor was 2.5 mg/L (Figure K.5), which is the maximum concentration in both Scenario 1 and Scenario 2. The maximum TSS concentration added above ambient as a result of surface discharges was 0.7 mg/L in Scenario 2. The 35 mg/L threshold was not exceeded in the modelled scenario. The estimated maximum concentrations are slightly offset from the discharge location assuming the floating small particles suspended in the water column mix together at different locations. Larger particles do not remain suspended but quickly settle to the seafloor.

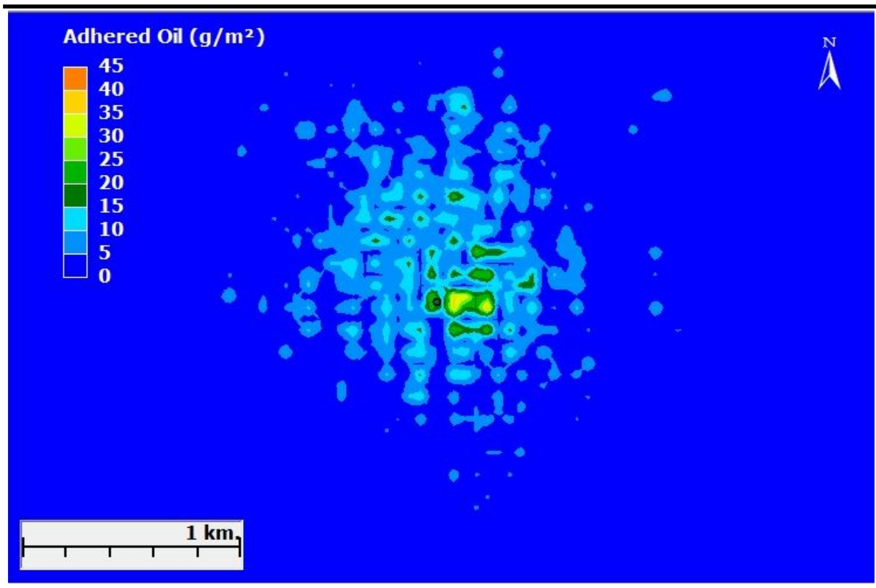
Figure K.5 Maximum TSS Concentration – Scenario 1 and 2 (Top hole Drilling)



K.3.3 Oil Deposits on the Sediment

At the end of the simulation in Scenario 2, NABF adhered to the cuttings settled primarily within a region with an area on the seafloor of approximately 1.2 km². Within that region, the total hydrocarbon concentration reached a maximum of 40.8 g/m² (Figure K.6); the maximum hydrocarbon concentration was reached at a lateral distance between zero and 50 m from the discharge point (within the nearest depositional grid cell size of 50 meters). Concentrations above 5 g/m² occupied 0.9 km².

Figure K.6 Deposited Adhered Oil Concentrations – Scenario 2



K.4 DRILL CUTTINGS MODELLING SUMMARY AND CONCLUSIONS

Modelling was performed using GEMSS® and its drill cuttings and muds deposition module, GIFT. Two scenarios were peformed. In Scenario 1, a simulation was performed representing the deposition of cuttings after jetting and top hole drilling. In Scenario 2, a simulation was performed representing the both the riserless releases and releases at the surface of cuttings with adhered NADF, if permitted. During the first 9 days of the simulation, cuttings were discharged directly at the seabed during jetting and drilling of the upper well sections. Drill cuttings and adhered muds from subsequent sections were simulated to be release 12 m below sea level over 21 days.

Output from the drill cutting modelling included estimations of the total thickness of materials deposited on the sea floor, and maximum increased total suspended solids concentrations above ambient conditions. The concentration of hydrocarbons adhered to the cuttings that deposited on the sea floor in Scenario 2 was estimated in terms of mass per unit area. The results of the modelling are shown below in Table K.5 and Table K.6.

Table K.5 Model Results Summary – Scenario 1

Maximum Depositional Thickness (mm)	Area (km^2) with Thickness > 50 mm threshold	Maximum TSS (mg/L)	Area (km^2) with TSS > 35 mg/L threshold	Maximum Hydrocarbon Deposition (g/m^2)	Area (km^2) with Hydrocarbons > 5 g/m^2
33.5	0	2.5	0	N/A	N/A

Table K.6 Model Results Summary – Scenario 2

Maximum Depositional Thickness (mm)	Area (km^2) with Thickness > 50 mm threshold	Maximum TSS (mg/L)	Area (km^2) with TSS > 35 mg/L threshold	Maximum Hydrocarbon Deposition (g/m^2)	Area (km^2) with Hydrocarbons > 5 g/m^2
34.9	0	2.5	0	40.8	0.9

According to model results, the thickness of drill cuttings on the seafloor does not exceed the threshold value of 50 mm, reaching a maximum value of 33.5 mm and 34.9 mm (Scenario 1 and Scenario 2, respectively) at the top of the deposited mound near the release location. The top hole was predicted to deposit 33.5 mm of the total deposition in the first 9 days. The maximum TSS concentration in the water column above the well during the bottom releases is 2.5 mg/L, within 300 m of the release location. In Scenario 2, the maximum TSS concentration in the water column from the surface release is 0.7 mg/L, within 300 m of the release location. The TSS was not estimated to exceed the threshold value of 35 mg/L at any time during the simulation. Hydrocarbons deposited on the seafloor in Scenario 2 had a maximum concentration of 40.8 g/m^2 with deposits generally settled in an area 0.9 km^2 at concentrations over 5 g/m^2.

With these results the following can be concluded in terms of environmental impact of the drill cuttings discharge:

As the maximum TSS concentration added above ambient concentrations as a result of top hole drilling near the seafloor was 2.5 mg/l and the maximum TSS concentration added above ambient as a result of surface discharges from the drillship was 0.7 mg/l, both increases on TSS concentration are considered to lead to minor effects on marine organisms, due to both, the small increase in TSS concentration (and to the short duration of such an increase.

In terms of seabed, natural seabed sediments are composed by mud predominantly at the wells area, with elevated values of total hydrocarbons recorded only in the vicinity of the Gye Nyame well, to be re-entered during this project. Biologically the area is characterised by a moderate value of benthic species richness, dominated by annelids and crustaceans, no sensitive habitats or threatened or endangered species were identified.

The results of the model performed indicate that the smothering threshold value of 50 mm of deposition thickness is not surpassed anywhere. Most of the area affected would result in a fine layer of cuttings of less than 1 mm depth. According to these results existing benthic communities are expected to be slightly affected, as any potential smothering impacts will be limited to a very small area around each well.

The model results also show that the NADF adhered to the cuttings would settle primarily within a region with an area on the seafloor of approximately 1.2 km^2, with a total hydrocarbon concentration expected to reach a maximum of 40.8 g/m^2. The organic nature of the NADF may also lead to an increase in the oxygen demand on the areas where it is discharged and the subsequent potential for anoxic conditions, but the nature of the compounds are highly biodegradable. Given the small area affected and the absence of sensitive habitats or threatened or endangered species, the potential impact on biodiversity is considered low, limited to local benthos, and readily recoverable.

K.5 REFERENCES

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