GOLDER

REPORT

Central Térmica de Temane Project - Environmental and Social Impact Assessment Report

Moz Power Invest, S.A. and Sasol New Energy Holdings (Pty) Ltd

Submitted to:

World Bank Group

Submitted by:

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Executive Summary

INTRODUCTION

Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE) in a joint development agreement is proposing the construction and operation of a gas to power facility, known as the Central Térmica de Temane (CTT) project. MPI's shareholding will be comprised of EDM and Temane Energy Consortium (Pty) Ltd (TEC). The joint development partners of MPI and SNE will hereafter be referred to as the Proponent. The Proponent propose to develop the CTT, a 450MW natural gas fired power plant.

The proposed CTT project will draw gas from the Sasol Exploration and Production International (SEPI) gas well field via the phase 1 development of the PSA License area, covering gas deposits in the Temane and Pande well fields in the Inhassoro District and the existing Central Processing Facility (CPF). Consequently, the CTT site is in close proximity to the CPF. The preferred location for the CTT is approximately 500 m south of the CPF. The CPF, and the proposed site of the CTT project, is located in the Temane/Mangugumete area, Inhassoro District, Inhambane Province, Mozambique; and approximately 40 km northwest of the town of Vilanculos. The Govuro River lies 8 km east of the proposed CTT site. The estimated footprint of the CTT power plant is approximately 20 ha.

Associated infrastructure and facilities for the CTT project will include:

a) Electricity transmission line 25km in length to the Vilanculos substation;

b) A water pipeline from a borehole to the CTT plant site;

c) Gas pipeline between the CPF and the power plant;

d) An access road, construction camp and contractor laydown areas at the CTT site.

PROPONENT

The project developers are Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE) in a joint development agreement. MPI's shareholding will be comprised of Electricidade de Mozambique E.P. (EDM) and Temane Energy Consortium (Pty) Ltd (TEC).

The ESIA Practitioner

The ESIA is being prepared by Golder Associados Moçambique Lda, coordinated by Aiden Stoop. The table below lists the primary contacts for the ESIA professionals and their roles. A complete team is presented in the EIS report.

Should you have any comments or queries, please contact Jamila das Neves or Cândida Boavida below.

Contact Persons	Aiden Stoop	Jamila das Neves/ Cândida Boavida
Purpose	Technical ESIA	Public Participation

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This ESIA has been prepared by Golder Associados Moçambique Lda. The ESIA comprises 3 volumes and is made up as follows:

Volume 1: Non-Technical Summary (NTS) and ESIA Main Report

The report summary is prepared to provide lead agencies with sufficient information about the findings and proposed actions of the main report to make a decision about the project.

The main report is divided into three parts. Part 1 includes general project information, the legal framework and the stakeholder engagement process. Part 2 sets out the project baseline for the receiving environment. Part 3 covers all aspects of project impact, mitigation and monitoring.

Records of consultation meetings with lenders, affected people, government agencies and nongovernmental organizations (NGOs); and a list of associated reports will be included in appendices to the main ESIA report.

Volume 2: Environmental and Social Management Plans (ESMPs)

The Environmental and Social Management Plans (ESMPs) are contained in Volume 2. Each ESMP is divided into construction, operation and decommissioning phases. Specific sub-plans dealing with environmental and social aspects and components support these ESMP's.

Volume 3: Specialist Studies

Specialist studies are included in Volume 3, which have been used to inform the ESIA.

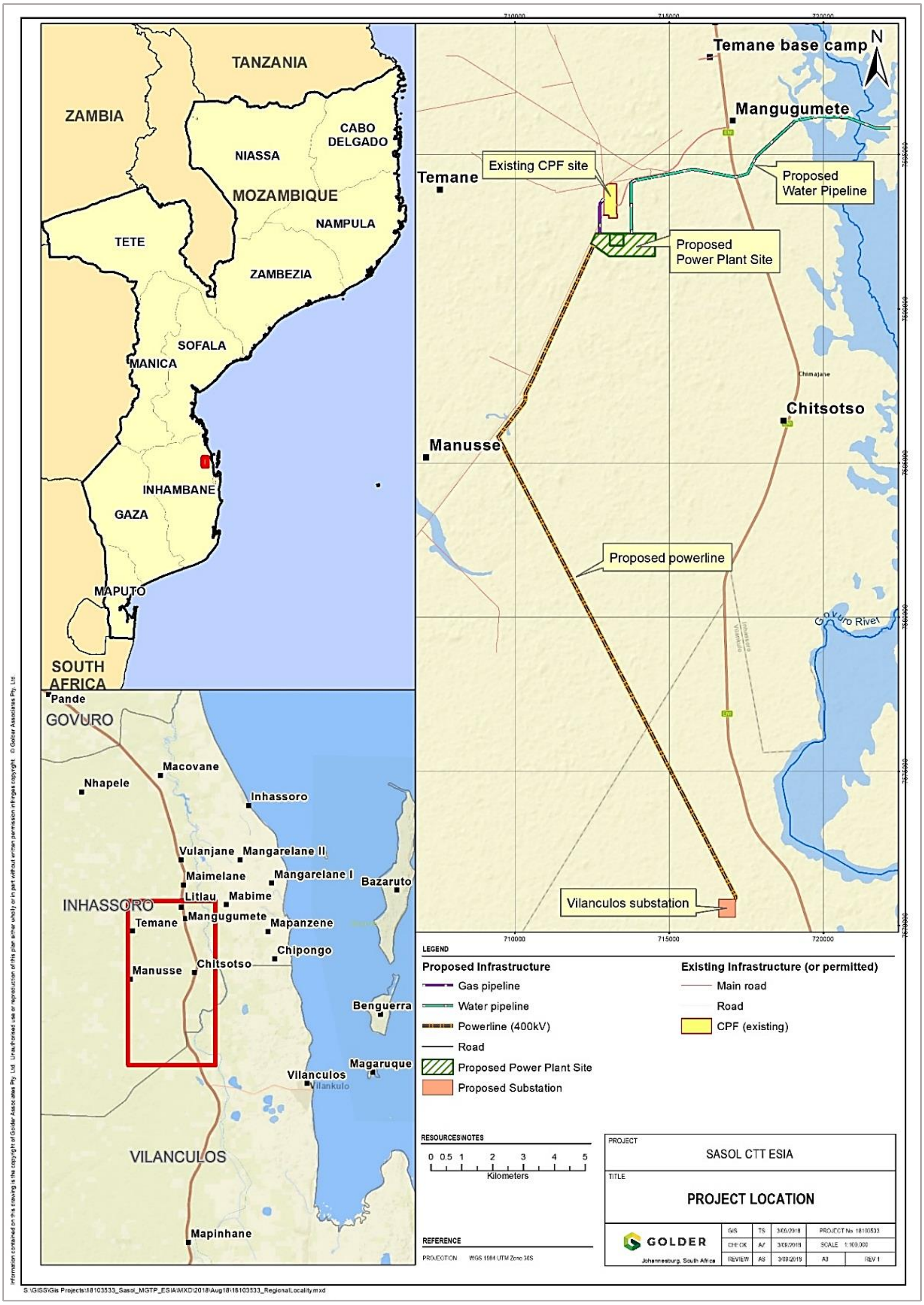

Figure A: Project Location

LEGAL FRAMEWORK

The relevant Mozambican legislation and international standards applicable to this project were considered for the studies included in the EIA process and in the resulting mitigation measures.

ESIA PROCESS

The registration of the proposed project was carried out in August 2014, together with the Ministry of Land, Environment and Rural development (MITADER), having been classified as a Category A Project and is therefore subject to an Environmental Impact Assessment (EIA) under Article 12 of the EIA Regulation (Decree 45/2004 of 29 September amended by Decree 42/2008 of 4 November), now Article 11 of the new EIA Regulation (Decree 54/2015 of 31 December).

The Environmental Pre-feasibility and Scoping Study (EPDA) was then carried out and the Terms of Reference (ToR) were defined for the Environmental Impact Study (EIS).

Public consultation was undertaken during the EPDA & ToR phase in early 2015, whereafter the EPDA & ToR, together with stakeholder comments was submitted to MITADER and approved later in 2015. Due to prevailing economic conditions, the project was on hold until 2018, when the next phase of the ESIA proceeded with impact assessment and devising mitigation measures. The EIS report together with Environmental and Social Management plans (ESMPs), will be submitted to MITADER for decision making in early 2019, after the next round of public consultation has been undertaken.

Furthermore, the CTT project ESIA complies with local Mozambican legislation as well as the World Bank Performance Standards (OP 4.03) and EHS guidelines.

Scheduling

It is expected that the following CTT project timeframes will be followed:

Construction: 18-24 months;

Operations (design life): 25 years (although plants are often re-furbished and the life extended); and

Decommissioning: 18-24 months.

The above timeframes are indicative and will be refined depending on the technology and supplier selected. These timeframes have been used to inform the assessment of impacts in this ESIA.

IMPACT ASSESSMENT FINDINGS

The potential environmental and socioeconomic impacts of the Project were identified through a process of developing a baseline through both desktop studies and fieldwork. The proposed project infrastructure and associated activities were analysed against this baseline and impacts were predicted using quantitative and qualitative methods. A variety of impacts were identified for the Bio-Physical Environment and the Socio-economic Environment. The following section describes the baseline setting and summarizes the main impacts identified and mitigation measures to reduce negative impacts and enhancing positive impacts.

BIOPHYSICAL ENVIRONMENT

BASELINE SUMMARY

The study area is situated along the coastal plain of Mozambique, approximately 20 km inland of the coastline and about 30 m above mean sea level. The topography of the study area ranges from flat to undulating. A low, north-south trending dune ridge runs between the coast and the Govuro River, and acts as a natural watershed. The Govuro River lies at 13 m above sea level (m.a.s.l). Land to the west of the river rises to 58 m.a.s.l, while that to the south rises to 68 m.a.s.l.

The vegetation in the project area consists mainly of a mixture of tall and short woodland and bush with grass areas and river habitat alongside the Govuro River. Most of the CTT plant and associated infrastructure are located on land that has been transformed through human activity with limited natural habitat that will be disturbed by the project. There is no identified Critical Habitat near any of the proposed project infrastructure and associated activities for the terrestrial environment (Figure B). There is potential critical habitat triggering under criterion 1,2,4 and 5 in the marine environment of the study area, linked to potential anchorage points and barge routes associated with the temporary beach landing activities. Given the temporary nature of the beach landing activities as described further in the subsequent sections, the critical habitat would be triggered for approximately 10 days during the first 12-15 months of the Project in blocks of 1-2 days each. In addition, mitigation measures will be implemented to reduce these impacts to an expected Low or Negligible impact as detailed in Sections 7.2.1.22 and 7.2.1.23.

Numerous tree species are felled by locals and used as firewood or to produce charcoal. Subsistence firewood collecting does not necessarily have a negative impact on vegetation, as dead wood is often gathered. The use of various plant materials for building huts, granaries, livestock pens and various other rural infrastructure is common throughout the region, and one of the main forms of ecosystem goods.

Various crops are grown on both a subsistence and commercial basis. Subsistence farming is by far the most common form of agriculture and features prominently throughout the area. Maize and cassava are common crop plants and are often grown together. Depending on productivity, each plot is cultivated for a few years (sometimes up to four) before being abandoned in favour of a new plot. Several forms of fresh produce were observed for sale at a road side stall including mangos, Marula fruits, pumpkins, paw paws, chilli peppers and nuts which would be typically grown in homestead gardens. Fishing in the Govuro River and the barrier lakes is common in the study area and an important means of obtaining protein. Along the coast communities rely on artisanal fishing practices as the primary source of protein.

The Govuro River is the major drainage feature in the region, and as such, it is of considerable importance as a source of water. The lower reaches of the river are significantly influenced by tidal fluctuations and are probably too saline for use as drinking water. It is anticipated that water further upstream is probably far less saline and can be used by local people for fresh drinking water. This notwithstanding, along much of its reach, the river is used for other purposes, such as bathing and clothes washing.

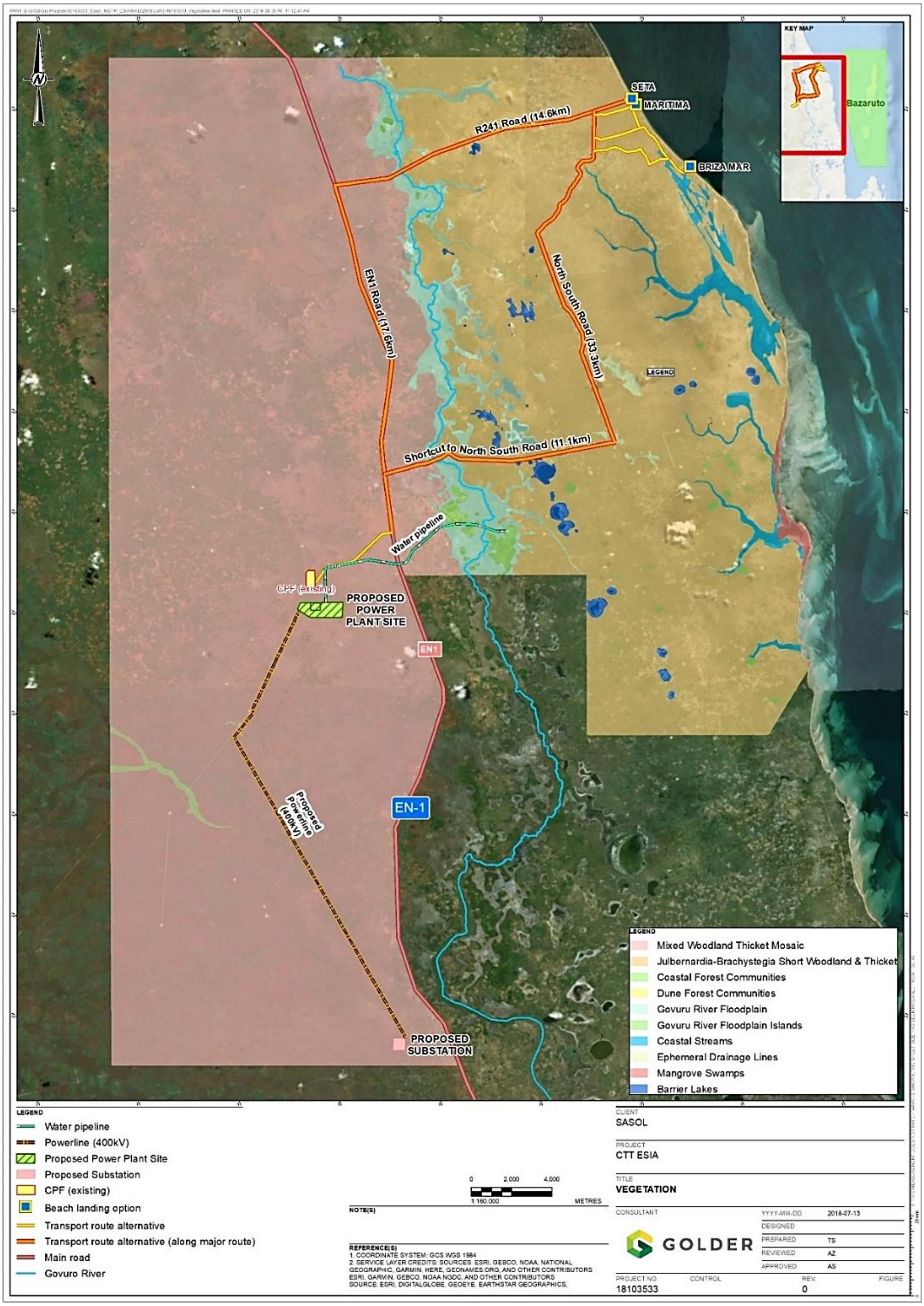

Figure B: Broad-scale habitat units associated with the study area

Bazaruto Bay and the marine area to the north is fairly shallow with an average water depth of approximately 10 m. Coral reef systems are distributed throughout the Study Area, the largest of which are located off the coast north of Inhassoro. In Bazaruto Bay, seagrass beds associated with the sand tidal flats typically occur in shallow waters of less than 5 m depth. Within the Study Area, an extensive seagrass bed is located off the shoreline where beach landing sites Maritima and Seta are located. The seagrass beds serve as a food source for the populations of green turtle and dugong that are resident in the area. The seagrass meadows of the tidal flats in Bazaruto Bay are known to support the largest remaining populations of dugong in the Western Indian Ocean. In addition, seagrass meadows act as a shelter and nursing areas for several juvenile fish species and have importance as fishing grounds for the subsistence (artisanal) fisheries within the Study Area.

The Bazaruto Archipelago and its coastal waters is a marine protected area (MPA) and National Park, which supports the most viable dugong population in East Africa as well as turtles, dolphins and marlin. The proposed beach landing points are located north and south of Inhassoro town on the mainland coast, outside the National Park. Two potential identified anchorage points were identified on historical maritime maps as well as studies conducted previously by Sasol and were analyzed for this EIA, although the final selection of the anchor point has not yet been made. At least one of these two previously identified anchorage points is expected to have been used for off-loading in the past for the construction of the CPF. These two sites (identified in Figure 28) are located approximately 10-18 km offshore, within the Bazaruto Archipelago National Park although not directly above coral reef or seagrass beds (see Figure 90). Studies of additional potential anchor sites and consultation with BANP for the selection of the most suitable anchorage point are ongoing at present. Three marine mammal species of Conservation Concern are found in the coastal waters of the Study Area, the Dugong, Indian Ocean Bottlenose Dolphin and Indo Pacific Humpback Dolphin.

IMPACTS AND MITIGATION MEASURES

The following residual impacts are likely to occur after mitigation measures have been applied. The section below summarises the impacts from the Highest to the Lowest (shown in brackets), with mitigation measures summarised below each impact.

<u>Change of Land use and loss of Agricultural land (Moderate).</u>

The CTT project infrastructure footprints will affect small areas that currently comprise of cultivated fields, savannah areas, urban areas and peri-urban areas. These land uses will permanently change to industrial use. Areas on which project infrastructure will be built, will no longer be used for agricultural land. These areas are limited in size; however, the loss will be permanent. These areas will be avoided as far as possible; however, some land will be lost and owners will be compensated accordingly.

Mitigation Measures:

Minimise the project footprint and therefore disturbance to a minimal area as possible.

<u>Loss or disturbance of natural habitat due to vegetation clearing (Moderate)</u>

Some infrastructure or activities will be built on areas that are undisturbed or are natural habitat. The extent of loss or disturbance will be minimal and will only occur in areas such as the southern transport route option, where the jeep track will be upgraded and widened to a create a new road.

Mitigation Measures:

CTT will ensure that vegetation clearing is restricted to the proposed development footprints only, and clearly marked so that no unnecessary vegetation clearing takes place.

If selected as the preferred road option, the alignment of the upgraded Shortcut Road (southern route option) will be re-routed to avoid impacting the adjacent inland pan/depression habitats.

Topsoil stripped during construction will be stockpiled and used to rehabilitate disturbed areas; and

A suitable rehabilitation programme will be developed and implemented in all disturbed areas by the construction Contractor.

<u>Groundwater deterioration (Moderate)</u>

There may be spills from the evaporation pond at the CTT site during operations, which may lead to a deterioration of groundwater quality.

Mitigation Measures:

The contractor will design and build the evaporation pond (and other infrastructure) in a way that it can avoid contamination, with warning systems that are built to detect any pollution of groundwater should this ever occur.

<u>Increase in ambient noise levels (Gas Engines) during Night-time (Moderate)</u>

During the operational phase, the option of the Gas Engine technology may cause elevated levels of noise during the night-time that may result in a disturbance to communities.

Mitigation Measures:

Equipment will be designed to minimize the noise, applying World Bank standards. This should result in very minimal noise at night.

<u>Impacts on Surface Water Quality of Govuro River (Low)</u>

During the construction phase a temporary bypass bridge will be constructed across the Govuro River as part of transporting heavy equipment from the beach landing site to the CTT site. This may result in impacts on the water quality as a result of in-stream and river bank disturbances during the construction of the bridge.

Mitigation Measures:

The Contractor will construct the Govuro River crossings during the dry season so as to limit the amount of impact on the sites, particularly in terms of flow diversion and surface water runoff following rainfall.

Implement low-impact construction techniques to minimise the impact on the river system.

Limit movement of construction vehicles and activities to the demarcated zone only; and restrict vehicles to service roads.

Monitor the water quality downstream of the river crossing sites during construction on an at least bi-annual basis.

<u>Contamination/ pollution of soil and water resources (Low)</u>

During normal construction and operational activities, there is a possibility for contamination/ pollution of soil and water resources from leaks and spills of fuel and lubricants from construction vehicles and other machinery and equipment if not properly maintained or handled correctly at the CTT site.

Mitigation Measures:

The Contractor will ensure that it regularly maintains and services all vehicles and machinery to minimise the potential for leaks and spills of fuels.

The Contractor will develop protocols to manage the storage, handling and disposal of all chemicals and other hazardous substances used on-site during all phases of the proposed project.

Indirect injury/mortality of Dugong due to the movement of barges (Low)

As part of the beach landing activities, heavy equipment will be moved via barges across Bazaruto Bay at low speeds, however there is a remote possibility that barges may come into contact with Dugong, although it is highly unlikely. If the mitigation measures are not implemented correctly and injury or mortality does occur, this will result in a high impact due to the importance of Dugong species.

Mitigation Measures:

The beach landing activities will only occur during a portion of the entire project construction phase i.e. only bringing in oversized and extremely heavy power plant components over as little as 8 months (conservatively estimated at 8-15 months). These beach landing activities are expected to be completed quickly (in less than 24 hours) and to occur infrequently – approximately for 1-2 days with periods of up to 3 to 4 months between shipments. There will be only one barge trip per transhipment vessel, and as soon as the barge has been fully loaded, the transhipment vessel will depart. The Proponent has indicated that there is flexibility in scheduling delivery of components so scheduling of these activities is likely outside of peak tourist periods.

Strict speed restrictions of <5 km/hr will be enforced on barge vessels, as well as smaller crafts that may be used from time to time between the anchor point and beach jetty, to protect Dugongs (and other mammals).

A Certified Marine Mammal Observer (MMO) will be employed by the Proponent or the Contractor responsible for such activities to observe and monitor all barge and transhipment movements so as to ensure that collision risks are avoided with marine mammals and other species.

Demarcated barge/shipping lanes will be determined and will need to be strictly adhered to in order to avoid sensitive habitat such as sea grasses and corals. These barge/shipping lanes will be demarcated with buoys (non-Styrofoam).

Construction of Anchorage point near or within Bazaruto National Park (Low)

The anchorage point has not yet been selected and will be determined based on acceptable ongoing studies. The anchorage point should be located outside the Bazaruto National Park (BNP) unless anchorage sites outside the BNP are clearly not available, or would clearly have greater overall adverse environmental or social impacts than if they were inside the BNP. The environmental studies will be updated for the final preference of the anchor site and submitted to the World Bank, thus the final determination of the anchorage point therefore is subject to the World Bank’s non-objection. The construction of an Anchorage point near or within the BANP may result in a low impact if the correct mitigation measures are employed. Should an anchorage point be located near sensitive receptors and mitigation measures not employed, they may result in a high impact.

Mitigation Measures:

Studies are ongoing to identify acceptable anchorage points located outside of the boundary of the Bazaruto Archipelago National Park/IBA and away from popular recreational sites. A buffer of at least 250 m should be maintained between the outer extent of the boundary and the anchorage points/navigation routes of the transhipment/barging vessels. The sites will be surveyed in order to avoid sensitive receptors and habitats such as coral reefs, sea grass beds etc. The vessel will be anchored for only approximately 1-2 days with periods of up to 3-4 months between shipments over a maximum 15 month period early in the construction phase. The infrequent nature of the trips allows for flexibility around the high tourist seasons of the BANP.

The Contractor will implement strict controls to ensure that leakages of hydrocarbon fuels, oils and/or lubricants from barges, transhipment vessels and heavy equipment are minimised/eliminated. Daily maintenance and monitoring checks of vessels will be conducted; and

Decrease in Ambient Air Quality (Low)

The two technology options will both have a residual impact of low in terms of ambient Air Quality as a result of Nitrogen Dioxide (NO_2) emissions. If the mitigation measures are not adequately applied, the impact may become Moderate for the Gas Engine option only. The Gas Turbine impact without mitigation measures will still result in a Low impact.

Mitigation Measures (Gas Turbine option):

Technology will be designed to avoid and minimise impacts.

<u>Increase in Mozambique's National Green House Gas emissions (Low)</u>

The CTT project will increase greenhouse gas emissions of the overall Mozambican National GHG emission levels.

Mitigation Measures:

Consider a gas engine technology that has lower GHG emissions.

<u>Decline in groundwater levels (Low)</u>

The CTT project may result in a decline in groundwater levels as raw water for the project will be supplied from aquifers in the area by abstraction through boreholes either on site or near the Govuro River.

Mitigation Measures:

Mitigation and management of abstraction boreholes need to include continuous level and abstraction volume monitoring. It is proposed that additional boreholes be used to augment the water supply from W5A and T9, as the required abstraction is likely to not be sustainable in the long-term from only the two boreholes. These boreholes are located far from community wells and will not impact them.

<u>Powerline collisions / electrocution by large bird species (Low)</u>

The CTT powerline which will be approximately 25km in length may pose as a risk to large birds such as raptors in terms of collisions or electrocution.

Mitigation Measures:

The design requirements for the powerlines will include 'raptor friendly'. devices/designs that will be included such as staggered insulators, raptor-protectors and/or perch deterrents to prevent the electrocution of large birds that may perch on the towers.

To minimize collisions by flying birds or fruit bats with power line wires, bird flight diverters shall be installed in the higher-risk segments of the transmission line. Also, in higher-risk areas for bird or fruit bat collisions, self-supporting towers (rather than guyed V-Towers) shall be used as far as possible because of the collision risk posed by guy wires. A spacing of 3 meters between conductors shall be employed in order to avoid and minimize large bird collisions with electric cables.

Periodic monitoring along the power lines should be undertaken by an ornithologist to ensure that raptor friendly devices installed on power lines are effective.

SOCIO-ECONOMIC ENVIRONMENT

BASELINE SUMMARY

The project area is situated in the District of Inhassoro, in the northern part of the Inhambane Province in southern Mozambique. The district is bordered to the north by Govuro District, to the south by the Districts of

Vilanculos and Funhalouro, to the East by the Indian Ocean and to the West by the Districts of Massinga and Mabote (Figure C).

The Inhassoro district is subdivided into the Administrative Post of Bazaruto and the Administrative Post of Inhassoro, the latter being the most populated. The proposed CTT project area consists of 12 villages and communities, namely: Temane, Mangungumete, Manusse, Chitsotso, Mabime, Mapanzene, Chipongo, Maimelane, Mangarelane, Litlau, Munavalate and Pambara. The main ethno-linguistic groups in Inhassoro district comprise the Matsuda, the Ndau and Elomwe. The predominant local language in the region is Xitswa. There is high unemployment in the study area amongst these villages and literacy levels are low.

Women and elderly people are the most vulnerable in the project area. Women living alone are vulnerable to several social and economic threats, especially in a society where women and men do not enjoy equal opportunities in society In the same way, the elderly population do not have the same opportunities as younger members of the community, while they are more susceptible to health problems, disabilities and food insecurity.

The annual health report (2017) shows that Inhassoro District has only 1 physician for every 31,980 inhabitants and 1 nurse for every 3,366 inhabitants (compared to the WHO recommended ratio of 1 per 10,000 and 1 per 1000 respectively). The main reasons for health consultations are malaria, diarrhoea, Human Immunodeficiency Virus (HIV)/ Acquired Immune Deficiency Syndrome (AIDS), anaemia, tuberculosis and acute respiratory tract infection including pneumonia. Inhassoro is generally poorly served with no district hospital (as at 2018) and relies on the District hospital located in Vilanculos.

Subsistence agriculture is indicated as the principal economic activity, followed by poultry and small-scale fishing. Activities that are least practised include tourism, sea product collection and commercial agriculture. Charcoal and Palm wine production are also economically rewarding for local communities. Firewood is sold along the EN1 and along the gravel road leading from Inhassoro to Vilanculos through the eastern parts of the study area. Palm wine is sold and consumed by households throughout the study area.

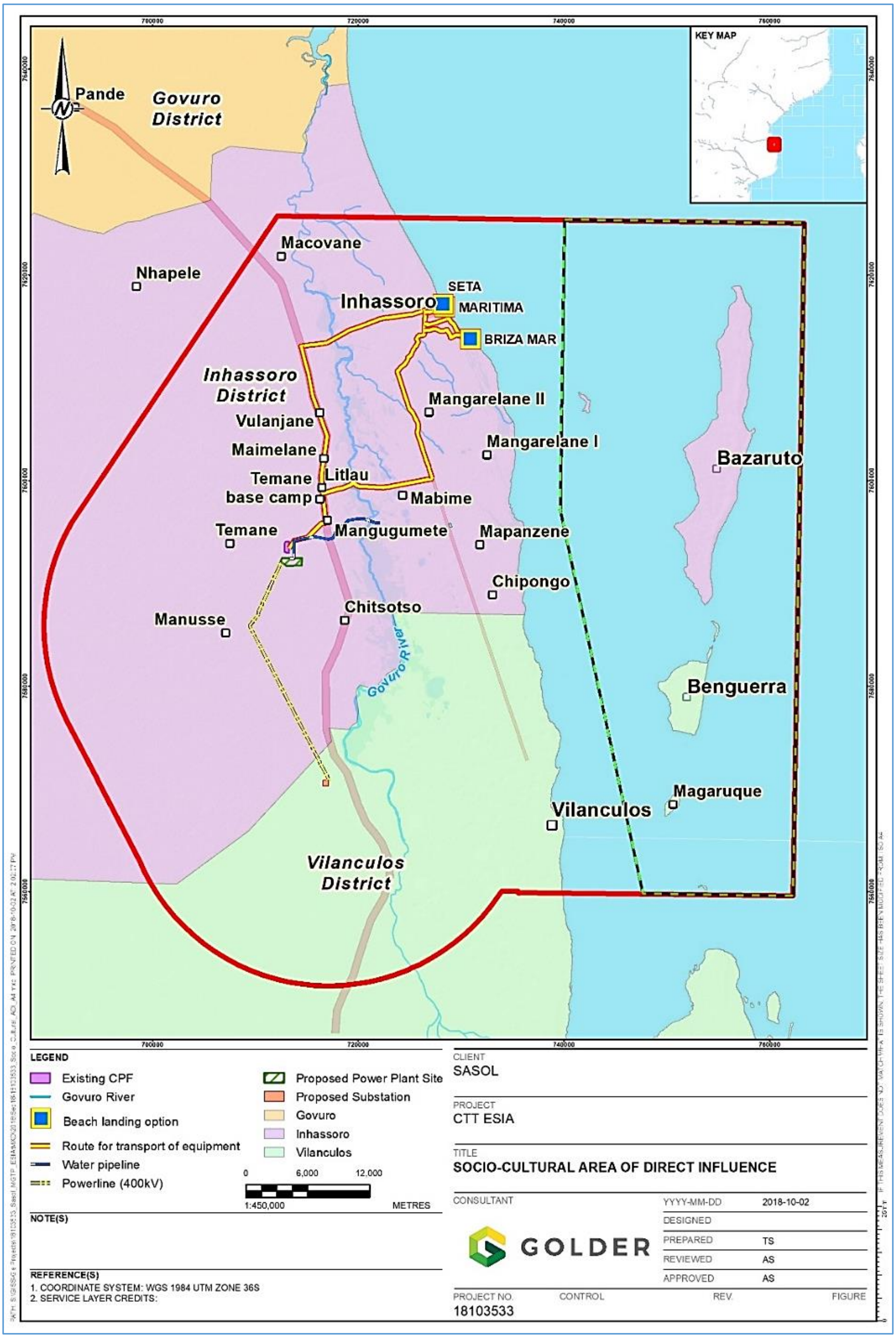

Figure C: Communities within the project area

The CTT Site is situated in an important area in relation to Iron Age social formation and settlement along the Indian Ocean coast of southern Africa. Sites located within the study area have been dated to the Iron Age. One site is a pottery scatter site possibly indicative of a small farming community. The site is situated south east of Manusse, approximately 5 km west of the powerline route. Archaeological evidence was found to be limited at this location.

The artefacts identified during the 2015 fieldwalking phase, namely pottery, shell and lithics, are considered to be typical of those well-known sites along the southern coast of Mozambique and are categorised as 'Moveable' cultural heritage as defined by Mozambican Law and no features were found which could be classed as 'Critical' or 'Non-Replicable' cultural heritage in terms of World Bank standards.

The town of Inhassoro has developed into a popular tourist venue for both holiday and fishing enthusiasts due to the scenic and tranquil environment, recreational and game fishing for amateurs, fishing competitions, snorkelling, scuba diving and wind surfing. The Bazaruto Archipelago, considered one of East Africa's best and certainly Mozambique's premier fishing destination, is in close proximity and tourism to this destination might be affected by the vessels transporting the heavy equipment to be offloaded in Inhassoro.

IMPACTS AND MITIGATION MEASURES

The following impacts are likely to occur after mitigation measures have been applied. The section below summarises the impacts from the Highest to the Lowest (shown in brackets), with mitigation measures summarised below each impact.

Employment Opportunities (Moderate – Positive)

The CTT project will employ between 690-850 people (for Gas Engine and Gas Turbine options respectively) during the construction phase depending on the final technology option selected. This will further stimulate the informal sector as it is likely that informal jobs will be created in trading and providing services to construction workers etc. During the operations phase, approximately 70 full-time employees will be employed with some contractors such as security, cleaners, drivers and gardening personnel.

Mitigation measures:

Directly affected communities will be given preference for employment should they meet the job requirements, will be

Where possible, the CTT project will create employment opportunities for women and youth.

An internal monitoring system will be established to ensure that CTT adheres to local employment laws and policies.

Electricity Supply (Economic growth) (Moderate – Positive)

The proposed CTT project will ensure improved, stable and more flexible electricity supply in Mozambique as there is a growing electricity demand. The CTT project will also improve power supply to EDM and a more stable power supply to the North of the country. Consequently, the improved supply of electricity may:

Enable the country's economic growth because most economic activities are dependent on a reliable and steady supply of electricity; and

Improve the local business environment and local industry due to a stable electricity supply.

Mitigation Measures:

CTT will maintain community relations in order to avoid interruptions during the operation phase (e.g. social unrest).

Community Development (Moderate – Positive)

CTT be required to implement a sustainable and integrated community development initiatives aimed at uplifting local project affected communities. These development initiatives, especially if implemented in consultation with other community development role-players in the area, can contribute considerably towards education, health, socio-economic development, sustainable jobs and income stability within the project area.

Mitigation measures:

CTT will implement sustainable and integrated community development initiatives by reviewing community development initiatives which are on-going in the area and consult with communities to identify and support necessary development gaps related to water supply, education, health and other identified needs.

Physical and economic displacement (Moderate)

The CTT project may require physical and economic displacement to make way for the proposed project infrastructure such as the transmission line and water pipeline. These options and route alignments are still to be refined which may result in a reduction of impact or a complete avoidance of the impact

Mitigation Measures:

Seek to re-align the transmission line in certain sections, the water pipeline and transportation route (southern transport route option) to avoid any sensitive receptors along the route and thus the need for resettlement or compensation.

If resettlement or compensation is unavoidable, then Project-affected people will be identified and compensated accordingly viz.; the client will have to develop a comprehensive resettlement action plan in accordance with national legislation and IFC standards (currently an abbreviated resettlement action plan/framework has been prepared as a first step).

Light pollution at night from Transhipment Vessel (Moderate).

Light pollution at night as a result of direct glare, and indirect sky glow from the transhipment vessel anchored off-shore may result in a moderate impact to sensitive receptors such as tourism facilities at Bazaruto Island or along the coast near Inhassoro.

Mitigation Measures:

Where possible, relocate the anchorage points outside of the Bazaruto National Park and away from sensitive receptors such as tourism facilities.

Reduce any unnecessary lighting at night as far as possible.

Increased economic revenue (Low – Positive)

The CTT project will result in local economic spending by CTT, the Contractor and suppliers. This will lead to a stimulation of local businesses which will increase their revenue and have a positive impact on the local economy.

Mitigation measures:

CTT and contractors must ensure that Local businesses are given first preference during the procurement of required goods and suitably skilled and available services.

Preference should be given to suitable local sub-contractors.

CTT will develop a local content management plan (includes local employment and procurement of local good and services).

Improved infrastructure (Low – Positive)

It is anticipated that the CTT project will upgrade roads and a bridge crossing where necessary (dependant on the route selected from beach landing to CTT site). It is also likely that where the CTT project may impact on public roads such as the EN-1 or R241, that they will maintain/repair these roads as long as they are impacting them. Consequently, this will improve public infrastructure such as roads and bridges (in the case of the southern transport route option).

Impact of changes to land surface on undiscovered archaeological remains and cultural sites (Low)

The CTT project construction activities has the potential to impact on undiscovered archaeological remains which are buried and may become disturbed through excavations and other earth moving works. The project may also impact cultural sites if mitigation measures are not applied correctly. In both cases, if mitigation measures are not applied, the impacts may be high due to the sensitivity of the archaeological remains or cultural sites affected.

Mitigation Measures:

CTT will adhere to its Chance Find Procedure (CFP) in accordance with Mozambican heritage legislation.

If significant archaeological remains are discovered, the need for excavation and ‘preservation through record’ may be required.

Impacts to the identified cultural sites can be avoided by selecting the northern transport route (which already exists and requires no widening).

Demarcation of areas to be avoided so as to avoid disturbance of traditional ceremonial activities.

Population Influx (Low)

The study area has already experienced a significant influx of people in search of work and business opportunities in the past decade. It is likely that this existing impact will continue to increase considering the proposed CTT project. Consequently, this will have social implications such as:

Increased pressure on local resources, infrastructure and social services which are already not adequate and enough for the local people; and

Increased social pathologies such as drug and alcohol abuse, prostitution, gender violence, increased incidence of sexually transmitted diseases and other communicable diseases.

Mitigation Measures:

The client will develop/ update a comprehensive influx management plan aimed at identifying areas of potential influx and appropriate influx management measures. Additionally, relevant stakeholders should be engaged and consulted during the development of the detailed influx management plan.

Exposure to Gender based violence and sexual exploitation and abuse (Low)

Due to the influx of employment and business seekers, it is likely that the women and children within the project area will be exposed to gender-based violence and sexual exploitation and abuse. The following factors are likely to induce and escalate gender-based violence and sexual exploitation and abuse within the project area in the form of sex-trafficking, prostitution, domestic violence, sexual abuse and drug abuse:

Some men seeking employment and business opportunities within the project area are likely to pose a risk to women and children in terms of them being exposed to violence and sexual exploitation. It should be noted that women and children have been identified as vulnerable;

Access to disposable income might result in irresponsible financial expenditure such as spending money on drugs, alcohol and prostitution. Consequently, contributing to STIs; and

Alcohol and drug abuse among construction workers can result in irresponsible behaviours that could escalate to violence or domestic abuse.

Mitigation Measures:

Access to the construction site must be controlled to prevent sex workers from entering the construction camp.

Implement GBV and SEA campaigns (including educational awareness around risks such as sexually transmitted diseases) in the project affected communities.

<u>Health Impacts (Malaria; TB; HIV/AIDS; STIs; Soil and Waste related; Hazardous substances) (Low)</u>

The CTT project may induce population influx that is likely to introduce various health impacts in the form of migrant workers (disease communication such as STI's, HIV/AIDS etc), increased pressures on health facilities and services, waste generation and unhygienic practices by local communities etc. If mitigation measures are not adequately applied certain health related impacts such as STI's, HIV and AIDS may be high.

Mitigation Measures:

Information and awareness campaigns on HIV/AIDS and STIs in both the community and the workplace

Support for widespread availability and social marketing of condoms in the workplace, hot spots in the community (bars and taverns) and at the lodge/hotel in Inhassoro.

Support awareness and behaviour change communication activities in the communities.

Develop workplace health strategies as part of the occupational health plan or organisational health plan.

Extend specific community-based malaria and vector controls as part of the communicable diseases strategy.

Prevent discharge of inadequately treated water from the waste-water and sewerage treatment plants.

<u>Tourism impacts form Beach Landing activities (Low)</u>

The operation of the temporary Beach landing site and associated activities may have a possible impact on the local tourism industry in Inhassoro town and the Bazaruto Island by making the area less desirable to visit from a tourism point of view.

Mitigation Measures:

Plan the shipments and off-loading periods during the low occupation period (outside of main holiday periods) to a maximum and limit activities to during day time hours only.

Only use the local Inhassoro facilities to accommodate the beach landing contractor staff as well as any other CTT worker accommodation needs that cannot be met at the main construction camp.

<u>Light pollution at night from CTT plant (Low)</u>

Light pollution at night as a result of direct glare, and indirect sky glow from the CTT plant may result in a low impact to sensitive receptors such as surrounding communities and sensory disturbance to certain fauna species.

Mitigation Measures:

Identify zones of high and low lighting requirements, focusing on only illuminating areas to the minimum extent possible to allow safe operations at night and for security surveillance.

Plan the lighting requirements of the facilities to ensure that lighting meets the need to keep the site secure and safe.

Utilise security lights that are movement activated rather than permanently switched on where feasible.

Fit all security lighting with 'blinkers' or specifically designed fixtures, to ensure light is directed downwards while preventing side spill.

Eliminate any ground-level spotlights as these invariable result in both direct glare and increased sky glow.

CONCLUSION

The implementation of the CTT project will make a critical contribution to Mozambique's National Energy Strategy, the main goals of which are to promote universal access to electricity, reinforce Mozambique's position as an important regional power hub, to support social development and poverty alleviation, and to promote general economic growth.

A cumulative assessment was undertaken as part of the ESIA and considered the CTT project impacts as well as other proposed projects within the area and identified the various cumulative and residual impacts that may result. In this study, it was concluded that the CTT project will have a low impact in terms of its residual impacts contributing to cumulative impacts on the surrounding area.

The analysis carried out in the ESIA has identified a variety of impacts and mitigation measures that has facilitated the preparation of Environmental and Social Management Plans for the project to guide CTT and its contractors during construction, operations and decommissioning phases.

The ESMPs aim to outline measures to minimise any negative impacts incurred by the Project during the construction, operational and decommissioning phases. The ESMP's have been developed for each phase of the project and accompany the full ESIA as a separate Volume. Mitigation measures and monitoring programmes have been identified in all of the specialist investigations and were also drawn into the management plans for implementation.

The studies have concluded that the identified impacts can be mitigated to acceptable levels and furthermore that the various options that have been assessed are all viable alternatives with only slight differences between them. The project complies with local Mozambican legislation as well as the World Bank Performance Standards (OP 4.03) and EHS guidelines.

Therefore, the implementation of the identified mitigation measures will reduce any negative environmental and social impacts of the CTT project to an acceptable level and will enhance the positive impacts to maximize their effect on the surrounding communities.

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ACRONYMS/ABBREVIATIONS

Acronym or Abbreviation	Description
ADI	Area of Direct Influence
AII	Area of Indirect Influence
ALARP	As Low as Reasonably Practicable
ANE	National Road Administration
APE	*Agent Polyvalent Communitaire*
ARA	*Administração Regional de Águas*
ARI	*Acute respiratory infection*
BANP	Bazaruto Archipelago National Park
BFW	Boiler Feed Water
BOD	Burden of Disease
c-EMP	*Construction Environmental Management Plan*
CBD	Convention on Biological Diversity
CCGT	Combined Cycle Gas Turbines
CEDAW	Convention on the Elimination of All Forms of Discrimination against Women
CFM	*Caminhos de Ferro de Moçambique*
CFP	*Chance Find Procedure*
CHAA	*Critical Habitat Area of Analysis*
CHA	*Community Health Agent*
CHIS	*Community Health Information System*
CHMP	*Cultural Heritage Management Plan*
CIA	*Cumulative Impact Assessment*
CITES	*Convention on International Trade in Endangered Species*
CLO	*Community Liaison Officer*
CMR	*Contractor Management Review*
CORDIO	*Coral Reef Degradation in Indian Ocean*
CPF	Central Processing Facility

Acronym or Abbreviation	Description
CR	Critically Endangered
CRPD	Convention on the Rights of Persons with Disabilities
CSR	Corporate Social Responsibility
CSIR	Council for Scientific and Industrial Research
CTRG	Central Térmica de Ressano Garcia (Thermal Power Plant at Ressano Garcia)
CTT	Central Térmica de Temane
DALY	Disability Adjusted Life Year
DD	Data deficient
DHIS2	District Health Information System
DINAB	Directorate of Environmental Impact Assessment
DUAT	Direito do Uso e Aproveitamento da Terra
EBRD	European Bank of Reconstruction and Development
ECOW	Ecological clerk of works
EDM	Electricidade de Moçambique, E.P (Mozambique Power Company)
EEZ	Exclusive Economic Zones
EHS	Environmental, Health and Safety
EIR	Environmental Impact Report
EMP	Environmental Management Plan
ESHIA	Environmental, Social and Health Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EPs	Equator Principles
EPC	Engineering, Procurement and Construction
EPDA	Estudo de Pré-viabilidade Ambiental e Definição de Âmbito (Environmental Pre-feasibility and Scope Definition Report)
EQTs	environmental quality targets
EWT	Endangered Wildlife Trust

Acronym or Abbreviation	Description
FGD	Focus Group Discussion
FGR	Flue-Gas Recirculation
FSO	Floating, Storage and Offloading unit
FUNAE	*Fundo Nacional de Energia*
GAML	Golder Associados Moçambique Limitada
GHG	Greenhouse Gas
GRM	Grievance Redress Mechanism
HAZOP	hazard and operability study
HIA	Health Impact Assessment
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HCI	Homogeneous Charge Compression Ignition
HEL	Higher Explosive Limits
HSS	Health Systems Strengthening
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
HRSG	Heat Recovery Steam Generator
IAPs	Interested and Affected Parties
IBA	Important Birding Area
IEOP	Inhassoro Early Oil Project
IFC	International Finance Corporation
INP	*Instituto Nacional de Petróleo*
IP	*Industrial Park*
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature
kV	kilovolt
kW	kilowatt
LC	Least Concern

Acronym or Abbreviation	Description
LEL	Lower Explosive Limits
LFL	Lower Flammable Limit
LOC	Loss of Containment
LULUCF	Land Use, Land Use Change and Forestry
LPF	Liquids Processing Facility
LPG	Liquefied Petroleum Gas
MATIP	Mozambique Anchor Tourism Investment Program
MGEPP	Mozambique Gas Engine Power Plant (Project in Ressano Garcia, Mozambique)
MICOA	Ministério para a Coordenação da Acção Ambiental (Mozambican Ministry for the Coordination of Environmental Affairs)
MIREME	Ministry of Mineral Resources and Energy
MISAU	*Ministério da Saúde*
MITADER	Ministério da Terra, Ambiente e Desenvolvimento Rural (Mozambican Ministry of Land, Environment and Rural Development)
MMO	Marine Mammal Observer
MPI	Moz Power Invest, S.A.
MSDS	Materials Safety Data Sheets
MW	Megawatt
NCDs	Non-Communicable Diseases
NGO	Non-Governmental Organisation
NSI	No Significant area of Influence
NT	Near Threatened
OCGE	Open Cycle Gas Engines
oEMP	Operational Environmental Management Plan
OHSMP	Occupational Health and Safety Management Plan
ORC	Organic Rankin Cycle
PAC	Potentially Affected Communities

Acronym or Abbreviation	Description
PAR	Photosynthetic Active Radiation
PPZ	Partial Protection Zone
PSA	Production Sharing Agreement
RAP	Resettlement Action Plan
RPIP	Resettlement Planning and Implementation Programme
SAPP	Southern African Power Pool
SCADA	Supervisory Control and Data Acquisition
SCM	Site Conceptual Model
SCR	Selective catalytic reduction
SEP	Stakeholder Engagement Plan
SEPI	Sasol Exploration and Production International
SASS5	South African Scoring System Version 5
SGS	Société Générale de Surveillance
SNCR	Selective non-catalytic reduction
SNE	Sasol New Energy Holdings (Pty) Ltd
SP	Significance Points
SPDTM	Strategic Plan for the Development of Tourism in Mozambique
SPI	a Specific Pollution Index
SSA	sub-Saharan Africa
STE/CESUL	Projecto de Interligação da Rede Nacional de Energia Centro-Sul (Interconnection Project of South-Central National Energy Network)
STH	Soil-transmitted helminthiasis
STIs	Sexually transmitted infections
TEC	Temane Energy Consortium (Pty) Ltd
TLBs	tractor loader backactors
ToR	Terms of Reference
U	Uncertain

Acronym or Abbreviation	Description
UF	Ultrafiltration
UFL	Upper Flammable Limit
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAC	Visual absorption capacity
VCE	Vapour cloud explosion
VECs	Valued environmental and social components
VECs	*Valued Ecosystem Components*
VU	Vulnerable
WHO	World Health Organisation
WIO	Western Indian Ocean
WLE	Wet Low Emissions
WWF	World Wide Fund for Nature

1.0 INTRODUCTION

1.1 Background to the Project

The Mozambican economy is one of the fastest growing economies on the African continent with electricity demand increasing by approximately 6% - 8% annually. In order to address the growing electricity demand faced by Mozambique and to improve power quality, grid stability and flexibility in the system, Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE) in a joint development agreement is proposing the construction and operation of a gas to power facility, known as the Central Térmica de Temane (CTT) project. MPI's shareholding will be comprised of EDM and Temane Energy Consortium (Pty) Ltd (TEC). The joint development partners of MPI and SNE will hereafter be referred to as the Proponent. The Proponent proposes to develop the CTT, a 450 MW natural gas fired power plant.

The proposed CTT project will draw gas from the Sasol Exploration and Production International (SEPI) gas well field via the phase 1 development of the PSA License area, covering gas deposits in the Temane and Pande well fields in the Inhassoro District and the existing Central Processing Facility (CPF). A description of the PSA gas field and its regulatory management framework is included in a separate report[1]. Consequently, the CTT site is in close proximity to the CPF. The preferred location for the CTT is approximately 500 m south of the CPF. The CPF, and the proposed site of the CTT project, is located in the Temane/Mangugumete area, Inhassoro District, Inhambane Province, Mozambique; and approximately 40 km northwest of the town of Vilanculos. The Govuro River lies 8 km east of the proposed CTT site. The estimated footprint of the CTT power plant is approximately 10 ha once built, although during construction approximately 20 ha will be required to accommodate the plant footprint as well as the construction camp and contractor's laydown areas adjacent to the plant site (see Figure 1).

Associated infrastructure and facilities for the CTT project will include:

1) Electricity transmission line (400 KV) and servitude; from the proposed power plant to the proposed Vilanculos substation over a total length of 25 km running generally south to a future Vilanculos substation. [Note: the development of the substation falls outside the battery limits of the project scope as it is part of independent infrastructure authorised separately (although separately authorised, the transmission line will be covered by the Project ESMP, and the Vilanculos substation is covered under the Temane Transmission Project (TTP) Environmental and Social Management Plans). Environmental authorisation for this substation was obtained under the STE/CESUL project. (MICOA Ref: 75/MICOA/12 of 22nd May 2012)];
2) Piped water from one or more borehole(s) located either on site at the power plant or from a borehole located on the eastern bank of the Govuro River (this option will require a water pipeline approximately 11 km in length);
3) Access road; over a total length of 3 km, which will follow the proposed water pipeline to the northeast of the CTT to connect to the existing Temane CPF access road;
4) Gas pipeline and servitude; over a total length of 2 km, which will likely start from the CPF high pressure compressor and run south on the western side of the CPF to connect to the power plant;
5) Additional nominal widening of the servitude for vehicle turning points at points to be identified along these linear servitudes;

[1] See Summary of Upstream Gas Development Activities (Golder 2019).

6) A construction camp and contractor laydown areas will be established adjacent to the CTT power plant footprint, as well as a laydown area in Inhassoro Town in support of beach landing activities; and

7) Transhipment and barging of equipment to a temporary beach landing site and associated logistics camp and laydown area for the purposes of safe handling and delivery of large oversized and heavy equipment and infrastructure to build the CTT. The transhipment consists of a vessel anchoring for only approximately 1-2 days with periods of up to 3-4 months between shipments over a maximum 15 month period early in the construction phase, in order to offload heavy materials to a barge for beach landing.

   There are 3 beach landing site options, namely SETA, Maritima and Briza Mar (Figure 17). The SETA site is considered to be the preferred beach landing site for environmental and other reasons; it therefore shall be selected unless it is found to be not feasible for any reason; and

8) Temporary bridges and access roads or upgrading and reinforcement of existing bridges and roads across sections of the Govuro River where existing bridges are not able to bear the weight of the equipment loads that need to be transported from the beach landing site to the CTT site. Some new sections of road may need to be developed where existing roads are inaccessible or inadequate to allow for the safe transport of equipment to the CTT site. The northern transport route via R241 and EN1 is considered as the preferred transport route (Figure 4) on terrestrial impacts; however, until the final anchor point is selected and the barge route confirmed, the marine factors may still have an impact on which is deemed the overall prefereable route.

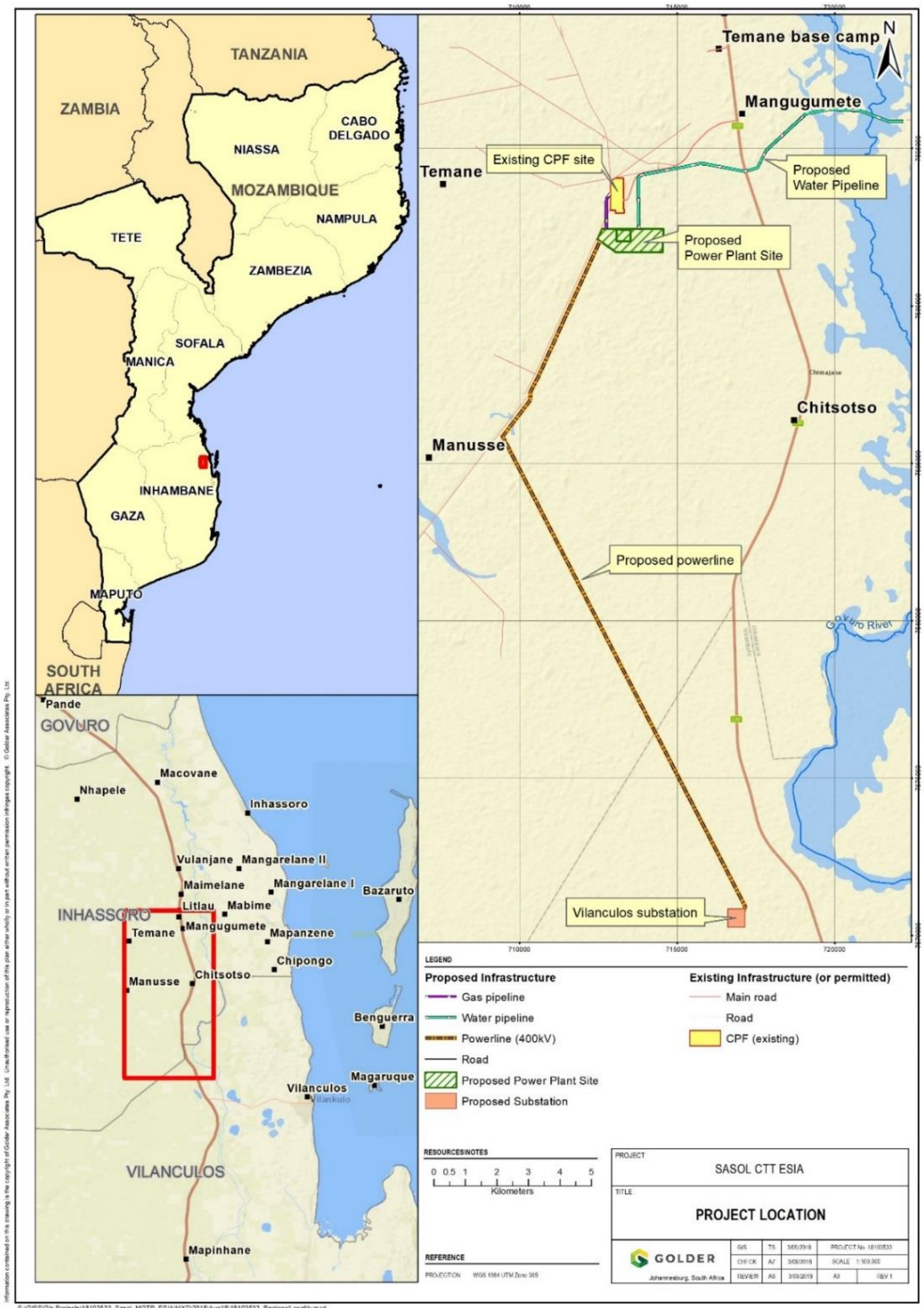

Figure 1: Project Location

1.2 Details of the Proponent

Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE) in a joint development agreement is proposing the construction and operation of a gas to power facility, known as the Central Térmica de Temane (CTT) project. MPI’s shareholding will be comprised of Electricidade de Mozambique E.P. (EDM) and Temane Energy Consortium (Pty) Ltd (TEC).

Dr. Aly Sicola Impija, board member of EDM, is the Proponent representative and will hold the environmental authorisation should it be granted.

Table 1: Proponent details

<table>
<tr><th colspan="2">MPI</th><th rowspan="1">SNE</th></tr>
<tr><td colspan="2">Moz Power Invest S.A. (MPI)
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1.3 Purpose of the Present Report

This document is the Environmental and Social Impact Assessment (ESIA) of the *Central Térmica de Temane* (CTT) Project in Inhambane Province, Mozambique, as described in section 1.1. The project is registered in terms of Mozambique's environmental law (Decree 45/2004 of 29 September amended by Decree 42/2008 of 4 November) with the Ministry of Land, Environment and Rural Development *(Ministério da Terra, Ambiente e Desenvolvimento Rural)* (MITADER) as a 'Category A' project. For 'Category A' projects, an Environmental and Social Impact Assessment (ESIA) must be prepared by independent consultants as a basis for whether or not environmental authorisation of the project is to be granted, and if so, under what conditions.

The ESIA will be undertaken in accordance with Decree 54/2015 of 31 December. The new Regulation on the Environmental Impact Assessment process has been in force since April 2016, after revoking Decrees 45/2004 of 29 September and 42/2008 of 4 November as amended) which were in place when phase 1 of the work was undertaken.

Golder Associados Moçambique Limitada (GAML) has been appointed by the Proponent to undertake the CTT ESIA according to local legislative and international lending standards.

1.4 Study team

Table 3 shows the ESIA study team. The team provides a good balance between local and international expertise. The core team members have worked extensively in Mozambique and elsewhere in Africa.

GAML is part of the Golder Associates group, which is comprised of more than 165 offices worldwide. Golder Associates was established in 1960 and is a global, employee-owned, organisation that employs more than 6,500 people. Golder provides a wide range of independent consulting, design and construction services to clients in specialist areas of earth, environment and energy. Golder is known as an industry leader in Health & Safety and as a responsible global citizen. Golder operates from offices located throughout Africa, Asia, Australasia, Europe, North America and South America. The company has extensive knowledge of local cultures, languages and regulatory requirements.

GAML has extensive energy, oil and gas experience, and has been responsible for a number of Sasol's previous ESIA processes in the project areas. GAML is registered with the Ministry of Land, Environment and Rural Development (MITADER) to conduct ESIAs in Mozambique and has extensive experience in undertaking such studies.

The project leads for this ESIA and their contact details are as follows:

Table 2: Contact details of ESIA leads

ESIA Lead	Organisation/Location	Contact Details
Jamila Das Neves	Golder Associados Moçambique Limitada	6th Floor, Millennium Park Building, Vlademir Lenine Avenue No 174, Maputo, Moçambique Tel: +258 21 301 292 E-mail: JDasneves@golder.com
Aiden Stoop	Golder Associates Africa (Pty) Ltd (South Africa)	Building 1, Golder House, Magwa Crescent West Maxwell Office Park, Waterfall City, Midrand, South Africa Tel: +2711 254 4800 E-mail: AStoop@golder.co.za

Table 3: ESIA team

Team Member	Responsibility	Organisation/Location
Jamila Das Neves	In-country ESIA Lead, Legal and Stakeholder Engagement	Golder Associados Moçambique
Aiden Stoop	ESIA Lead & Project Manager	Golder Associates, South Africa
Antonio Pimentel	Country Lead Consultant	Golder Associados Moçambique
Marcia Da Silva	ESIA Co-ordinator and administrator	Golder Associados Moçambique
Gisela Boavida	Stakeholder Consultation (EPDA & ToR phase)	Golder Associados Moçambique

Team Member	Responsibility	Organisation/Location
Zito Macane	Stakeholder Consultation: Xitsua Translator	Independent (Mozambique)
Lance Coetzee	Air Quality	Golder Associates, South Africa
Michael van Niekerk	Greenhouse Gas	Golder Associates, South Africa
Warren Aken	Aquatic Ecology	Golder Associates, South Africa
Andrew Zinn	Terrestrial Ecology & Ecosystem Services	Golder Associates, South Africa
Rejale Macane	Field Technician: Biodiversity Surveys	Independent (Mozambique)
Simplicio Chivambo	Fauna and Flora	Golder Associados Moçambique
Leonardo Adamowicz	Archaeology and Cultural Heritage	Patrimoz Serviços de Consultoria, Moçambique
Francois Malherbe	Noise	FM Acoustic Consulting, South Africa
Willie Bouwer	Traffic	Gibb (Pty) Ltd, South Africa
Cândida Boavida	Waste	Golder Associados Moçambique
Ilze Snyman	Soil	Golder Associates, South Africa
Fransisco Nato	Hydrogeology	Golder Associados Moçambique
Trevor Coleman	Water Resources	Golder Associates, South Africa
Andre Mota	Field Technician: Bio-physical	Golder Associados Moçambique
Dr Mark Divall	Health	Shape Consulting, South Africa
Dr Sithandiwe Ntila	Social	Golder Associates, South Africa
Helder Nhamaze	Social	KULA Associates, Mozambique
Raufo Usta	Tourism	Independent (Mozambique)
Johan Bothma	Visual	Golder Associates, South Africa

None of the members of the ESIA study team have any vested interest in the CTT project.

1.5 Structure of the report

The ESIA comprises 3 volumes and is made up as follows:

Volume 1: Executive Summary and ESIA Main Report

The report summary is prepared to provide lead agencies with sufficient information about the findings of the main report to make a decision about the project.

The main report is divided into three parts. Part 1 includes general project information, the legal framework and the stakeholder engagement process. Part 2 sets out the project baseline for the receiving environment. Part 3 covers all aspects of project impact, mitigation and monitoring.

Records of consultation meetings with lenders, affected people, government agencies and nongovernmental organizations (NGOs); and a list of associated reports will be included in appendices to the main ESIA report.

Volume 2: Environmental and Social Management Plans (ESMPs)

The Environmental and Social Management Plans (ESMPs) are contained in Volume 2. Each ESMP is divided into construction, operation and decommissioning phases. Specific sub-plans dealing with environmental aspects and components are included in each plan.

Volume 3: Specialist Studies

Specialist studies are included, which have been used to inform the ESIA.

The Volume 1 is structured as indicated in Figure 2 below.

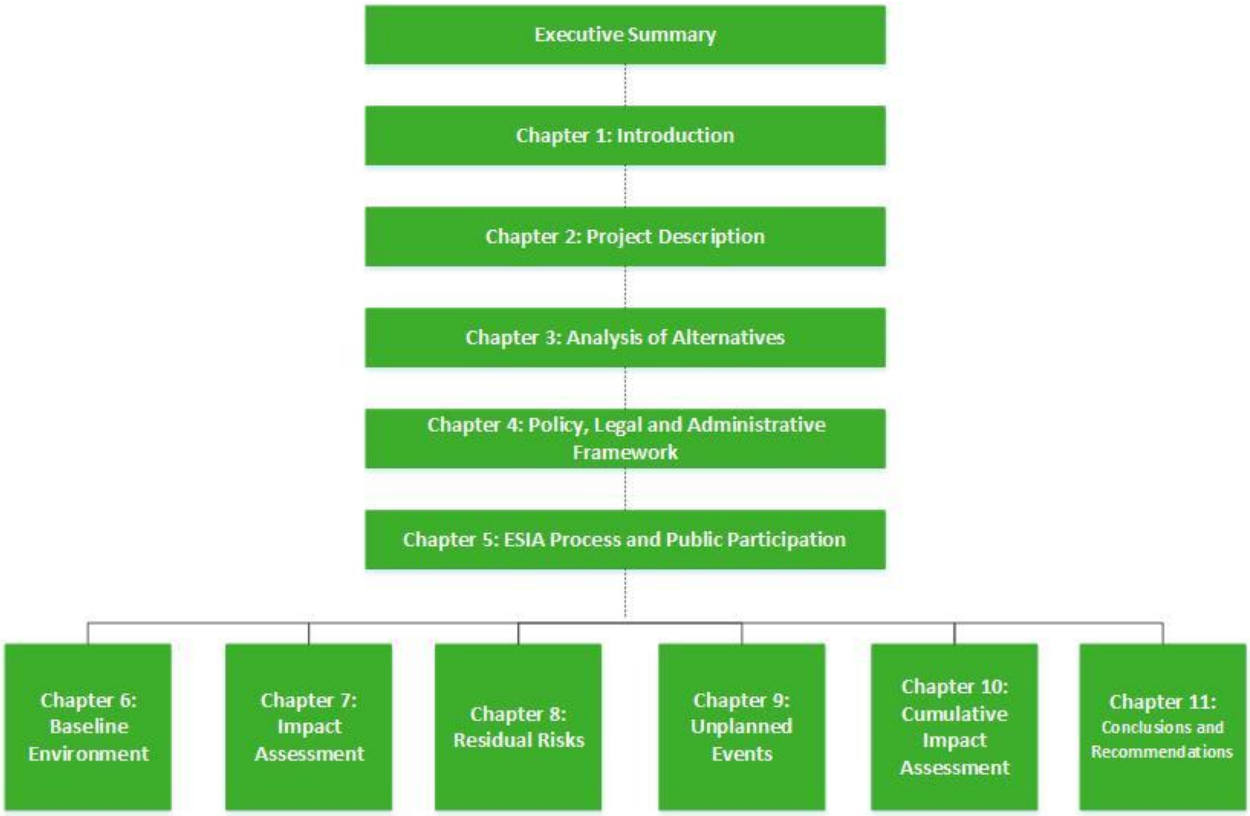


Figure 2: ESIA report structure

2.0 PROJECT DESCRIPTION

2.1 Gas to Power Plant and Key Infrastructure

The Central Térmica De Temane (CTT) project will produce electricity from natural gas in a power plant located 500 m south of the CPF. The project will consist of the construction and operation of the following main components (Figure 4):

- Gas to Power Plant with installed capacity of approximately 450 MW;
- Gas pipeline (±1 - 2 km) that will feed the Power Plant with natural gas from the CPF or from an alternative gas source;
- 400 kV Electrical transmission line (±25 km in length) with a servitude of 100 m that will include a fire break (vegetation control) and a maintenance road to the Vilanculos sub-station. The transmission line will have a partial protection zone (PPZ) of 100 m width (i.e. 50 m on either side of centre line). The transmission line servitude will fall inside the PPZ;
- Water supply pipeline to one or more borehole(s) located either on site or at borehole(s) located east of the Govuro River;
- Paved access road to the CTT site and gravel maintenance roads within the transmission line and pipeline servitudes;
- Temporary beach landing structures at Inhassoro town for the purposes of delivery of heavy and oversized equipment and infrastructure to build the power plant. This will include transhipment and barging activities to bring equipment to the beach landing site for approximately 1-2 days with up to 3-4 months between shipments over a period of approximately 8-15 months; and
- Temporary bridge structures across the Govuro River, as well as possible new roads and/or road upgrades to allow equipment to be safely transported to the CTT site from the beach landing during the construction phase.

Figure 3: Examples of gas to power plant sites (source: www.industcards.com and www.wartsila.com)

The final selection of technology that will form part of the power generation component of the CTT project has not been determined at this stage. The two power technology options that are currently being evaluated are:

- Combined Cycle Gas Turbine (CCGT); and
- Open Cycle Gas Engines (OCGE).

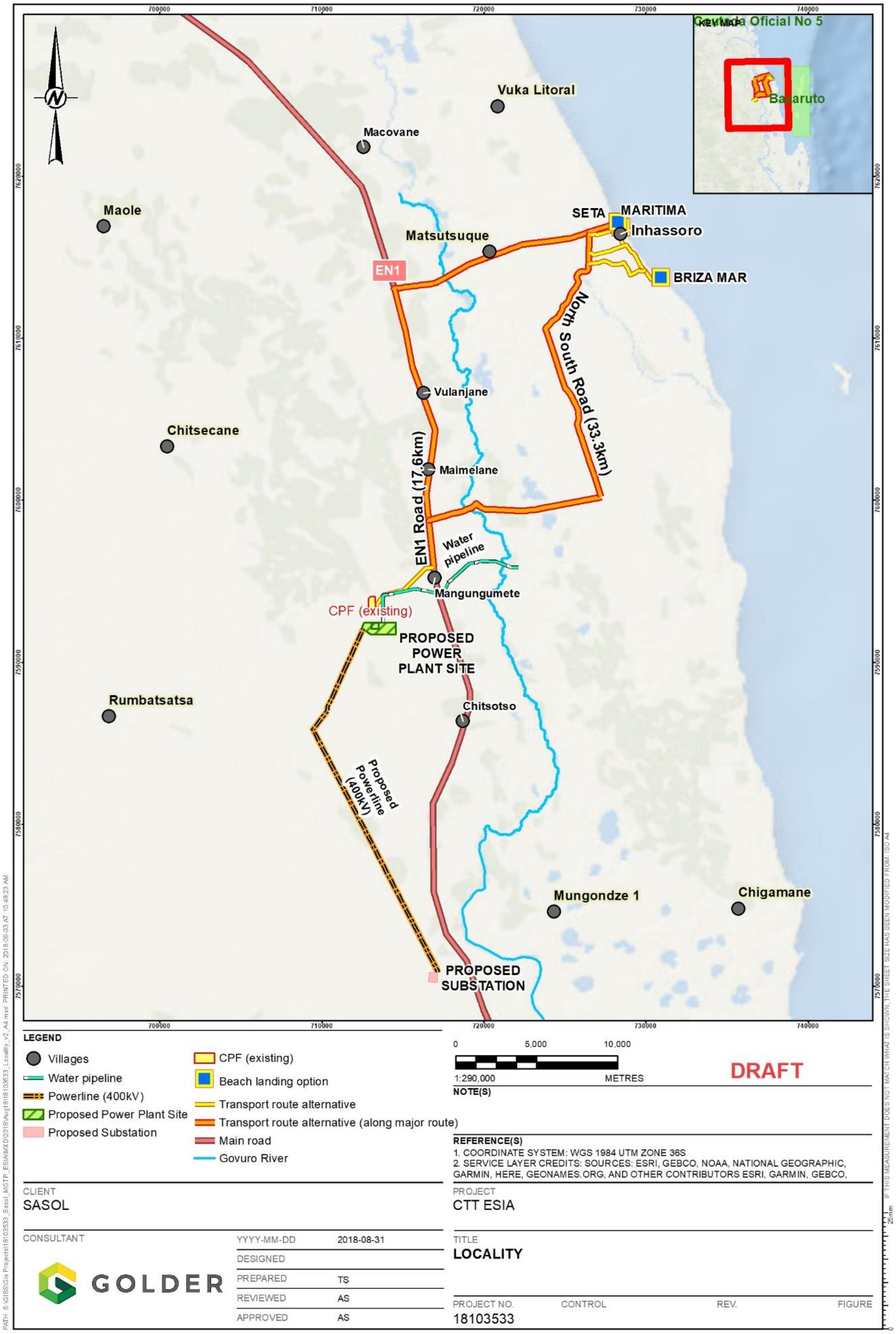


Figure 4: CTT Key Infrastructure

2.1.1 Combined Cycle Gas Turbines

The CTT will be composed of the following possible configurations for power output of up to 450 MW:

- Combined Cycle Gas Turbines (CCGT) of a capacity in the range of 300 – 400 MW; and
- Open Cycle Gas Turbine (OCGT) of a capacity in the range of 0 - 100 MW.

The power output from each of the gas turbines will be limited to a maximum of 100 MW under the reference site conditions. This limitation, for gas turbines, is provided by the off-taker.

The configuration of the Combined Cycle Gas Turbines will depend on the power output of the gas turbine adopted for the project (these being standard products from machine suppliers). Air Cooled Condensers (ACC) will be adopted in any case, so as to minimise the use of water by the power plant.

The main power block of a CCGT is made up of the following components:

- Gas Turbine (GT): producing power with the gas combustion and driving of electrical generators;
- Heat Recovery Steam Generator (HSRG): that converts the heat from the gas turbine exhaust fumes into steam (as part of the water steam cycle); and
- Steam Turbine (ST); converting the steam expansion into mechanical energy and electrical energy in a dedicated generator.

Within the CCGT, each GT is coupled with an HRSG. Several HRSGs may produce the steam for an ST.

Each ST is coupled with one ACC (Air cooled condenser), condensing the steam and directing it to the HRSG in a closed circuit. Depending on the output of the gas turbine to be adopted for the CTT, the configuration of the CCGT may be one of the following:

- 1 train with: 2 GTs + 2 HRSGs + 1 ST;
- 1 train with: 3 GTs + 3 HRSGs + 1 ST;
- 1 train with: 4 GTs + 4 HRSGs + 1 ST; and
- 2 identical trains with: 2 GTs + 2 HRSGs + 1 ST.

As indicated before, the CCGTs may be complemented with 1 or 2 Open Cycle Gas Turbines. This add-on will consist of a gas turbine, burning gas, and converting this energy to electrical power via the rotational motion of the turbine, driving the rotor of an electrical generator(s). The exhaust fumes are directly discharged to the atmosphere.

The unit will continuously produce electrical power to be delivered to the electrical national grid by burning natural gas received from the CPF or an alternative gas source. The CCGT Power Plant is expected to run on a base load operation but with some flexibility to operate in a load following mode, in particular to maximise output during the evening peak load period.

The process flow diagram presented in Figure 5 provides, for reference only, a CCGT configuration with 2 GTs, 2 HRSGs and 1 ST. Natural gas that is fed to the power plant may be heated, its pressure reduced, and sent to each gas turbine fuel skid and burner. The gas turbine burners may be of dry low emission type (DLN). Exhaust flue gases from each gas turbine are at around 600°C and will enter the respective Heat Recovery Steam Generator (HRSG) which will recover heat from the exhaust of the gas turbine. The heat recovery steam generators will generate steam at either a single or multiple pressure. The HRSGs is expected to be of natural circulation type, with horizontal flue gas flow.

Supplementary firing within the inlet duct of the HRSG may be implemented in order to maximise the power output of the power plant during peak periods or during extreme weather conditions, when the performance of the gas turbines is reduced. Flue gases will be cooled and discharged to the atmosphere at a suitable temperature, reducing any risk of condensation in the HRSGs and stack.

A continuous emission monitoring system (CEMS) will be in place in order to analyse the exhaust gases' flow rate and components, mainly Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2) and particulates as required by the local Authorities. A by-pass stack will also be installed for each gas turbine to allow the facility to operate the gas turbines in open cycle mode when the HRSGs or steam turbines are out of service. A typical schematic for a single pressure, non-reheat with bypass is shown in Figure 5 below.

Demineralised water will be pre-heated before it is sent to the HRSGs, to avoid acid corrosion on the HRSG coils by the exhaust gases. The hot make-up demineralised water will then be fed to a degassing unit and pumped to the economiser in the HRSGs. It will then pass through the evaporator and superheater sections of the HRSGs. Final steam generation pressure will be imposed by the downstream system.

The superheated steam (typically around 80 barg) is expanded in the steam turbine producing mechanical power which is then converted to electric power in the generator driven by the turbine rotor. The exhaust conditions are typically at vacuum to extract maximum work out of the unit (best efficiency). The exhaust steam/water mixture from steam turbine is fully condensed by the Air-Cooled Condenser (ACC).

The condensate is collected, and a small portion is used as condensing medium for the vacuum system and for the steam turbine gland seal condenser, whilst the majority is returned to the HRSG to replicate the described steam cycle. The water quality is controlled by the injection of suitable chemicals and by blowing down a small quantity of boiler water. Oxygen scavenger and amine injection will be provided to eliminate the residual oxygen and raise the pH to the value prescribed by the standards for the boilers, while phosphate injection at steam drums will be provided to control the boiler water pH directly. Steam drum blow downs (expected ca. 1% of total recycle flow) will control the dissolved (mineral) solids in the boiler water and will be sent to the waste water treatment facility for further work-up.

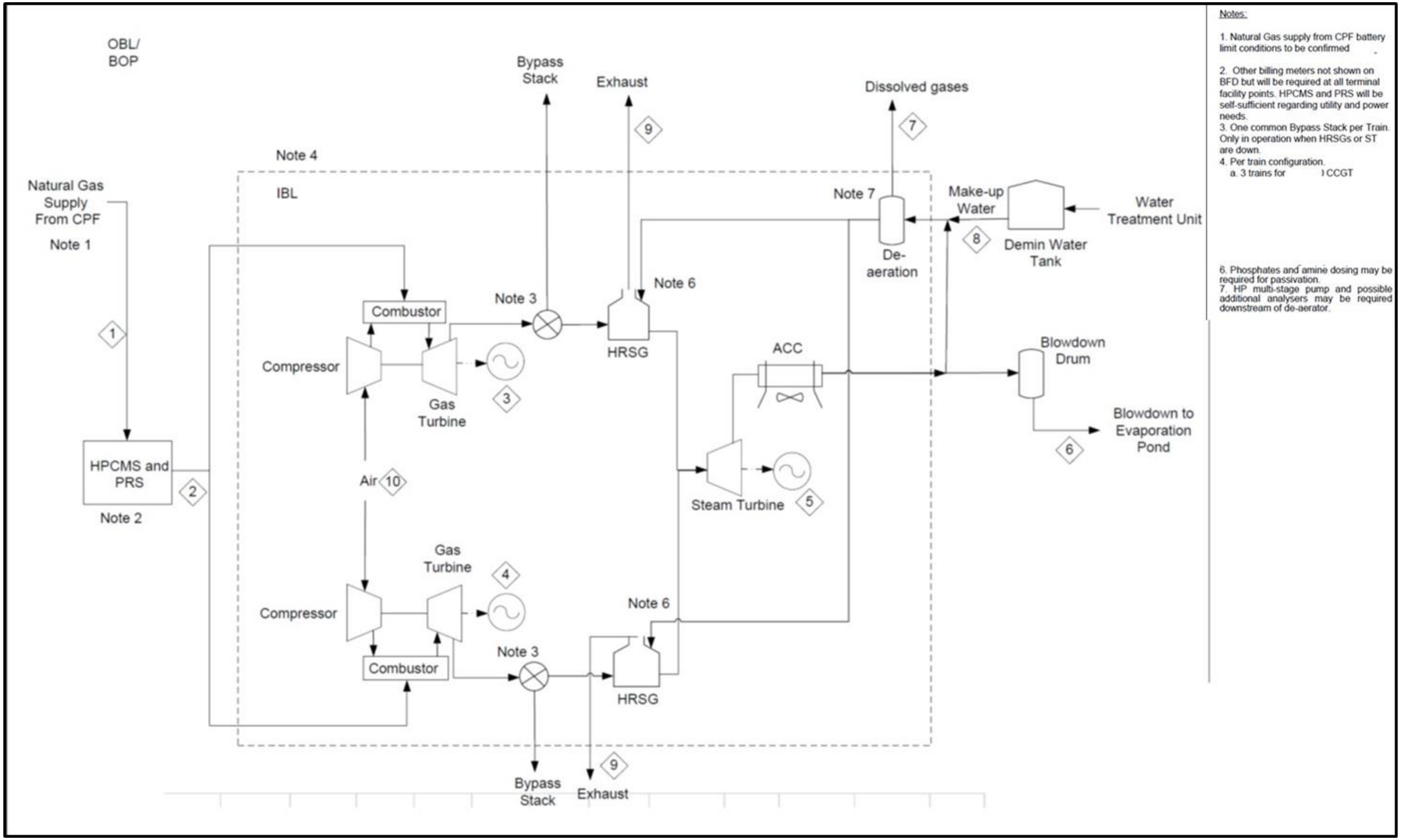


Figure 5: Basic process flow of Gas Turbines

2.1.2 Open Cycle Gas Engines

The OCGE configuration would be based on 24 Gas Engines of about 18 - 20 MW each, comprising of the following equipment:

- Gas Engines;
- Air Insulated Switchyard (AIS); and
- Step-Up Transformer:

In the larger engine configuration, only 24 engines will be installed (22 in operation). Each engine generates around 18 - 20 MW. Due to the relatively low Methane Number of the natural gas (~70), a derating of 12% is expected on the gas engine. As a result, approximately. 24 engines may eventually be in operation with 2 spares. Natural gas that is fed to the power plant is heated and sent to each gas engine fuel skid and burner. The gas engines are equipped with water and oil radiator coolers mounted on the engine hall. Lubrication oil is used to primarily lubricate, but also to cool the engines. The engine exhaust stacks are ca. 28 m high and bundled together. Each stack will have its own silencer. The exhaust manifold will not be designed to allow for retro coupling to a heat recovery boiler. Heat recovery using Heat Recovery Steam Generator (HRSG) or Organic Rankin Cycle (ORC) to generate additional power and increase thermal efficiency may be considered during the detailed design phase of the project.

Water quality is not as critical as with the gas turbines option, therefore the demineralization unit is not required. Since the HRSG and steam turbine is not required in this case, water quantities are much lower than for gas turbines. The main water use in the process is for gas engine cooling. Generators will produce power at a voltage of either 11 or 15 kV depending on fault levels calculated. Power generated will be sent via an air insulated high voltage substation where the voltage is stepped up to 400 kV and a 25 km 400 kV transmission line connected to the substation near Vilanculos. Refer to Figure 6 below for a basic process flow illustration of Gas Engines.

Table 4 below outlines a simplified comparison between Gas Turbines and Gas Engines. It should be noted that these technology options are further evaluated within the ESIA in subsequent chapters.

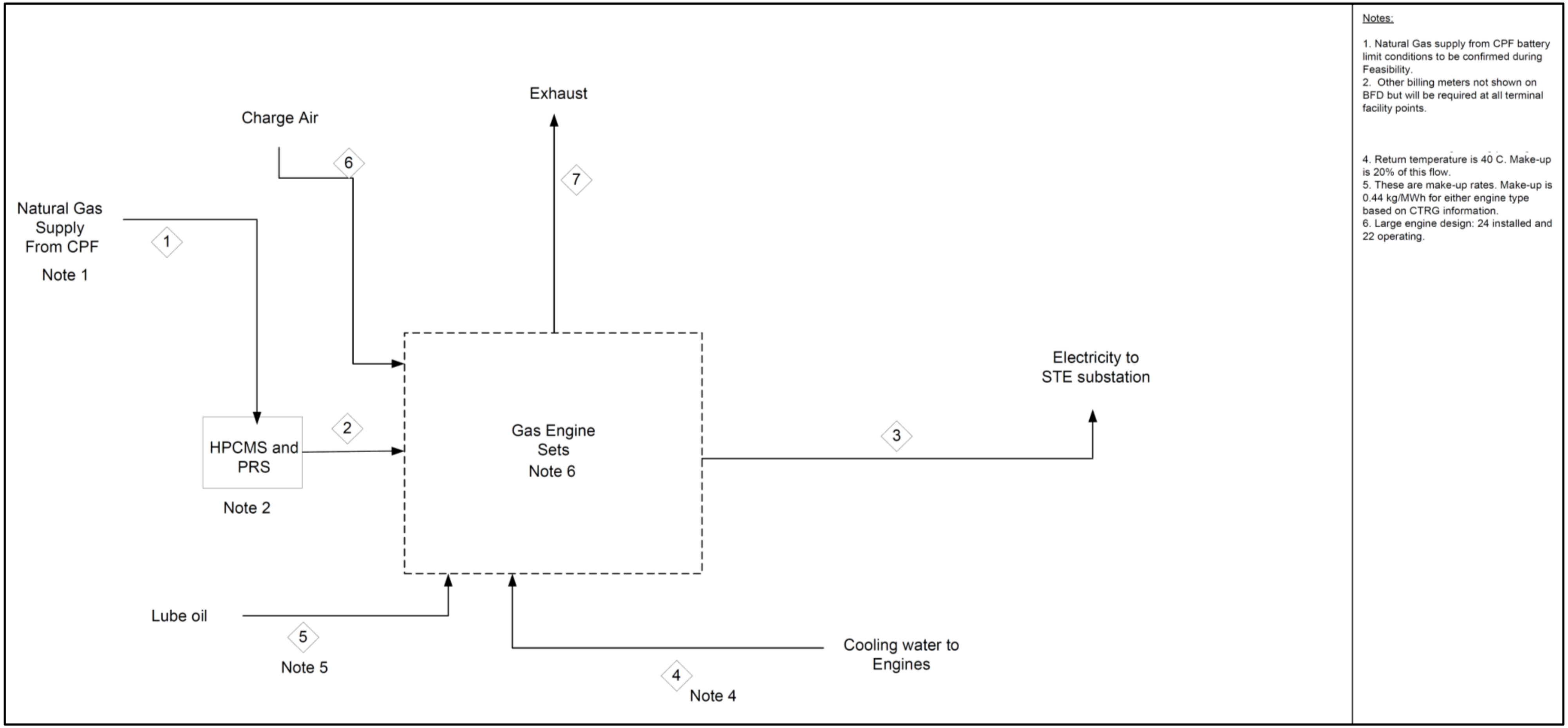


Figure 6: Basic process flow of Gas Engines

Table 4: Simplified comparison of Gas Engines vs Gas Turbines

Technology Selection Category	Gas Engine		Gas Turbine	
Capital expenditure	✓	Higher cost (USD$>1,000 per kW of installed capacity)	✗ ✗	Cheaper than engines (per kW of installed capacity) for power outputs of 200 MW or more. In Combined Cycle mode, more capital needed for demineralised water production, boilers, condensors and steam turbine
Operating costs	✗	Approx. 20 % more expensive than turbines (USA$0,05 per kW hour)	✓	Lowest cost (USA$0,04 per kW hour)
Maintenance Costs	✗	Higher maintenance intensity and more expensive due to piston action	✓	Lower than GEs due to having rotating parts.
Thermal efficiency	✓ ✗	Most efficient in open cycle (42 %) Lower efficiency vs turbines in combined cycle (CC) (46 %) in Reference Site Conditions.	✗ ✓	Less efficient than engines in open cycle (<36%) though aeroderivative are on par with gas engines. Higher efficiency vs. engines in combined cycle (up to 58% but efficiencies of ~53% are expected on Temane Reference Site Conditions)
Ramping (ability to incrementally increase electricity generation capacity)	✓	Excellent ramping due to modular configuration even in CC mode (low exhaust temps)	✗ ✗	Increased degeneration with ramping. In CC mode, ramping impacted more as high temps subject HRSG to thermal stress and also because ST has slow start-up times.
Availability and firm capacity	✓ ✓	Above 95% and in n+2 redundancy configuration can achieve 98+% In CC mode, approximately about 0 - 6.25% of power output lost if a GE goes down.	✗ ✗	Typically >94% possible depending on configuration proposed, over rolling duration of 4 - 5 years. In CC mode, a 25 - 45 loss in power is possible depending on the GT/HRSG configuration.

Technology Selection Category	Gas Engine		Gas Turbine	
Temperature, loading and altitude degeneration (Impact on electrical output capacity)	✓	No major degeneration at loads, at temperatures up to 40ºC and at altitude.	×	Lower power outputs (up to 15% loss) and lower efficiency at partial loading (below 60% loading) for the OCGT. In case of CCGT operation, partial loading has a minor impact on efficiency. For gas turbines in OCT, a reduction of the power output is observed fortemperatures above 30 ºC and for altitude above sea level. This loss can be minimised with the use of air inlet cooling, such as evaporative cooling, fogging or chillers.
Water requirement (see also cooling requirements)	✓ ×	Less than typical GTs In CC mode, water consumption much the same as CCGT.	✓ × ×	New FlexAero GT's do not require water for NOx suppression. In CC mode additional water required but if recycled, overall make-up can be kept low though still somewhat higher than GEs.
Water quality required	✓ ×	In OC (Open Cycle) mode, only need RO treatment. In CC mode will need demineralised quality and will need to treat salts	× ×	Even in OC mode, will need demin water quality when water used for NOx control (although unlikely for CTT site). In CC mode will need demineralised quality and will need to treat salts.
Modularisation/ Construction logistics	✓	Skid mounted – easy to install Generally heavier than the turbines and will therefore require heavier logistics for transportation and installation	✓ ✓	High Power:Weight ratio. Low foundation loads.
Degradation with aging	✓	Less than 2 % over life cycle	×	More than 3 % over life cycle

Technology Selection Category	Gas Engine		Gas Turbine	
Project Time	✓	Shortest construction and commissioning period (18-24 months)	×	Longer than gas engines to construct and commission (18 - 24 months for OCGTs and up to 30 months for CCGTs)
Lube oil requirements	×	Uses roughly 10 times more oil than turbines	✓	Les oil than engines

The following components are also being assessed in terms of feasibility for the best technological choice for the CTT project.

- Lube oil management;
- Emission control;
- Auxiliary systems directly associated with the steam turbines and generator sets, such as transformers;
- Electrical equipment (including power block sub-station) and materials (including interconnecting cables) directly associated with the generator sets and their auxiliary systems, up to the connections to the common switchyard or to the transmission line;
- Control systems (including equipment, control room, interconnecting cables, materials and software) up to the connections to an overall (common) Power Plant Supervisory Control and Data Acquisition (SCADA) or distributed control system;
- Water supply source and volumes required;
- Utility and process systems and piping associated with the CTT plant site. This will include flocculated water for cooling water and potable water, fire water, sewers, etc. Including utilities and power required for start-up and construction; and
- For CCGT only, demineralised water supply including de-aeration, dosing, regeneration, handling of spent/regenerated products, inter alia.

Raw Water Treatment System

The Raw Water Treatment System provides the following qualities of water:

- Raw water (clarified only): for firefighting;
- Potable water; and
- Demineralised water (for the steam cycle, turbine air inlet cooling etc).

The raw water from either borehole may not have to undergo clarification due to the low suspended solids content (<10 mg/l). Based on this, it was also decided not to install sand filters. Raw water is pumped directly to the combined Raw Water/Fire Water reservoir tank. Although the suspended solids are below 10 mg/l and will not influence pump and valve operation, the pump suction is at a height of 500 mm to allow settling of any potential solids and sludge that may form from ingress of dust for example. From the Raw Water/Fire Water reservoir tank, the water is pumped to the Ultrafiltration package. The Ultrafiltration (UF) is a pre-treatment step for the Reverse Osmosis (RO) unit. It filters out the suspended solids and bacteria.

The permeate from the UF serves as the feed to a chlorination step to produce potable water and it also feeds the RO unit. The UF backwash is collected in a sump and pumped to the evaporation pond. The RO is a 2 stage RO unit. It reduces the TDS content by 90% to 95% per stage and result in a permeate with approximately 4 mg/l TDS. The permeate from the RO unit is pumped to the Ion Exchange unit. Brine reject from the RO unit is pumped to the evaporation pond. A mixed bed polishing Ion Exchange Unit is the last step in the process. It produces water of the required Boiler Feed Water (BFW) feed quality for the HRSG.

At this early stage in the project a provisional layout of infrastructure footprints, including the proposed linear alignments is indicated in the locality map in Chapter 1.0 above. A conceptual layout of the CTT plant site is shown below in Figure 7.

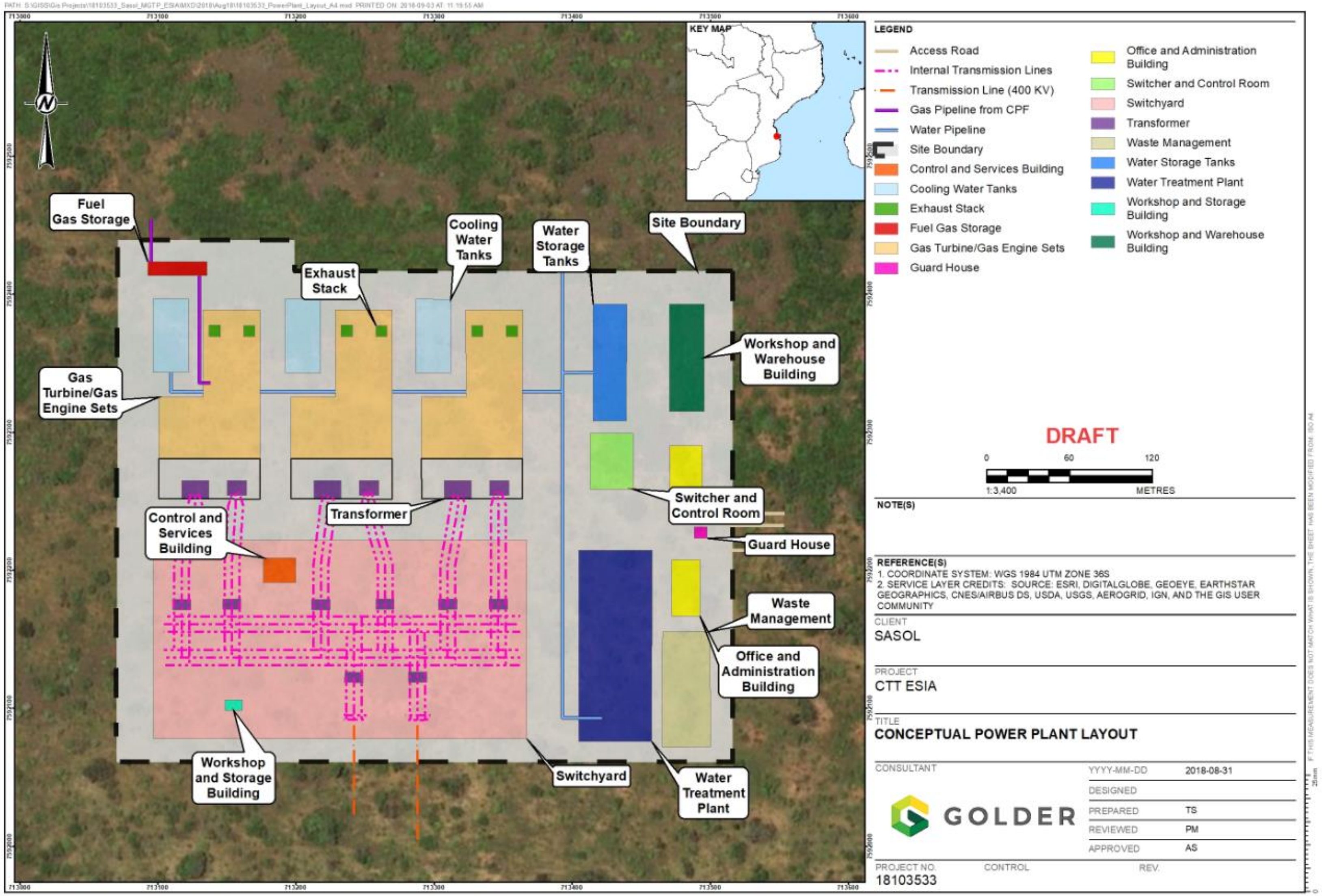


Figure 7: Conceptual layout of CTT plant site

2.2 Ancillary Infrastructure

The CTT project will also include the following infrastructure:

- Maintenance facilities, admin building and other buildings (work shop, warehouse etc.;
- Telecommunications and security;
- Waste (solid and effluent) treatment and/or handling and disposal by third party, (ablution facilities will be a combination of septic tanks and French drains/ soak away pits);
- Site preparation, civil works and infrastructure development for the complete plant;
- Construction camp (including housing/accommodation for construction workers); and
- Beach landing laydown area and logistics camp.

2.3 Gas Pipeline

A gas pipeline will be established from the existing CPF to the CTT plant, or an alternative source, to supply the required natural gas for electricity generation. The pipeline will be buried to a depth of approximately 1 m below ground level (bgl). The depth of burial is intended to minimise the risk of pipeline exposure due to erosion gulley's or accidental excavation. It is estimated that the diameter of the gas pipeline will be between 6 – 14" composed of welded carbon steel and will be approximately 1 – 2 km in length. It is estimated that the gas pipeline will have a mean flowrate of 68,000 Sm^3/h and peak flowrate of approximately 87,000 Sm^3/h. The minimum requirement is that the temperature of the gas is at least 5°C above the hydrocarbon dew point at the delivery pressure. The pressure of the delivered gas will be approximately 60 barg, although this may differ once the final technology decision is made and could fall within a range of 45 - 55 barg.

The outer surface of the pipe is likely to be encased in a 3-layer polypropylene coating, in order to inhibit corrosion. Welded joints are protected using a heat shrink wrap sleeve, applied after the weld is completed. The pipeline is buried with a surrounding cushion of frictionless material, typically a well-graded sand without rocks or large stones in it, to prevent damage to the pipe coating during the process of pipelaying or during operation. An impressed current Cathodic Protection system is used to apply a small electrical current to the metal surface of the pipeline. Combined with a sacrificial anode, this stops the pipe from corroding. There is no risk to humans or animals caused by this system. Taking into account current methods of pipe manufacture, pipeline construction and maintenance and cathodic protection, the design life of a pipe buried according to these specifications is likely to exceed 30 years. Once the contractor's obligations have been met with respect to the reinstatement of topsoil, and the warranty period has expired, the responsibility for rehabilitation maintenance along the gas pipeline reverts to the proponent. Rehabilitation is checked annually and, where necessary, action is taken to maintain the grass, control erosion gulley's or to remove invasive species.

The trench for the gas pipeline is typically excavated using large tractor loader backactors (TLBs) or occasionally tracked vehicles in very difficult conditions (refer to Figure 8). In the study area, where deep sandy soils exist, blasting is unlikely to be necessary to excavate the trench to full depths. Trench construction is undertaken by stripping the topsoil and placing it in a windrow along the side of the trench opposite to the construction vehicles. Trench spoil is then removed and windrowed on the same side of the trench. The pipe is brought onto site by low loaders and is lifted by mobile cranes and placed on blocks, in rows, next to the trench. The pipe ends are then reamed, butted together and welded. Welding is done by highly skilled certified welders. The integrity of each weld is checked using X-ray methods, which are capable of detecting very fine faults. The shrink wrap sleeve is then applied and heated, in order to seal the welded joint.

The pipe coating is checked for defects using a handheld device which is capable of detecting pinhole-sized flaws when moved over the pipe. These are marked and repaired.

The pipe is then lifted into the trench by side booms using slings, typically in 100 m welded sections. The graded material is placed around the pipe, following which the remainder of the excavated material is replaced. The backfill is not compacted and is left slightly mounded over the trench to allow for settlement.

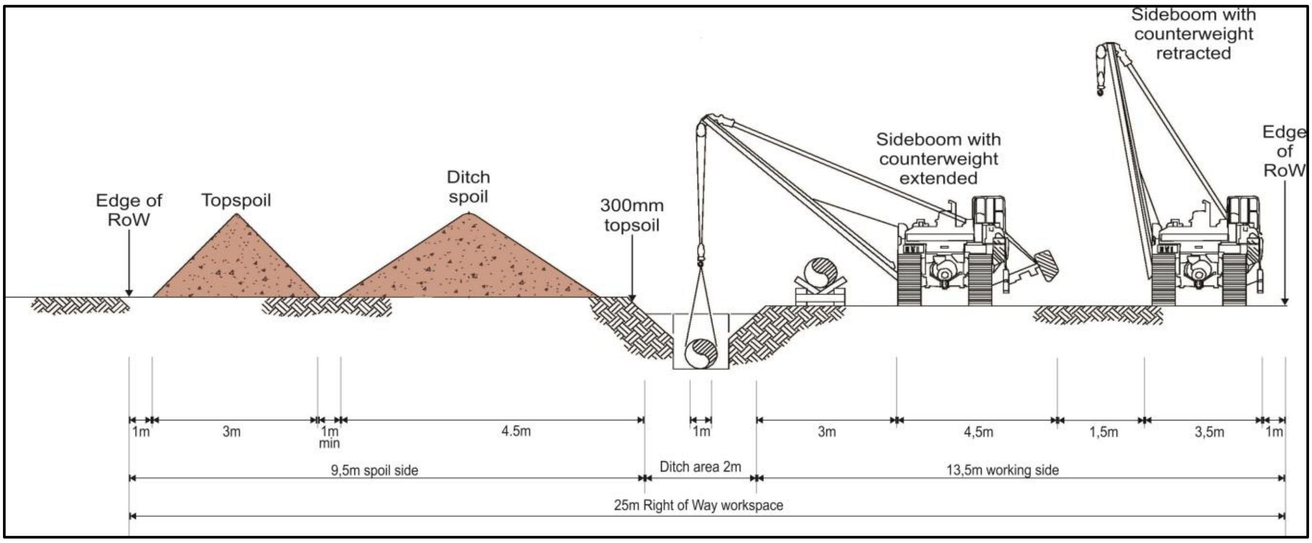


Figure 8: Schematic diagram showing the construction train for a typical gas pipeline. Due to the small diameter of gas pipelines, the construction right of way width does not typically need to exceed 25 m

After the trench is filled in, topsoil is recovered from the windrowed stockpile and replaced over the surface of the trench and surrounding disturbed area. Current practice in the Temane area is to allow the pipelines to rehabilitate from the natural seed beds in the soil and by colonisation from the surrounding area. Borrow pits are sometimes required for pipeline bedding (sand). The location of borrow pits for the project has not been determined yet but existing borrow pits, used to supply the previous construction projects or maintenance activities, will be re-opened in preference to opening new borrow pits.

Hydrotesting

The commissioning of a gas pipeline involves pressure testing, which is a mean of checking that all of the pipes and welds in a pipeline can withstand the pressures under which they will be operated. The CTT gas pipeline will be hydrotested, which means that they are filled with water in sections and are subjected to pressures that exceed the maximum design pressure by 50%. If the pipeline shows no sign of de-pressuring, then it is considered to be sound and the next section is tested. Water used for pressure testing is typically obtained from existing boreholes and may be re-used in the following section of the gas pipeline, if necessary. The quantity of water required for a 1 km section of an 8" pipeline is around 32 m^3. Depending on a number of variables, including the period of time in which the water stands in the pipes, biocides and corrosion inhibitors may be added to the water. The specification for these products and the proposed method of dealing with the wastewater is normally put forward by the contractor as a part of a suite of required best practice Method Statements.

It should be noted that there will be isolation and emergency shut-off valves at the start and end of the gas pipeline, in addition to maintenance valves (pigging valves). It has been assumed that the design standards for pipelines, general safety standards and inspections carried out will be aligned with Sasol's current practices at the CPF and Temane/Pande wellfields.

2.4 Water Pipeline

A buried water pipeline will be established from either a borehole on site or from one east of the Govuro River (approximately 11 km away).

For either options it will be an HDPE pipe of approximately 6-inch *150 NB) in diameter to cater for the water demand of the project for either technology. Should the option to utilise a borehole on the east of the Govuro River be chosen, the pipeline will follow existing CPF pipeline servitudes and will cross the Govuro River by means of existing steel pipe sleeves that are already installed (pipe-jacked) under the river to ensure the safety of the pipeline and minimal disturbance to the river. Should there be no pipe sleeves available to use, then additional sleeves will be installed to accommodate the water pipeline.

2.5 Project Schedule

It is expected that the following CTT project timeframes will be followed:

- **Construction**: 18 - 24 months;
- **Operations** (design life): 25 years (although plants are often re-furbished and the life extended); and
- **Decommissioning**: 18 - 24 months.

The above timeframes are indicative and will be refined depending on the technology and supplier selected. These timeframes have been used to inform the assessment of impacts in this ESIA.

2.6 Employment

The labour force is still to be determined as it is influenced by the type of technology to be selected for the construction and operation of the CTT, as well as the selected supplier or vendor. However, the following indicative numbers can be used for planning purpose and have informed the ESIA:

- Construction Phase:
  - Gas Turbines: approximately 850 people; and
  - Gas Engines: approximately 690 people.

It is envisaged that the construction phase spilt between locals and expatriates will be a ratio of approximately 85% to 15% respectively.

- Operational phase:
  - For both Gas Turbines and Gas Engines: there will be approximately 70 people for both technology options. Although this number may increase due to the type of technology and supplier option chosen.

It is envisaged that the operational phase spilt between locals and expatriates will be a ratio of approximately 70% to 30% respectively. Although a target of expat employees below 10% should be considered and implemented. It may be required that there be an initial period of training and transfer of skills in the first 2 to 3 years before there is a hand over from an expat to a local employee,

The estimated worker skills breakdown during construction phase is as follows:

- Unskilled, local general workers: 60%;
- Local Semi skilled: 20%;
- Local Skilled: 5%; and
- Expat Skilled: 15%.

For the operational phase, a general organogram of the head office management team is shown in Figure 9 below, along with a CCT plant organogram shown in Figure 10. Provision will also be made for the following likely contractors:

- Security: 4 x 4-man shifts = 16 staff + 1 supervisor per shift = 20 total;
- Cleaning: 3 Cleaners on day shift + 1 supervisor = 4;
- Gardening services: 2 on dayshift = 2; and
- Transport: 4 shift drivers + 2 dayshift drivers = 6.

Total Contract personnel (estimate as above) = 32.

Operational Phase Organogram:

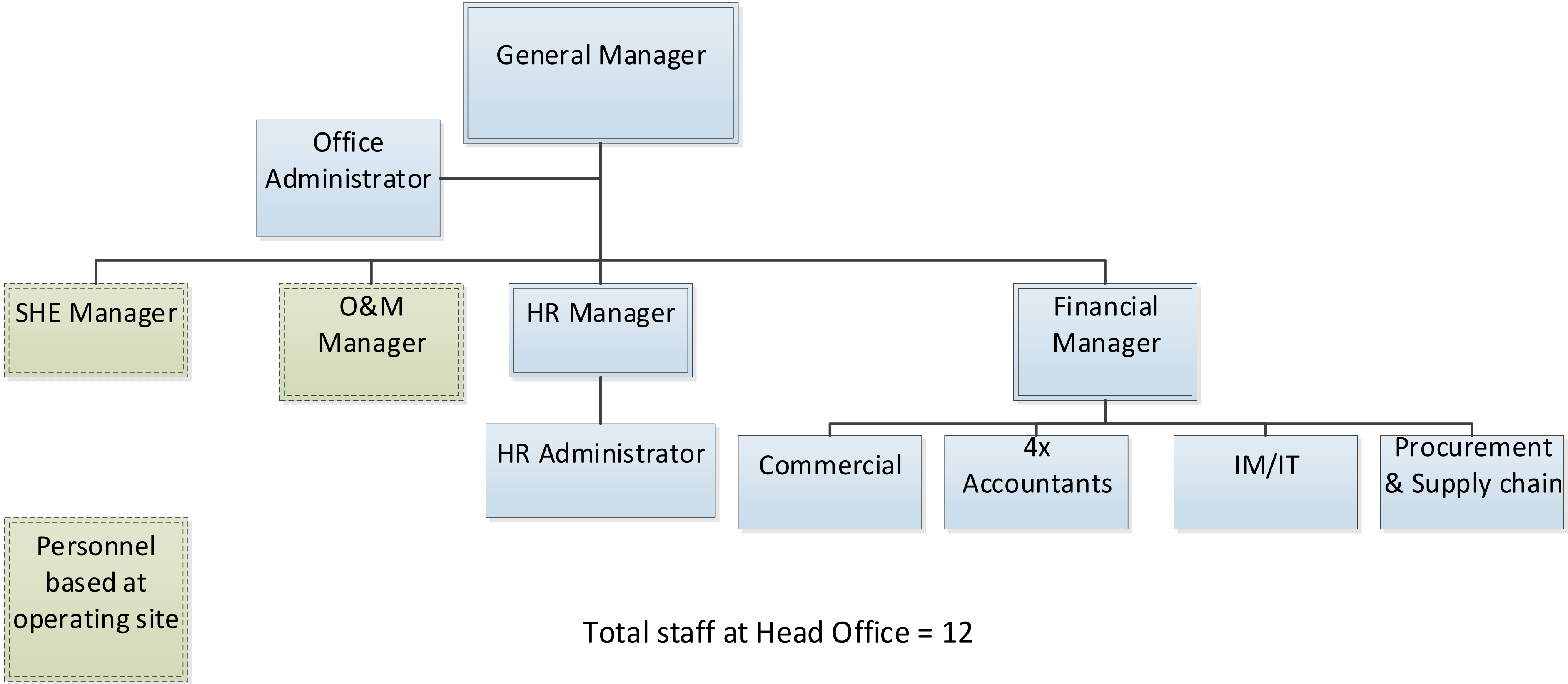


Figure 9: CTT Head Office operational phase organogram

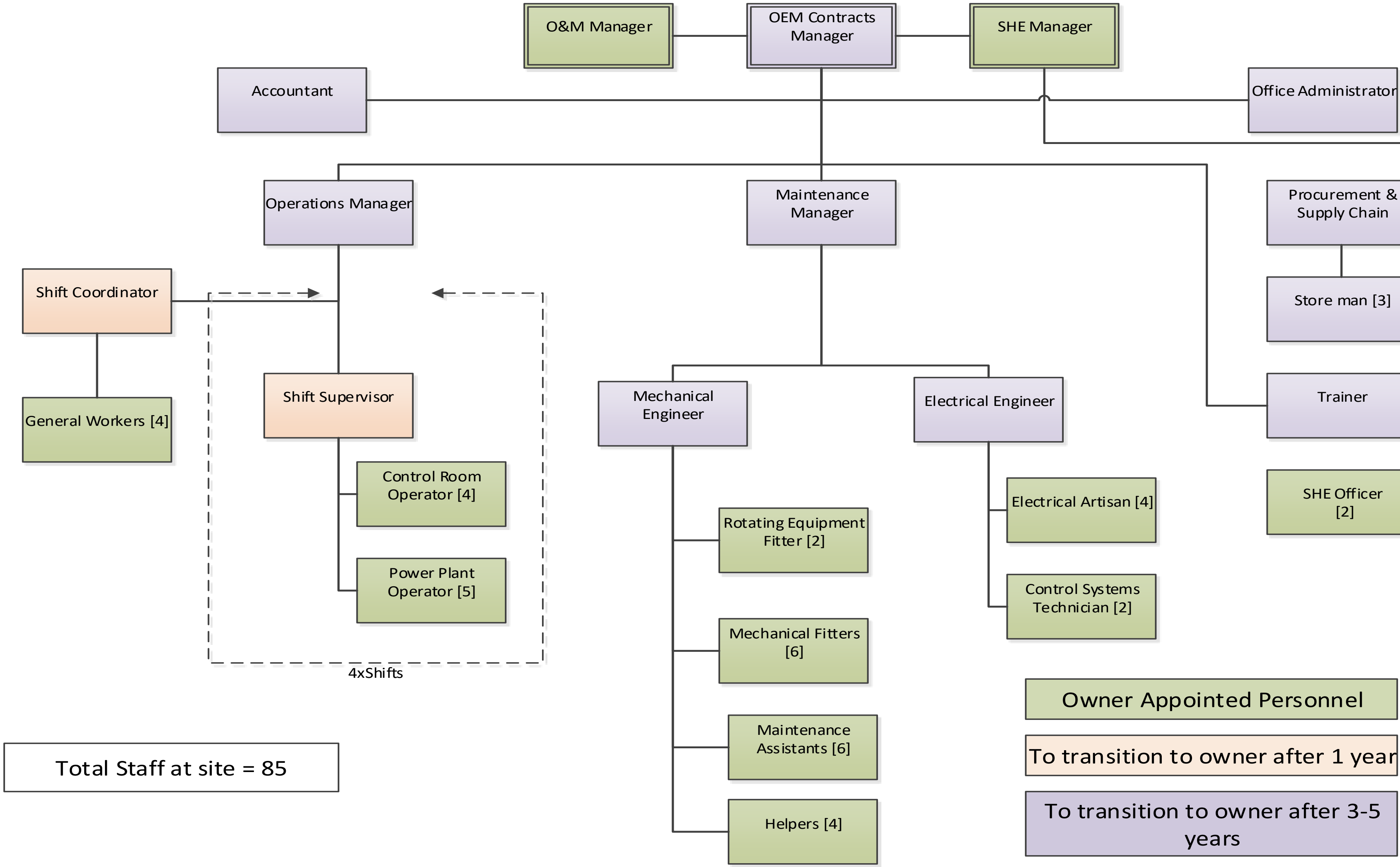

O&M Manager
OEM Contracts Manager
SHE Manager
Accountant
Office Administrator
Operations Manager
Maintenance Manager
Procurement & Supply Chain
Shift Coordinator
Store man [3]
Shift Supervisor
General Workers [4]
Mechanical Engineer
Electrical Engineer
Trainer
Control Room Operator [4]
Electrical Artisan [4]
SHE Officer [2]
Rotating Equipment Fitter [2]
Power Plant Operator [5]
Control Systems Technician [2]
Mechanical Fitters [6]
4xShifts
Owner Appointed Personnel
To transition to owner after 1 year
Maintenance Assistants [6]
To transition to owner after 3-5 years
Total Staff at site = 85
Helpers [4]

Figure 10: CTT plant operational phase organogram

2.7 Raw Material and Equipment

The raw materials required for the construction and operation of the CTT are still to be determined during the detailed engineering studies. There will be a need for borrow pit material as well as the establishment of a concrete batching plant on site during the construction phase.

Material which will be locally sourced (as far as possible) within the Temane area and surrounds, is likely to include:

- Road construction aggregate – G7 or G6;
- Road construction aggregate – Calcrete;
- Fine aggregate for concrete production;
- Coarse aggregate for concrete production – Calcrete;
- Grouting material (although certain concrete types may need to be imported);
- Reinforcing aggregate, typical sizes, are sourced from Villanculos; and
- Cement – Smaller quantities are available from Vilanculos. Larger quantities will need to be sourced from Beira or Maputo (Cimentos).

All project structural steel has been previously sourced from outside the Temane area. Asphalt binder will likely be sourced from Maputo or Beira (both have existing suppliers).

Natural gas is to be used as a feed stock to generate electricity, and this will be piped from either the existing CPF or from an alternative gas source to the CTT site. It should be noted that the gas that will supply the power plant will be from existing known reserves.

The heavy equipment and pre-fabricated components of the power plant will be brought in by ship anchored offshore (Figure 28) and transferred by barge and landed on the beach near Inhassoro. The equipment and components will be brought to site by special heavy vehicles capable of handling abnormally heavy and large dimension loads. Figure 11, Figure 12 and Figure 13 show examples of the activities involved with a temporary beach landing site, offloading and transporting of large heavy equipment by road to site.

Various options for the beach landing site and the routes they will follow in order to bring equipment and materials to the CTT site are currently still being evaluated and the alternative options are shown in the subsections that follow.

Figure 11: Typical beach landing site with barge offloading heavy equipment (source: Comarco)

Figure 12: Example of large equipment being offloaded from a barge (Note the levels of the ramp, the barge and the jetty (source: SUBTECH))

Figure 13: Heavy haulage truck with 16-axle hydraulic trailer transporting a 360-ton generator (source: ALE)

2.8 Vehicles and Heavy Equipment

Due to the early stages of the project, exact vehicle trips and numbers are unknown at this stage. However, based on the Traffic specialist's experience and other projects of a similar nature, the following has been assumed. During the construction phase the heavy equipment will be transported to the site via abnormal load vehicles. This will be a two-stage delivery as the equipment will first be transported from the barge to a laydown area and then later to the site (Table 5). The number of trips over the construction period is shown in the following tables and based on a quote provided by the transport company ALE Heavy Lift during 2014. They further indicated that a maximum of 2 components could be shipped in a week to the site, thus the OCGE option would take 20 weeks and the CCGT option would take 15 weeks. The duration would also be extended due to the waiting period of 3-4 months between some of the shipments.

Table 5: Abnormal Vehicle Trips from Beach Landing to the CTT site

Equipment	Quantity	Weight (T)	Length of unit (m)	No of Pieces per unit	Arrival Month	Number of Shipments	Days per Shipment	Weeks to Site	Trailer axles	Trailer Length (m)	No of Trips
Option 1: Combined Cycle Gas Turbines											
Gas Turbines	4 to 9	93.5	10.8	1	0	1	3	5	12	16.5	4 to 9
Generators	4-7										
Transformers	6	91	7.5	1	4	2	2	3	12	16.5	6
HRSG	6	130 (can be broken down in to smaller parts of 20 Tons each)	20	4	8	3	2	12	14	19.5	6
Steam Turbines	1 or 2	~80									
Option 2: Gas Engines											
Gas Engines	24-26	295	14.5	1	0	1	6	12	20	28.5	24 - 26
Generators	24-26										
Transformers	6	91	7.5	1	6	2	2	3	12	16.5	6

The 2007 census data indicated the less than 4% of households in the Province of Inhambane owned a vehicle; a low vehicle ownership was therefore assumed. An 80% Public Transport and on-site accommodation factor plus vehicle occupancy of 1.8 was used to calculate the final worker vehicle trips. Trips are shown per month for the duration of the construction phase of the project (Table 6).

Table 6: Construction Phase Daily Traffic

Month	No of Construction Workers	Worker Vehicle Trips	Truck Deliveries / Day
1	110	12	55
2	160	18	75
3	160	18	80
4	210	23	105
5	210	23	110
6	270	30	135
7	320	36	160
8	360	40	180
9	510	57	240
10	510	57	240
11	560	62	260
12	610	68	275
13	680	76	305
14	680	76	305
15	730	81	325
16	780	87	345
17	850	94	375
18	730	81	375
19	730	81	325
20	610	68	320
21	510	57	270
22	460	51	230
23	410	46	210

Month	No of Construction Workers	Worker Vehicle Trips	Truck Deliveries / Day
24	360	40	190
25	270	30	165
26	150	17	125
27	150	17	75
28	100	11	70
29	100	11	50
30	100	11	40

Information provided in the previous reports indicated a maximum of 70 - 75 workers working in 3 shifts, thus 25 people per shift (at a worst-case scenario). If is further assumed that 30% of the employees would have cars. This percentage is higher than the local household car ownership due to international workers required on site that will have the use of private cars during their stay. The scenario below (Table 7) is a maximum as some of the employees would be housed in the facility itself and this could further reduce the number of trips.

Table 7: Operational Phase- Peak Hour Traffic

Type	Peak Hour Trips		AM Peak Trips		PM Peak Trips	
	Employees	Vehicle Trips	IN	OUT	IN	OUT
Employees with Cars (Trips per Shift)	8	8	8	8	8	8
Employees using Public Transport	17	4	4	4	4	4
Delivery Vehicles		5	5	1	5	1
Total Vehicle Trips		**17**	**17**	**13**	**17**	**13**

These numbers have been taken into consideration within the various specialist studies and are further elaborated within the subsequent chapters of the ESIA.

2.9 Beach Landing Jetty Construction

To facilitate the transportation of the heavy materials from the barge onto the heavy vehicles, a temporary jetty will be constructed. The jetty will be made up of 40 ft containers filled with sand. There are two options as to how the jetty can be orientated:

- Option 1 will have nine containers arranged as four (4) containers on either side and one (1) in the front. This configuration allows the jetty to be narrow (+/-14 m) and long (+/-100 m); and

- Option 2 will be made up of six (6) containers arranged as two (2) containers on either side and two (2) next to each other in the front. This configuration allows the jetty to be shorter (+/-80 m) and wider (+/-20 m).

Both options will have sandbags placed on the sides to reduce scouring with a row of sugar bags and final gravel surface will be placed on top of the containers to create a level road surface. The final design of the jetty will be dependent on the barge that is finally chosen for this project. Figure 18 below is a typical illustration of the temporary jetty.

When not in use the jetty will allow for pedestrian and vehicle crossings. Refer to Figure 18 and Figure 19 below for conceptual illustrations of the jetty. Under normal circumstances, (when no cyclones occur, and thus less intense sea conditions and wave action) the jetty has a life span of one year, which can be further increased by regular maintenance. The chosen beach landing site for the CTT project will only be required for 12 months and 15 months during the construction phase for the OCGE and CCGT technologies respectively. In addition, in case of a phased construction approach whereby the CTT plant will be built in two distinct phases, then the temporary jetty may be required for a longer period to accommodate for the second phase of construction whereby more equipment will be beach landing as part of that construction phase. For purposes of this ESIA we have assessed one construction phase.

The three beach landing site options are illustrated below in Figure 14, Figure 15 and Figure 16. The locations of these beach landing sites are shown in Figure 17. Figure 28 shows the location of the two previously identified anchorage points that may have been used in the past for the anchoring of transhipment vessels during periods of offloading equipment.

Figure 14: SETA Beach Landing Site

Figure 15: Maritima Beach Landing Site

Figure 16: Briza Mar Beach Landing Site

2.9.1 Temporary Jetty Construction and Removal

The duration for the construction and removal of the temporary jetty is anticipated to be 30 days. The SETA beach landing site is the preferred beach landing site from an environmental and social point of view assuming the use of one of the identified anchor sites, since the SETA site was previously used as the beach landing when the Sasol CPF was constructed and the site is currently transformed and will result in the least amount of disturbance to the local Inhassoro community and businesses (see Figure 14**,** Figure 15 and Figure 16).Although it is planned that the temporary jetty will be constructed at SETA, the other two options are still being evaluated as part of the ESIA and are both viable alternatives. Until the final anchor points and barge routes are confirmed, preferences of the sites from a perspective of marine impacts must still be evaluated. For purposes of the ESIA study, the SETA option is assessed and is representative of the other two options.

2.9.2 Duration of equipment off-loading at Inhassoro

There are three cargo options that the Proponent is evaluating, consisting of different shipments: The duration of Option 1 (Gas Engines) is 6 months and that of Options 2 and 3 (Gas Turbines) is 8 months. A cargo carrying ship (transhipment vessel) will transport the heavy equipment to an anchorage point off the coast of Inhassoro from where the equipment will be transhipped from vessel to barge and taken to the temporary jetty, (at this stage it is likely to be to be constructed on the beach at Seta Lodge) and off-loaded.

2.9.3 Equipment Arrival

The assumptions in the analysis as advised by the Proponent for the arrival of the equipment is as follows:

- ***Option 1***: Gas Engines: two Shipments (Gas Engines and Transformers) over 6 months where the Gas Engines are brought in on one shipment and the transformers are brought in on the other shipment; and
- ***Option 2***: Gas Turbines: three Shipments (Gas Turbines/Steam Turbines, Steam Generators and Transformers) over 8 months, where the Gas Turbines will be brought in in one shipment, the transformers in the other and the generators units (4 pieces x 6 units = 24 Pieces) in another shipment over this period.

It is therefore important to note that there will be periods of 3 - 4 months where there will be no activities taking place at the beach landing site and anchorage points. The mobile surface crane and trailers/trucks will be de-mobilised from site and parked at the laydown area after each operation and will be mobilized again for the next operation. Only the temporary jetty will be visible on the beach.

2.9.4 Anchorage Points

The Project will require a site where the trans-shipment vessel could be anchored during periods of off-loading heavy equipment (such as turbines) that will be needed for constructing the CTT power plant. Two anchorage locations have been previously identified on existing maritime maps, and at least one site is expected to have been used in the past by trans-shipment vessels for off-loading of heavy equipment of the equipment for the CPF. These are two anchorage locations in the leeside of Bazaruto indicated on existing nautical charts with depths around 15 to 20 m (see Figure 28). One anchorage point is located approximately 20 km east of SETA beach landing site (7 km from Bazaruto Island and 13 km from Santa Carolina Island). The other site is nearer to the mainland shore, approximately 13 km east of Briza Mar beach landing site (5 – 6 km from Santa Carolina Island and 10 km from Bazaruto Island).

As both previously identified anchorage sites are within the boundaries of the Bazaruto Archipelago National Park (BANP), an ongoing study seeks to identify alternative anchorage point(s) that would be located completely outside BANP, as well as being feasible from a technical, environmental, and social point of view. The anchorage point(s) and associated barge lane(s) to be used by this Project shall be fully outside BANP boundaries, unless alternative sites outside BANP either (i) are not at all available or clearly technically not feasible or (ii) would clearly have greater overall adverse environmental or social impacts than if they were within BANP.

Should the anchorage point(s) and/or barge route(s) have to be within the BANP for the above-mentioned reasons, a) the marine studies included within the ESIA will be updated and resubmitted to the World Bank for approval and b) the ESMP shall be updated to specify any further measures that may be necessary or appropriate to enhance the conservation and management of BANP and resubmitted to the World Bank for approval. Moreover, CTT would ensure that the locations of these facilities (i) have been formally approved by African Parks (legally responsible for BANP management) and ANAC (Mozambique's national conservation agency); (ii) are consistent with the Government-approved BANP Management Plan; and (iii) are legally permitted under Mozambican law—all in full compliance with IFC Performance Standard 6 (Paragraph 20) and the applicable Mozambican laws and regulations.

The vessel will not be anchored for extended periods of time and will most likely be anchored for 1-2 days at a time to offload the heavy equipment with up to 3-4 months between shipments, over a period of 8-15 months, although this will be defined once a technology option has been chosen as well as a preferred manufacturer of the various large and oversized power plant components. It should be noted that there will be a laydown area at the chosen beach landing site. This area will be used as a staging area to manage the large equipment and materials that will be offloaded from the barges. This is only expected to be used during daylight hours and for temporary storage of limited materials, equipment and vehicles (likely to be a mobile surface crane, two trailers and trucks).

Given the potential time between each shipment (up to 3 to 4 months) the equipment at the jetty will demobilize after each operation and need to be mobilized again for each operation.

Figure 17: Alternative beach landing sites

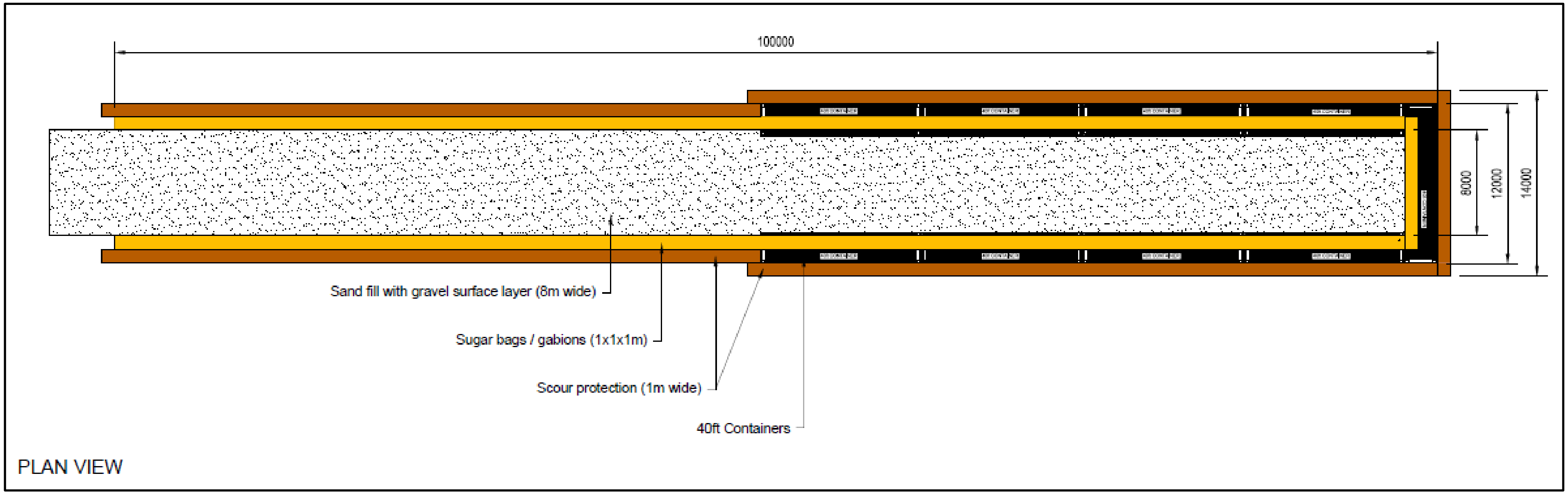


Figure 18: Conceptual layout of the jetty

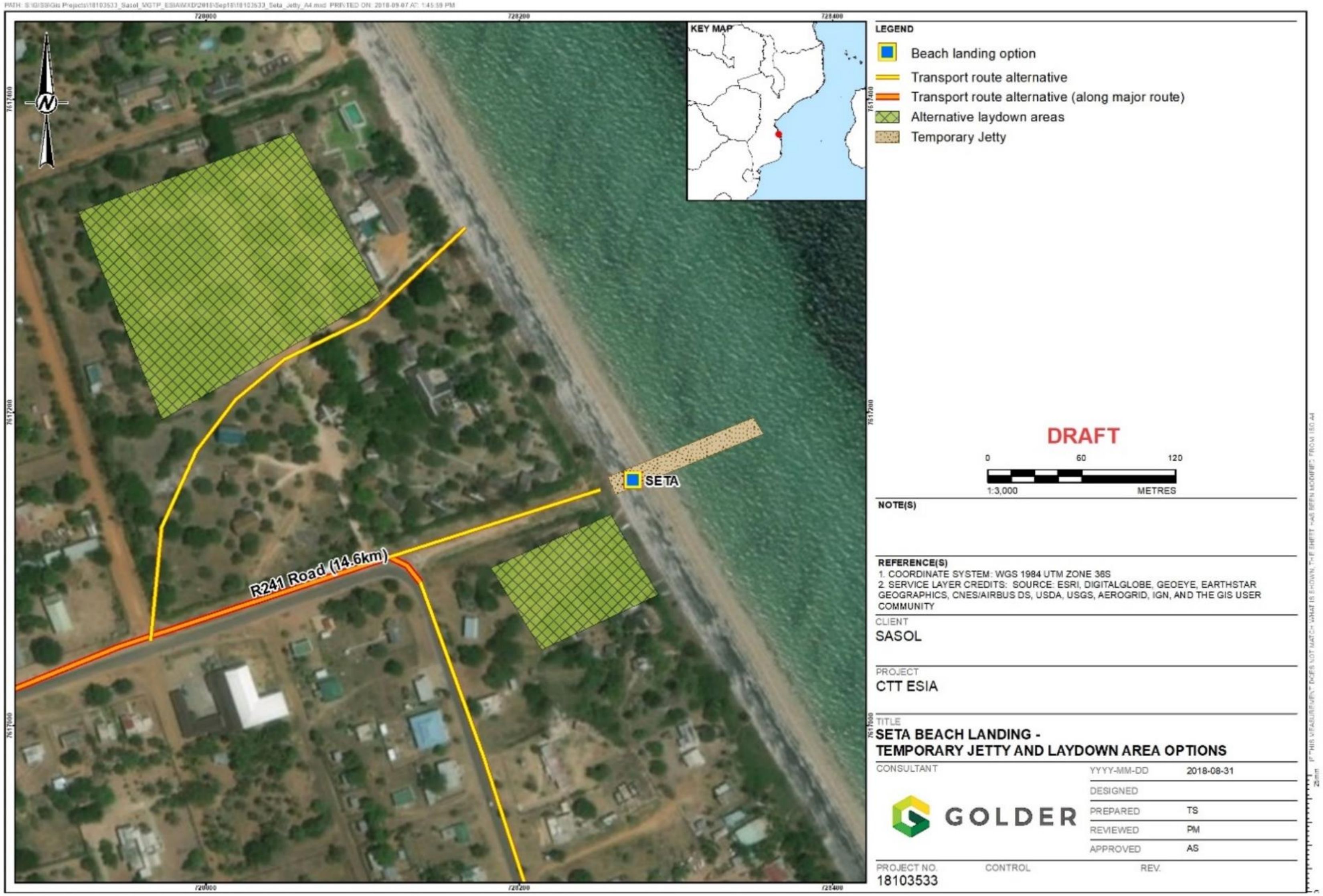


Figure 19: Conceptual illustration of the Jetty at SETA beach landing site

2.10 Construction Camp and Laydown Areas

A construction camp will be required to cater for the construction workforce and contractors at the CTT site. General equipment and material laydown areas for contractors at the CTT site will also be required during the construction phase. An example of the construction camp and laydown area is provided in Figure 20 below. It is worth noting that the CTT plant site, construction camp and laydown area all fall within the area which has previously been bush-cleared and de-mined for any potential unexploded ordnances. The linear features such as access roads, transmission line, gas and water pipelines have also been bush-cleared and de-mined. Prior to construction activities commences, the appointed Contractor will be responsible for clearing and site preparation.

Figure 21 below provides and indicative construction camp layout for an 850 person camp. It typically provides accommodation for workers, offices, administration offices, catering facilities, medical clinic, diesel generators and diesel storage tanks, sewage treatment plant as well as water treatment facilities. There are recreational facilities as well as security facilities on site.

2.10.1 Water system

Daily water allowance is 150 l/person/day. This is based on Council for Scientific and Industrial Research (CSIR) guidelines for human settlement planning. A minimum of 48 hours of storage is also specified. This is the daily water that will be required to cater for the construction personnel needs.

Borehole water will be sourced for normal construction activities. Where cleaner water is required such as for concrete mixing or cleaning lines/hydrotesting etc., a small portable water treatment facility will be brought in for these requirements. Drinking water provided via bottled source. Used plastic bottles will be removed from site and recycled via third party contractors in line with the CTT Waste Management Plan.

2.10.2 Ablution Facility

Daily sewer flow varies between 110 l/p/d (boarding houses) to 160 l/p/d (fully water reticulated house with one person) as per South African National Standards (SANS) 10400 P (Building Regulations). It is expected that French drains and septic tank combinations will be used at the construction camp.

2.10.3 Generators

The CTT project will be powered by onsite diesel generators during the construction/decommissioning phases and the gas engines/turbines during the operational phase. Construction phase power will be the responsibility of the appointed Contractor. It is estimated that the CTT construction camp will require up to a 5 x 450 kW (500 kVA) generator sets operating on average 12 hours per day for the duration of the site preparation and construction phase. The demand is based on average number of workers that are expected to be living at the construction camp. During the operational phase of the project the Gas Turbines/Engines may require some down time for services and maintenance. In the rare event that there is a full shut down the back-up Diesel Generators will be used to supply the required auxiliary power to the plant if required. Alternatively, a partial shut-down of the plant may be employed during the short annual periods of mandatory shut-down at CPF which implies no gas supply during such periods. It is understood that this will be limited to 24 - 72 hours per year.

A Green House Gas emissions assessment was conducted for the proposed project and is further elaborated on within this ESIA report.

2.10.4 Beach Laydown Area

It should be noted that there will be a laydown area at the chosen beach landing site. This area will be used as a staging area to manage the large equipment and materials that will be offloaded from the barges. This is only expected to be used during daylight hours and for temporary storage of materials, equipment and vehicles.

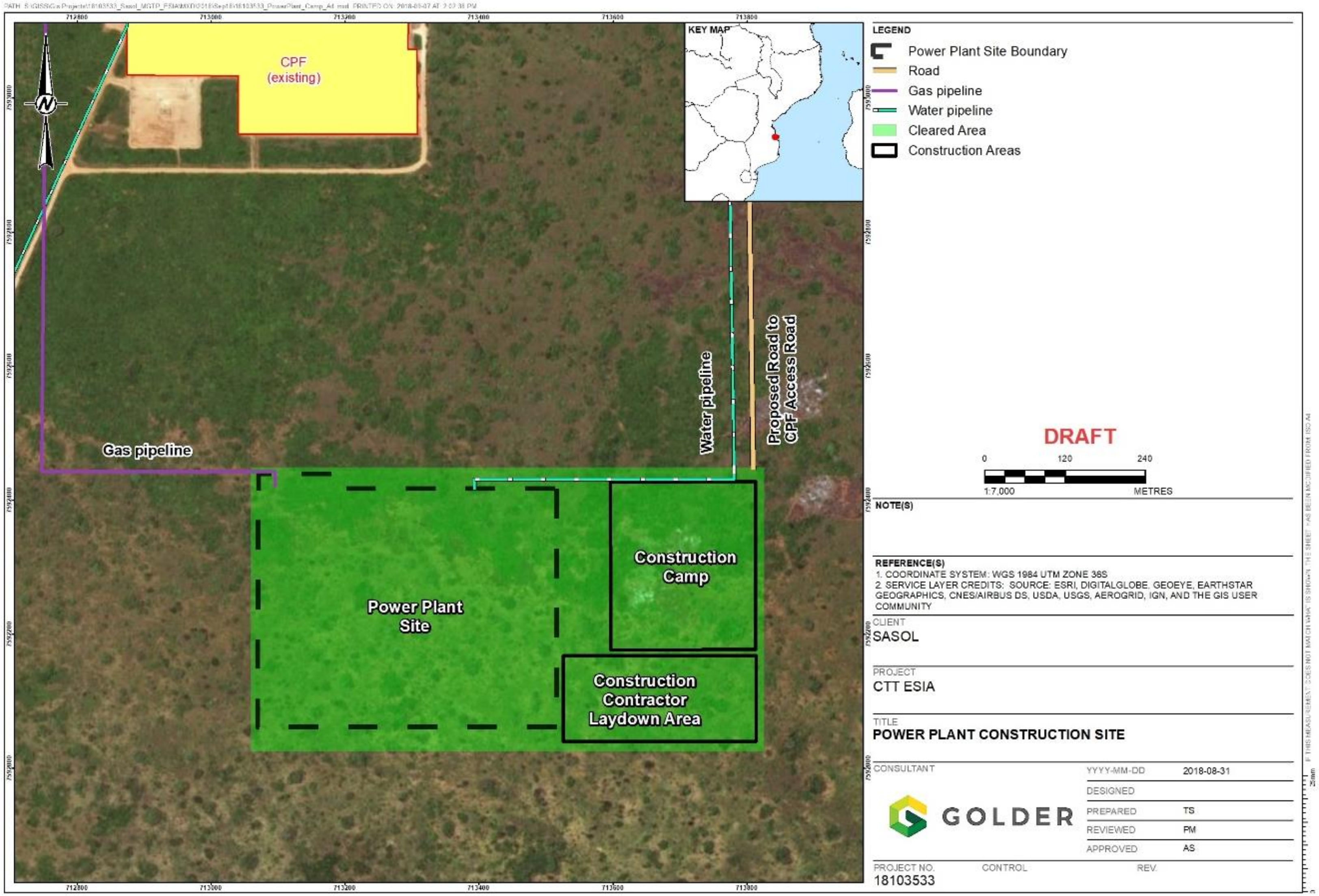


Figure 20: Conceptual illustration of CTT during construction phase

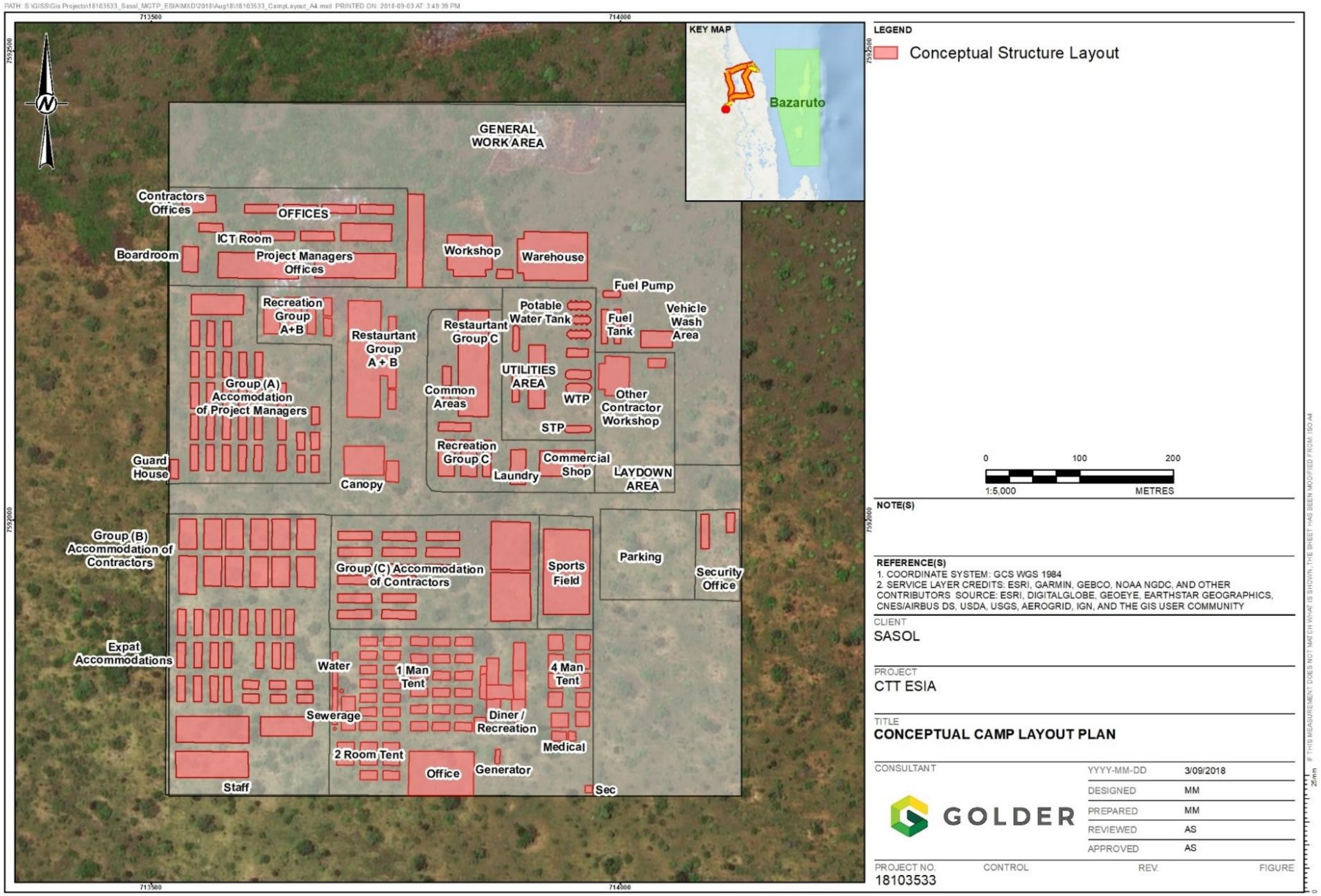


Figure 21: Conceptual Construction Camp Layout

2.11 Main CTT Access Road

A new access road will be constructed from the power plant access gate to the existing CPF access road. The new access road will be approximately 2 km long and will be gravelled initially (with dust suppression), alternatively the road may be paved from the outset to further reduce dust impacts. The main CTT plant road will be constructed to have a carriageway width of six (6) meters and maintenance access roads (for transmission line, gas and water pipeline) will have a finished width of four and half (4.5) meters and will be gravelled. After construction phase, the main CTT access road and internal CTT plant roads will have an asphalt or interlocking concrete block surface laid on prepared layerworks. Statutory and information signboards, road lines, crash barriers and all other roadworks ancillaries will be provided as required.

Gravel of adequate quality is to be sourced for road construction (as well as platform for main CTT site) from the closest available borrow pit. Any licence requirements or agreement with owner/license holder of borrow pits will be the responsibility of the construction contractor once appointed.

Temporary road – construction phase

During the construction phase the access road to the CTT will be composed of material that will be temporary to allow for frequent maintenance of the road due to the strain of multiple heavy vehicles utilising the road. The temporary access road will require importation of a layer of material to act as sub base. The layer is required to protect the subgrade (in -situ material). Locally sourced G7 material will be suitable for the subgrade. A proposed cross section for the temporary construction road is outlined in Figure 22 below.

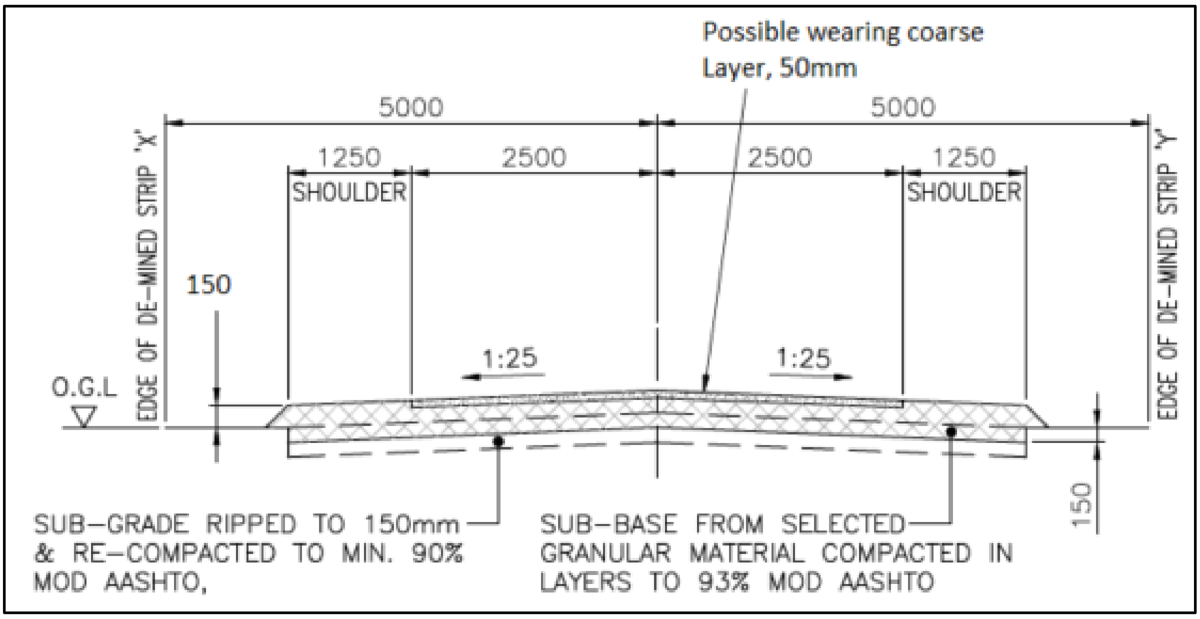


Figure 22: Temporary Road Cross section

Permanent Road – Sealed Road – Operational Phase

At the end of the construction phase the main CTT access road will be finalised and converted into a permanent road from a gravel road, alternatively if it is decided to pave the road during construction phase, then the road will be repaired at the end of construction. The final layerworks will need to be determined through a detailed design process. The design is based on anticipated traffic volumes, traffic type, design life, local material sources and local climates. A typical cross section is indicated in Figure 23 below. The final design of the road may be either paving blocks or sealed asphalt.

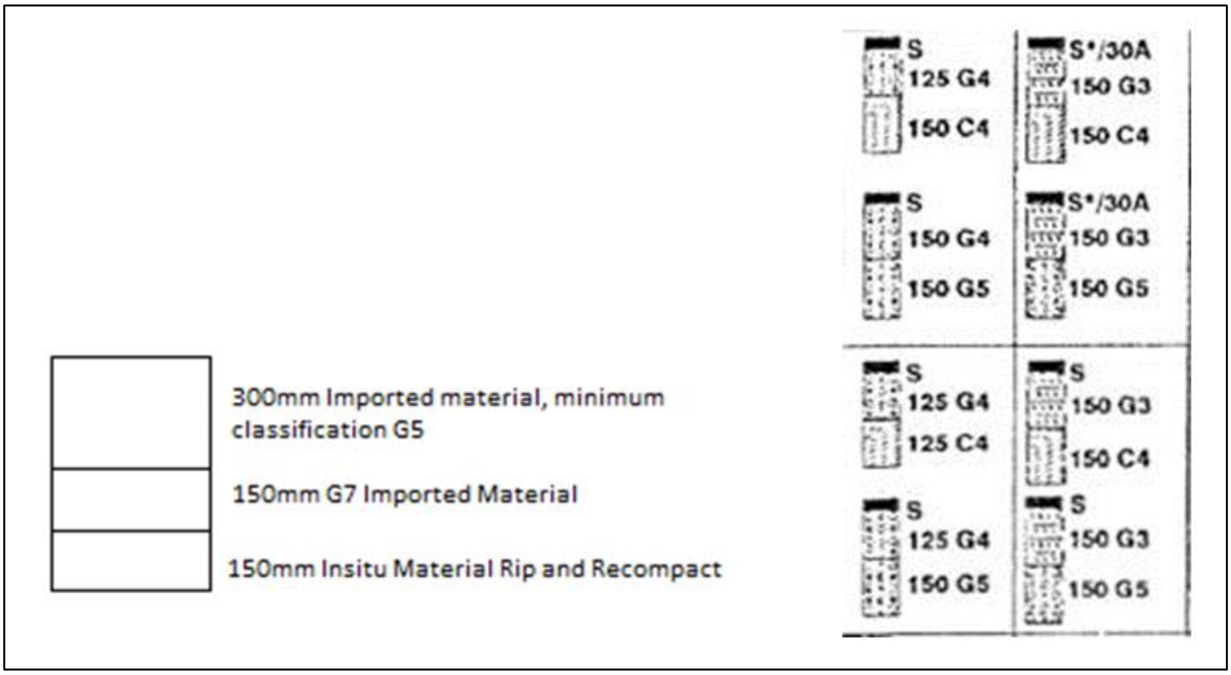


Figure 23: Permanent Road: Sealed Road Cross section

2.12 Water and Electricity Consumption

The type, origin and quantity of water and energy consumption are still to be determined based on the selected technology to construct and operate the CTT plant. At this stage it is known that water will be sourced from either an existing borehole located on site or from a borehole located east of the Govuro River for either of the technology options below:

- Gas Engine:12 m^3/day; and
- Gas Turbine (Dry-Cooling): 120 – 240 m^3/day.

During the construction phase, water will be supplied from either the borehole on site or east of the Govuro River (approximately 11 km away). This water will supply the projects construction and operational activities. However, some construction activities will require portable water. Therefore, a temporary mobile water treatment unit will be on site to treat the borehole water to the required quality. Furthermore, for drinking purposes, bottled water will be trucked in.

It should be noted that the following construction periods apply:

- Gas Turbines:
  - Site preparation: approximately 4 - 9 months; and
  - Construction: approximately 21 months (up to 15 months for OCGTs).
- Gas Engines:
  - Site preparation: approximately 9 months; and
  - Construction: approximately 5 months

It is anticipated that following construction, there will be a period of testing and start-up which could last for 5 months for each of the technology options.

Due to the various options still being considered and for purposes of simplification, it has been assumed that construction activities will take place over a period of approximately **18 - 24 months**.

2.13 Fuels and Lubricants

Natural gas from the CPF or an alternative source will be used as the fuel for electricity generation. Details of the specific chemicals and lubricants required in the CTT plant are dependent on the technology options. It must be noted that each chemical used must have a material safety data sheet compiled and distributed to the relevant personnel prior to usage.

2.14 Land Ownership

The land is currently owned by the Government of Mozambique. The Proponent has already secured the land rights for the project through a Land Use and Benefit Rights (Direito do Uso e Aproveitamento da Terra (DUAT)) application. It should be noted that there will be a PPZ established around the powerplant and all key infrastructure (i.e. transmission line, water pipeline as well as the gas pipeline). The PPZ is currently determined to be 100 m and would be applied to the linear infrastructure. However, the applicant and this ESIA recommends that a PPZ of 1,000 m be established around the CTT powerplant itself to prevent encroachment and settlement and to protect the surrounding communities.

2.15 Transmission Line

A 400 kV transmission line will be constructed from the CTT to the Vilanculos substation (this sub-station was previously authorised under a separate ESIA process) The 400 kV transmission line is approximately 25 km in length and will evacuate the power to the National Grid via the Vilanculous sub-station.

A typical Over Head Line (OHL) uses three main types of lattice steel towers (pylons). These are:

- **Suspension towers**: which support the conductors on straight stretches of line. Two alternative designs may be used on this Project - self-supporting or guyed V-towers;
- **Angle/Deviation towers**: which are used at points where the route changes directions. They are self-supporting towers; and
- **Terminal towers**: which are used where the line terminates at substations.

It is proposed to use a combination of self-supporting towers and guyed V-towers but where possible to avoid the use of guyed V-towers where economically viable, at minimum in high risk areas for collision risk posed by guy wires to birds (also fruit bats), including species of conservation concern such as several globally threatened vulture species, It is proposed that at least 3 meters of spacing between the conductors is implemented.

The tower height will be dependent on the terrain, height above sea level and span length (distance between towers) which will typically vary between 400 m and 500 m (Figure 24 provides a visual illustration of the towers).

ANGLE / DEVIATION TOWER

Source: Mott MacDonald: Mozambique Regional Transmission Backbone Project, ESIA, 2011

SUSPENSION TOWER - GUYED V TOWER

Source: Mott MacDonald: Mozambique Regional Transmission Backbone Project, ESIA: 2011

SUSPENSION TOWER - Y TOWER

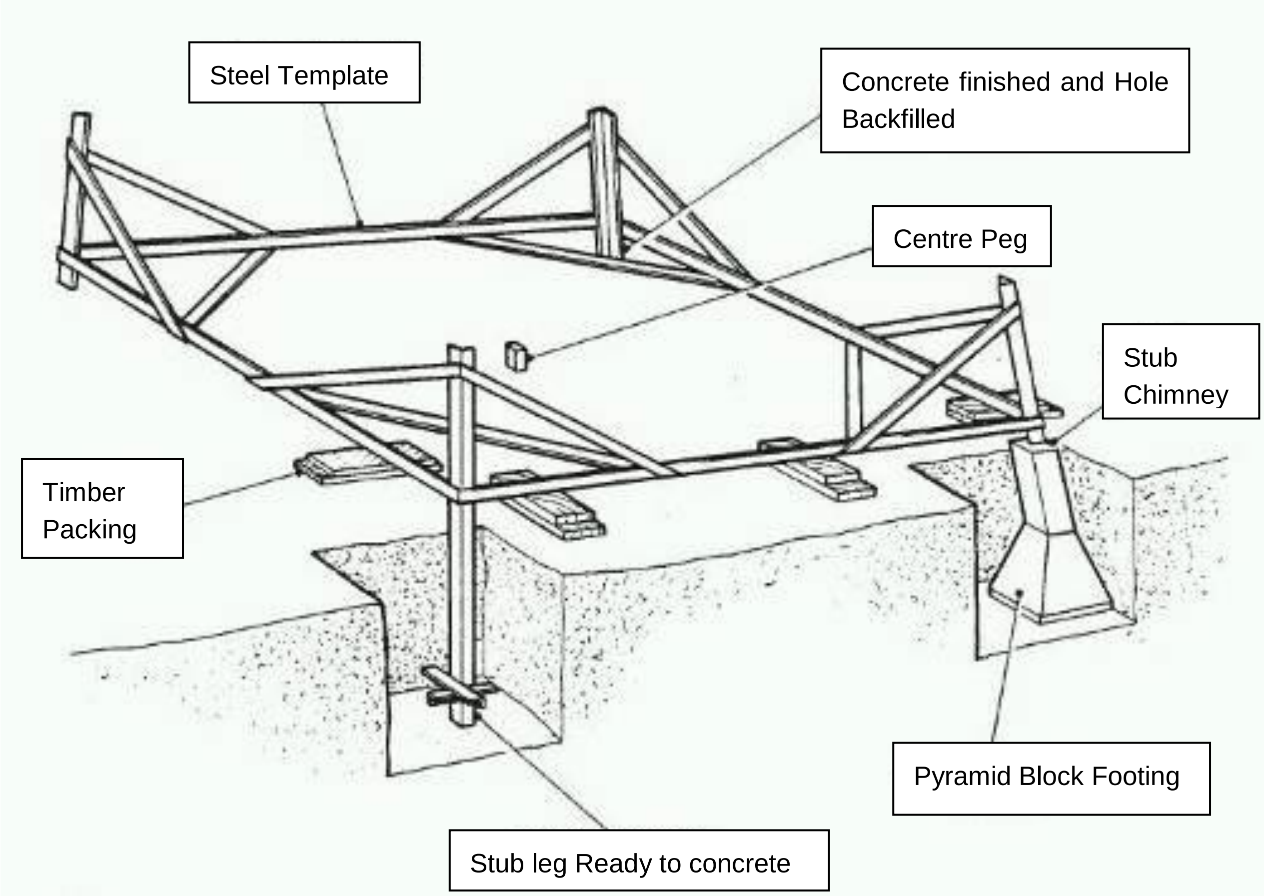
Source: Mail & Guardian, 2016-05-27

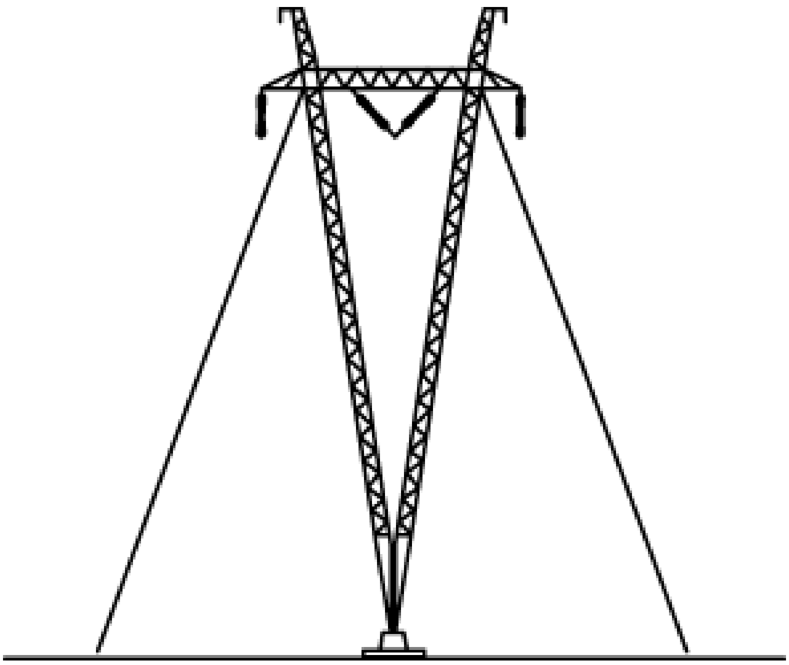
DEVIATION TOWER

Source: Mott MacDonald: Mozambique Regional Transmission Backbone Project, ESIA, 2011

Figure 24: Pylon Examples

The typical tower height will vary between 20 – 25 m and will have a PPZ of 100 m (50 m on either side of centre-line) established. Depending on the tower design finally chosen, the foundations will differ between one to four foundation columns, however they will both have level bases which will be used to erect the towers (Figure 25).





Source: Mott MacDonald, Mozambique Regional Transmission Backbone Project, ESIA, 2011

Figure 25: Pylon Foundations

The construction process will generally be undertaken sequentially as follows:

- De-mining & bush clearing (already mostly completed to ensure safety of personnel conducting surveys);
- Site preparation, including road access;
- Civil Works for pylon foundations;
- Pylon erection;
- Conductor stringing;
- Installation of bird flight diverters to minimize collisions by flying birds or fruit bats with the top (grounding) power line wires, particularly in the transmission line segments of relatively high use by bird species of conservation concern.
- Compliance quality testing; and
- Rehabilitation of disturbed areas.

Figure 26: Example of Pylon construction (source: http://cscon.co.za/ and EDM)

3.0 ANALYSIS OF ALTERNATIVES

3.1 No-go Alternative

The no-go alternative to the proposed gas to power plant would result in the future demand for electricity further exceeding supply. Hence the lack of a secure and reliable electricity generation and distribution system would constrain existing and future economic development and restrict socio-economic development. As a result, the no-go option would have a negative socio-economic impact on Mozambique and therefore is not considered to be a viable or acceptable alternative to the proposed project being developed.

3.2 Alternative Technologies and Fuels

Alternative power generation technologies were considered but found unfavourable for a number of reasons, which are briefly listed below:

- **Coal fired power**: This technology was not considered as it is not suitable to the variable power demand of Mozambique. Plans to build coal fired power stations in Tete Province (Benga and Moatize) have been shelved. Coal power generation thus does not provide complimentary power generation projects to technologies such as hydropower, solar PV, Wind and gas power generation. Importantly, it is an unlikely alternative as production from coal power is not flexible and cannot be easily flexed to balance power generated from other sources or demand variations;
- **Hydropower**: Small to medium scale Hydropower is relatively expensive to construct when compared to gas to power plants, and have long construction timeframes, extensive environmental and social impacts when large areas are inundated by the dam which is typically required for such projects. These projects are also highly dependent on the local site conditions, and maybe susceptible to climate change through prolonged drought;
- **Nuclear power**: This option was not considered due to the high costs involved with this technology and the long construction period;
- **Renewable power (wind & solar)**: The prevailing climate in Mozambique is understood to be unfavourable for very large-scale deployment (>150 MW) of wind energy generation at a single site. Solar projects typically require vast areas of land in order to generate electricity. For a comparable size power generation development from solar, large areas of land would be required and this may entail a considerable amount of resettlement of locals and loss of access to agricultural fields with associated socio-economic consequences which may prove unsustainable. Renewable energy projects are also compounded by the high costs per unit of electricity generated when compared to gas power technology (although as technology improves the costs for implementing solar and wind projects are declining but are directly related to the quality of the resource in country). Renewables are intermittent with capacity factors generally ranging from 20% (Solar PV) up to 50% (Wind) which does not offer dispatchable bulk power. In addition deployment of large scale wind and solar PV is also constrained by grid availability as the resource for wind and solar is wide spread and the high resource areas where large scale renewables deployment may be economically feasible do not overlap with locations where high voltage grid exists. Thus, the economic viability of delivering 450 MW of renewable power accounting for the transmission costs and network stability makes this option unfeasible. Therefore, renewable energy such as wind and solar energy were not considered a viable alternative; and
- **Importing power from neighbouring countries**: In the past Mozambique depended on neighbouring countries for power and imported electricity from countries such as South Africa during peak demand periods. However, since 2015 Mozambique has been a net exporter of power (without considering Cahora Bassa Hydropower). EDM currently on average exports about 100 MW to neighbouring countries. There is occasional import of power but only in cases of outages/disruption of Mozambique's generating plants. It is estimated that Mozambique will need additional electricity supply from 2023 onwards, mainly for its own use as demand grows and to meet opportunities of regional supply. The flexibility that gas power generation provides in balancing this power demand in Mozambique is advantageous as it will allow greater independence in managing its own power demand locally.

The decision to implement a gas to power plant was largely driven by the fact that natural gas is readily available in the Temane and Pande area gas and the existence of the Central Processing Facility (CPF). Gas supply to CTT will be coming from the PSA License, covering gas deposits in the Temane and Inhassoro areas. The short timeframes involved with constructing and commissioning a gas to power plant is more favourable than many of the above technologies, as it also offers the advantages of being a readily utilisable peak power supplier.

The gas to power technology also assists in diversifying Mozambique's energy mix (by technology and geography), as currently as Hydropower is provided from Cahora Basa and other sites, as well as other gas to power plants that currently operate at the Ressano Garcia site as well as a smaller unit in Maputo City with another project under consideration near Inhambane. The gas to power technology is also a cleaner form of fossil fuel derived power generation when compared to coal, diesel and oil generated electricity. The preferred gas power technology has not yet been determined at this stage and the options being considered and evaluated further in the ESIA are:

- Open Cycle Gas Engines (OCGE); or
- Combined Cycle Gas Turbines (CCGT).

3.3 Site Alternatives

Since the natural gas would be supplied from the CPF, a site closer to the CPF was favoured rather than a site closer to the Vilanculos substation. The Vilanculos substation is already permitted as part of the STE/CESUL project: Mozambique Regional Transmission Project – CESUL Transmission Project (Projecto de Interligação da Rede Nacional de Energia Centro-Sul) and holds an environmental license (approval letter from MICOA Ref: 75/MICOA/12 of 22nd May 2012). This project consisted of the Vilanculos substation and a 400kV high voltage alternating current (HVAC) overhead transmission line. The project is aimed at strengthening the power grid connectivity of Mozambique. The CTT project will seek to make use of this infrastructure by generating power and routing its own transmission line alongside the STE/CESUL transmission line and connecting to the Vilanculos substation and feeding power into the National power grid.

For the CTT plant to be located near the Vilanculos substation, would require a gas pipeline of approximately 25 km in length and may be far more expensive than the cost of an electricity transmission line of the same length. The various Temane sites around the CPF that were all investigated would only require a gas supply pipeline of 1 – 2 km in length which is economically favourable. The Temane sites are also more remote with far fewer people living in the area than compared with the area surrounding the Vilanculos substation, which may require substantial resettlement of people and loss of agricultural land through the land take required for the CTT project. The availability of water in the region of the Vilanculos substation was also a concern (due to limited information on the area).

For the preferred Temane sites, a high-level evaluation and comparison was done for two potential sites near the Temane CPF: Site 1 south of the CPF and Site 2 west of the CPF. Site 2 was subsequently disregarded due to unfavourable site conditions; topography and proximity to floodlines (see Figure 27 below).

Additionally, a third potential site at Temane to the east of the CPF (Site 3) was considered but not evaluated further due to the planned CPF expansion to the east. Moving further east away from this site, there would be the potential of having to relocate people and concerns with regards to flooding from the 1:100 year storm event.

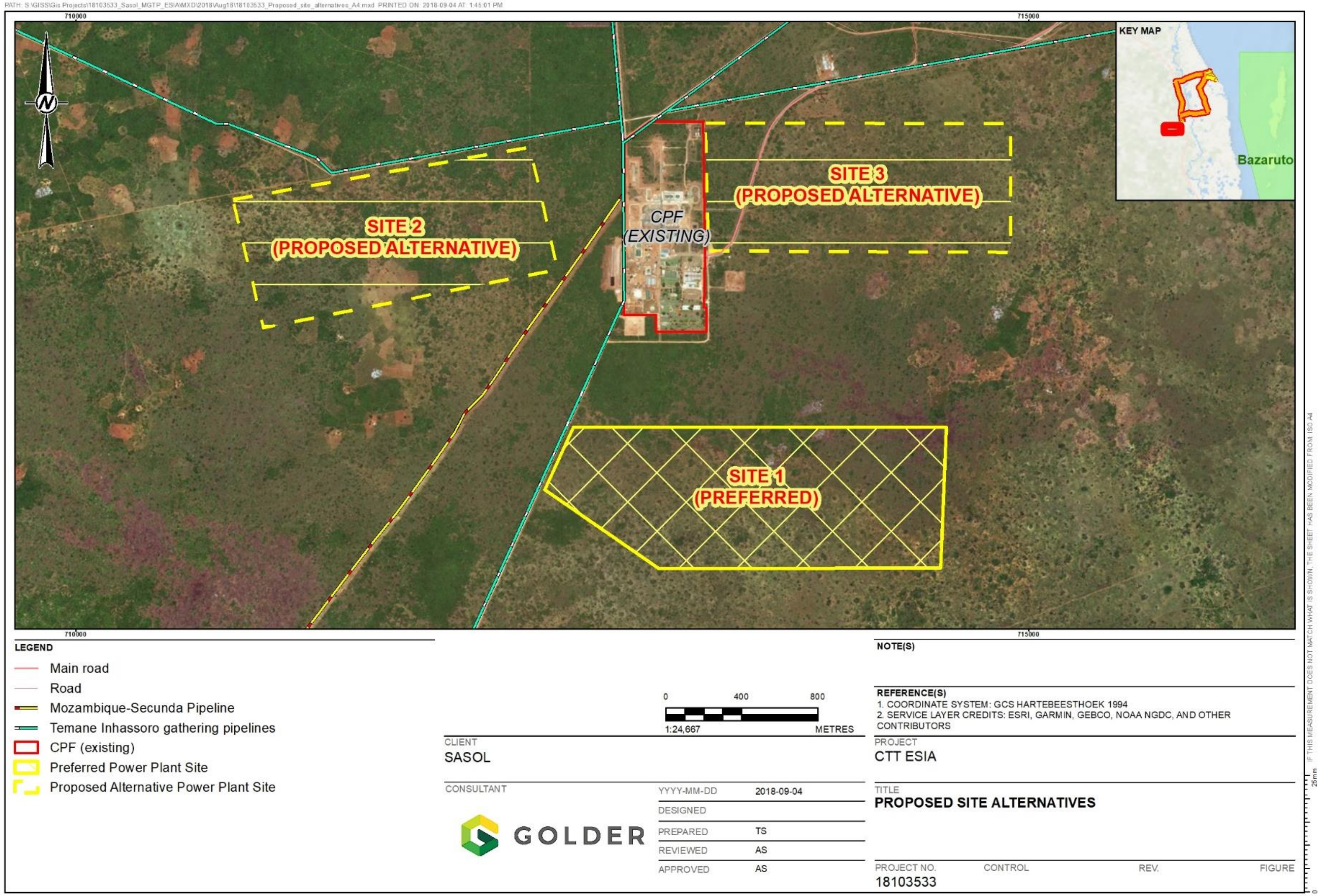


Figure 27: Proposed CTT site alternatives

Site 1 located 500 m south of the CPF was chosen as the preferred site and the high-level evaluation considered:

- Availability of land (lowest population density based on a Google Earth geographical survey);
- Topography/flood risk areas;
- Close proximity to the CPF to enable the shortest connection for the gas pipeline connection from the CTT to the CPF or from an alternative gas source;
- Distance to connect the 400 kV transmission line to the planned Vilanculos substation;
- Information on the water quality and quantity available for the CTT is known for this area as the project will utilise the same aquifer as that of the CPF; and
- New access road for the CTT will be a short distance (1 - 2 km) to connect to existing roads infrastructure.

The location of the CTT plant in close proximity to the CPF ensures that infrastructure development does not unnecessarily fragment the local landscape and that associated supporting services (power, water, roads etc.) can be centrally positioned and optimally utilised.

Table 8: Site alternatives assessment of sites adjacent to the CPF (A high score indicates preference for a site)

Location Factors	Site 1 (South of CPF)	Site 2 (West of CPF)
1. Availability of Land: a. Consider population density and local authority positions. b. Access to pipeline and power transmission servitudes. c. Consider future expansion of CPF and exclusion zone.	23	15
2. Suitability of Land (Site): a. Geology/Topography/Flood lines. b. Pipeline and road crossings.	20	15
3. Capital Cost, & Infrastructure Cost Trade-offs for: a. Gas pipeline, versus a transmission line. b. Water supply.	10	13
4. Environmental: Including cost & schedule impact of: a. Protected flora, fauna, avifauna. b. Cultural & heritage issues.	Similar impacts	Similar impacts
5. Site Access: Including de-mining, accessibility for construction.	Similar site access	Similar site access
6. Infrastructure Availability & Impact: a. Roads, staff accommodation proximity, noise etc.	8	9
Total	**80**	**71**

It should be noted that the Sasol CPF facility is considering applying for a PPZ of 1,000 m around its perimeter to prevent the encroachment and settlement of people in close proximity to the plant and to limit the noise exposure levels to surrounding receptors. Therefore, it is recommended that the CTT also apply for a PPZ of 1,000 m, with the Transmission line having a PPZ of 50 m (on either side).

3.4 Offshore Anchorage Points

The Project will require one or more sites where the trans-shipment vessel could be anchored during periods of off-loading heavy equipment (such as turbines) that will be needed for constructing the CTT power plant. Two anchorage locations have been previously identified on existing maritime maps and at least one of the sites is expected to have been used in the past by trans-shipment vessels for off-loading of heavy equipment of the CPF These are two anchorage locations in the leeside of Bazaruto indicated on the nautical charts with depths between 15 to 20 m (Figure 28). One anchorage point is located approximately 20 km east of SETA beach landing site (7km from Bazaruto Island and 13 km from Santa Carolina Island). The other site is nearer to the mainland shore, approximately 13 km east of Briza Mar beach landing site (5 – 6 km from Santa Carolina Island and 10km from Bazaruto Island).

As both previously identified anchorage sites are within the boundaries of the Bazaruto Archipelago National Park (BANP), an ongoing study seeks to identify alternative anchorage point(s) that would be located completely outside BANP, as well as being feasible from a technical, environmental, and social point of view. The anchorage point(s) and associated barge lane(s) to be used by this Project shall be fully outside BANP boundaries, unless alternative sites outside BANP either (i) are not at all available or clearly technically not feasible or (ii) would clearly have greater overall adverse environmental or social impacts than if they were within BANP.

Should the anchorage point(s) and/or barge route(s) have to be within the BANP for the above-mentioned reasons, a) the marine studies included within the ESIA will be updated and resubmitted to the World Bank for approval and b) the ESMP shall be updated to specify any further measures that may be necessary or appropriate to enhance the conservation and management of BANP and resubmitted to the World Bank for approval. Moreover, CTT would ensure that the locations of these facilities (i) have been formally approved by African Parks (legally responsible for BANP management) and ANAC (Mozambique’s national conservation agency); (ii) are consistent with the Government-approved BANP Management Plan; and (iii) are legally permitted under Mozambican law—all in full compliance with IFC Performance Standard 6 (Paragraph 20) and the applicable Mozambican laws and regulations.

It is understood that the vessel will not be anchored for extended periods of time and will most likely be anchored for 1-2 days at a time to offload the heavy equipment over approximately 8-15 months, although this will be defined once a technology option has been chosen as well as a preferred manufacturer of the various large and oversized power plant components.

Once anchorage points are determined, then barge/shipping lanes will be determined to seek to avoid sensitive habitat such as sea grasses and corals. These barge/shipping lanes will be demarcated with buoys (non-Styrofoam). As described elsewhere in this ESIA, the barges will be accompanied by a lead boat with an appropriate Marine Mammal Observer (MMO) or other suitably trained staff in order to guide the barge and ensure that collision risks are avoided with marine mammals and other species.CTT will need to undertake the appropriate studies and apply for the relevant permits prior to construction and shipments arriving for off-loading.

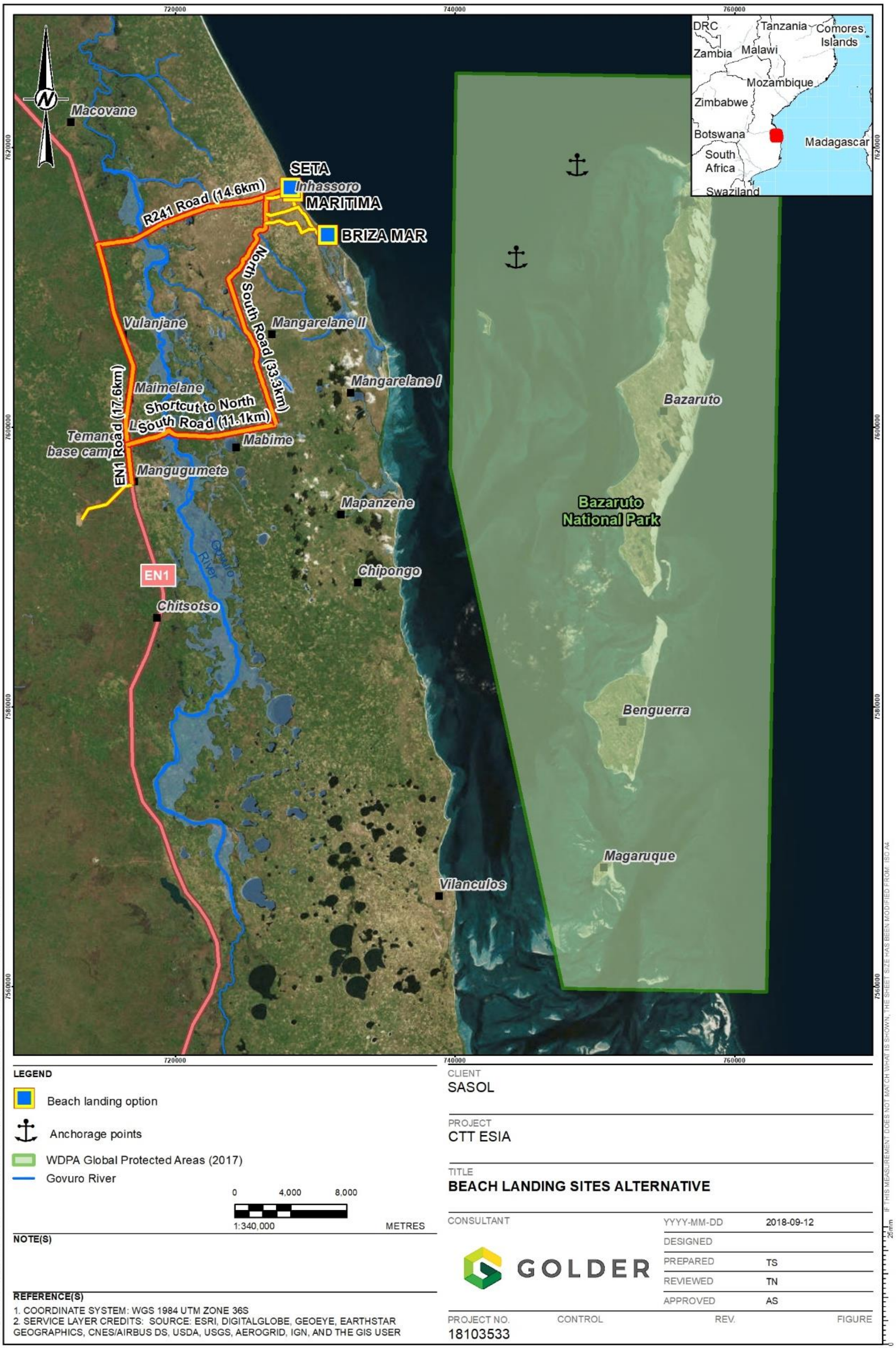


Figure 28: Previously Used or Identified Offshore Anchorage locations

3.5 Temporary Beach Landing Sites and Transportation Route Alternatives

Various alternative means of transporting large, over-sized and heavy equipment to site were formally studied and these included bringing in the equipment from overseas by ship and docking at one of the existing ports (Maputo, Inhambane or Beira) and then transporting by rail and/or road to the CTT site. These transport options via the existing ports of Maputo, Inhambane and Beira were confirmed to not be technically feasible for the following reasons:

- The existing port infrastructure such as crane capacities and jetties are not suitable for heavy point loads;
- Infrastructure limitations along the routes from these ports to CTT site (there is no rail infrastructure that connects the CTT site and certain road bridges are poorly maintained or damaged by flooding and cannot handle the loads required to travel across them); and
- There are numerous overhead obstructions along the roads from the ports to the CTT site (bridges, overhead electrical transmission lines, telephone lines and other infrastructure) with no alternative routes to bypass these obstructions.

Therefore, as part of the CTT construction phase it was confirmed that large, over-sized and heavy equipment would need to be brought in by a ship which would remain anchored at sea off the coast of Inhassoro. Equipment and materials would be transferred to a barge capable of moving on the high tide into very shallow water adjacent to the beach to discharge its cargo (Figure 11 and Figure 12) onto a temporary off-loading jetty (typically containers filled with sand) (Figure 18) near the town of Inhassoro. As the tide changes, the barge rests on the beach and off-loading of the equipment commences as mentioned in section 2.9.

Currently three (3) alternative beach landing sites are being evaluated together with alternative road route options to be used in transporting equipment and materials along public roads to the CTT site near the CPF. Figure 29 and Figure 30 indicate the alternative beach landing sites and routes being investigated respectively. These beach landing sites and road transport route alternatives are currently under evaluation. Currently, the SETA beach landing site is the preferred beach landing site (for environmental/social and technical reasons, although should the anchor points be moved, the new barge route must be studied to ensure this site remains the preference) together with the road route option to be used in transporting equipment and materials along the R241 then the EN1 then via the existing CPF access road to the CTT site near the CPF. As part of this transportation route, the Grovuro River bridge may need to be upgraded/strengthened to accommodate the abnormal vehicle loads. Alternatively, a temporary bypass bridge will be constructed adjacent to the existing bridge and will be dismantled and rehabilitated after the construction phase.

The alternative beach landing sites of Maritima and Briza Mar are still being evaluated as potential options, as well as the southern transport route, which would also require road upgrades and a new bridge construction across the Govuro at the position of the existing pipe bridge. SETA is currently considered the preferred site for environmental and other reasons, and it therefore shall be selected unless it is found not to be feasible once further technical studies are carried out or unless a new anchor point (and therefore new barge routes) increase the environmental or social risks of reaching this beach landing site. The preminary technical studies undertaken to date have shown all 3 sites to be viable alternatives with SETA the preferred location for environmental and other reasons.

It should be noted that the routes from the beach landing sites to the CTT may require raising of the existing power and telephone lines to allow the heavy vehicles to pass. In the vicinity of the Maritima and Briza Mar beach landing sites, there are tight corners to navigate in order to move equipment from either of these the beach landing sites which may require upgrading or widening of sections of roads in Inhassoro town. This may require some form of resettlement, either physical or economic in nature and this is dealt with later in the ESIA.

Figure 29: Alternative beach landing sites and routes at Inhassoro

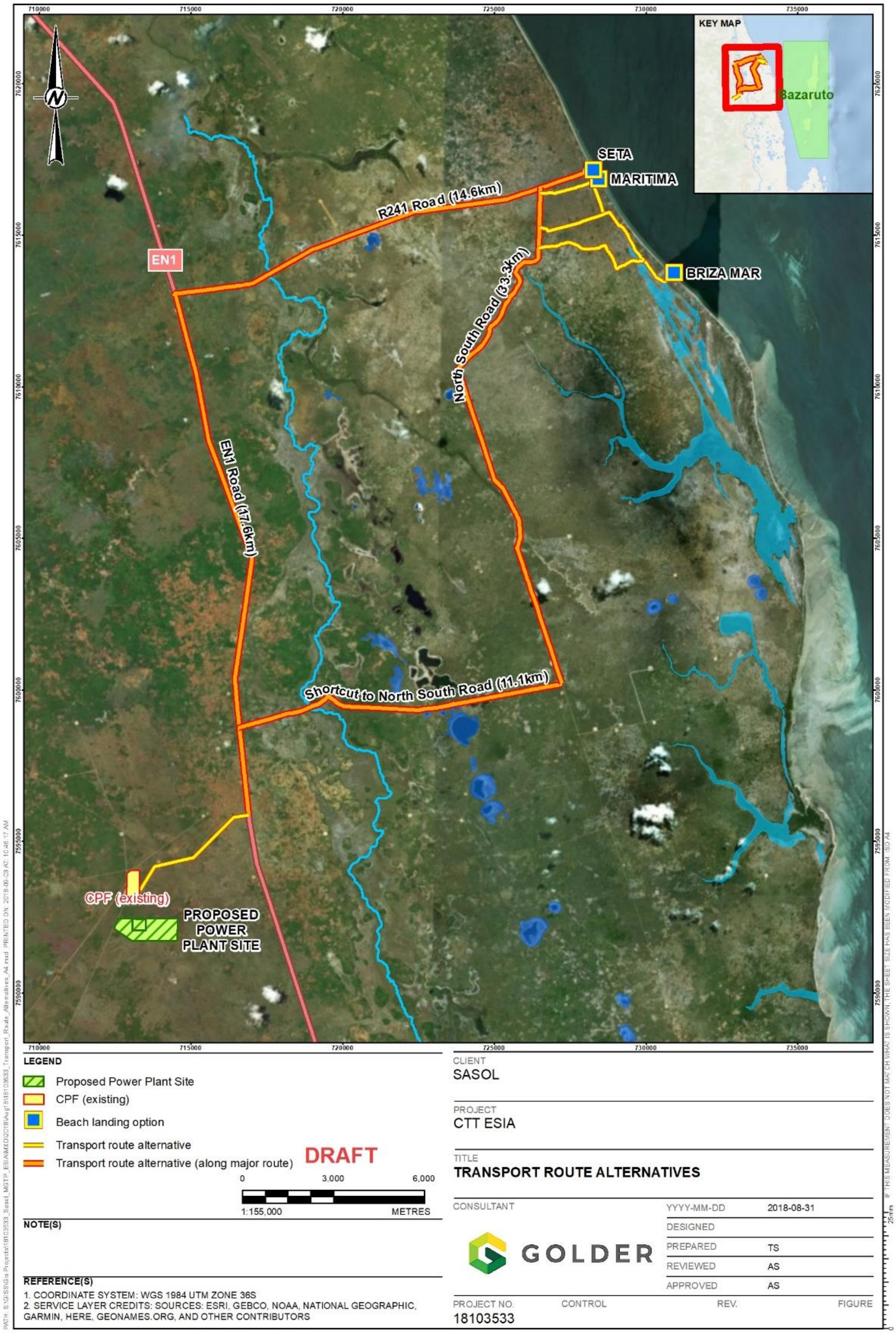


Figure 30: Alternative northern and southern route alternatives from Inhassoro to CTT site

3.6 Bridge Crossings and Road Upgrades

Depending on the Transportation route chosen, Bridge upgrades to various extents will be required. For the preferred transportation route (SETA beach landing to the EN1 via the R241) will require a temporary bypass bridge to be constructed over the Govuro River (Figure 31). This bypass bridge will require various piles and rafters to be installed as the deck (6 x 21.85m rafter beams) to allow the heavy vehicles to safely cross the river. These piles and rafters will be removed after the construction phase and the area will be rehabilitated. In contrast, the alternative transportation route currently crosses the Govuro River in the south by means of an existing pipe bridge (Kelly's pipe bridge) (Figure 32). This bridge will need to undergo a new bridge construction to enable heavy vehicles to cross. This bridge will also be constructed by using various piles and rafters to be installed as the deck (6 x 21.85 m rafter beams).

Figure 33 below provides a visual illustration of the rafters and piles that will be required for the bridge construction. It should be noted that the rafters and piles from the temporary bypass bridge across the northern section of the Govuro River will be removed after the construction phase of the CTT, however the upgrade to Kelly's bridge will remain and be accessible to the public as it is currently.

It should be noted that the temporary bypass bridge will have a gradual ramp from the R 241 road leading to and from the bridge to enable the safe transport of the heavy equipment. Figure 34 below shows a cross-section illustration of the temporary bypass bridge. The ramp will be kept to a minimum width so as to limit the footprint disturbance caused and will require a gentle gradient to allow the heavy and articulated loads to travel along it safely.

The impact of the bridge construction is further considered and discussed within the ESIA report.

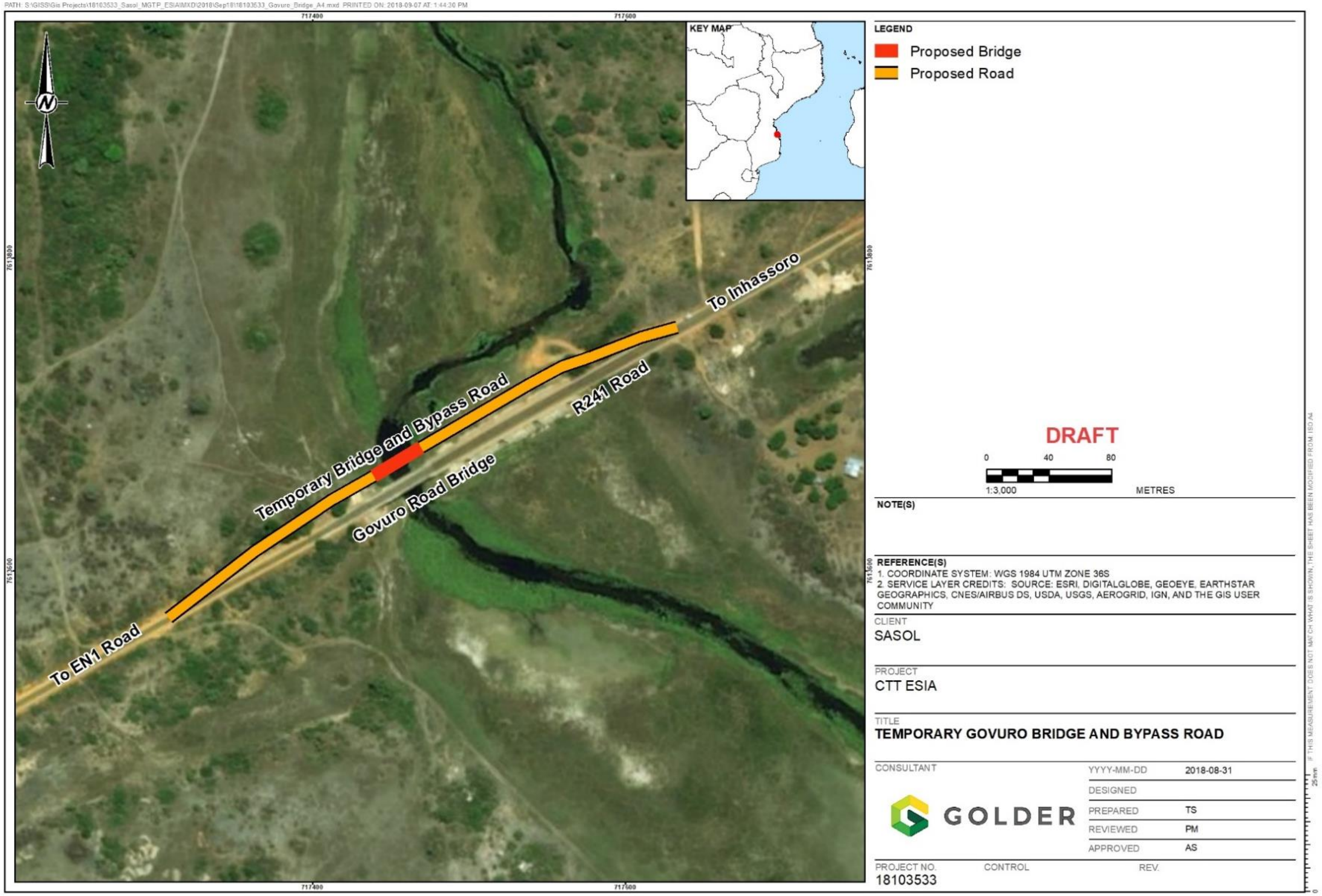


Figure 31: Temporary Bypass Bridge (northern transport route option)

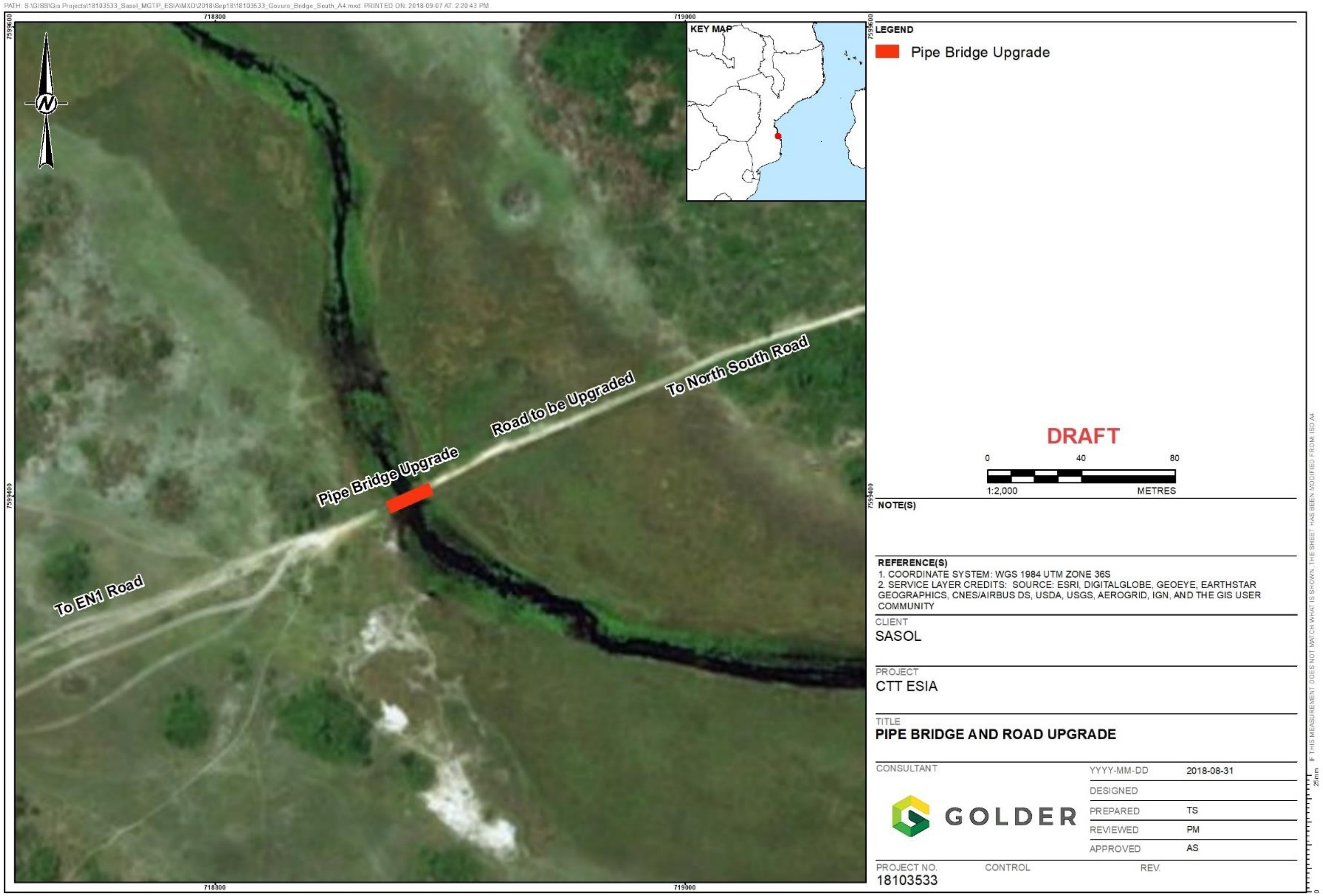


Figure 32: Kelly's Pipe Bridge location (southern transport route option)

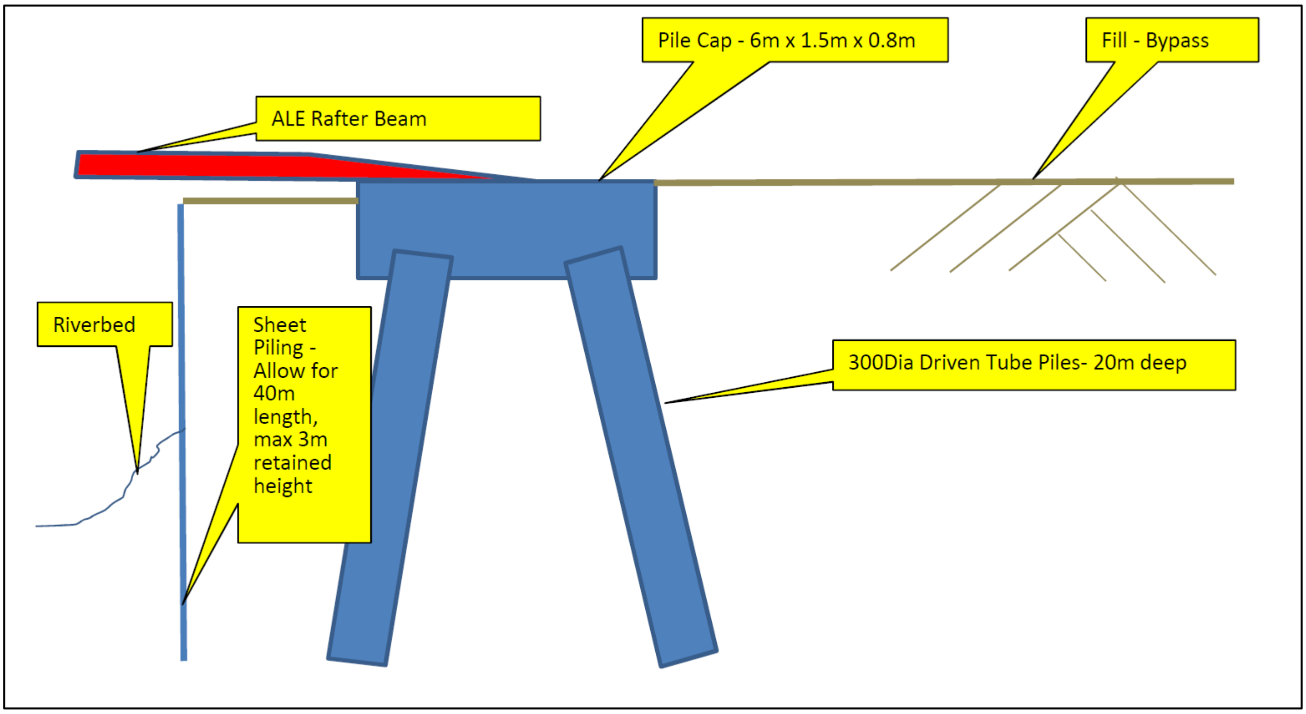


Figure 33: Conceptual illustration of rafters and piles to support the bridge crossings

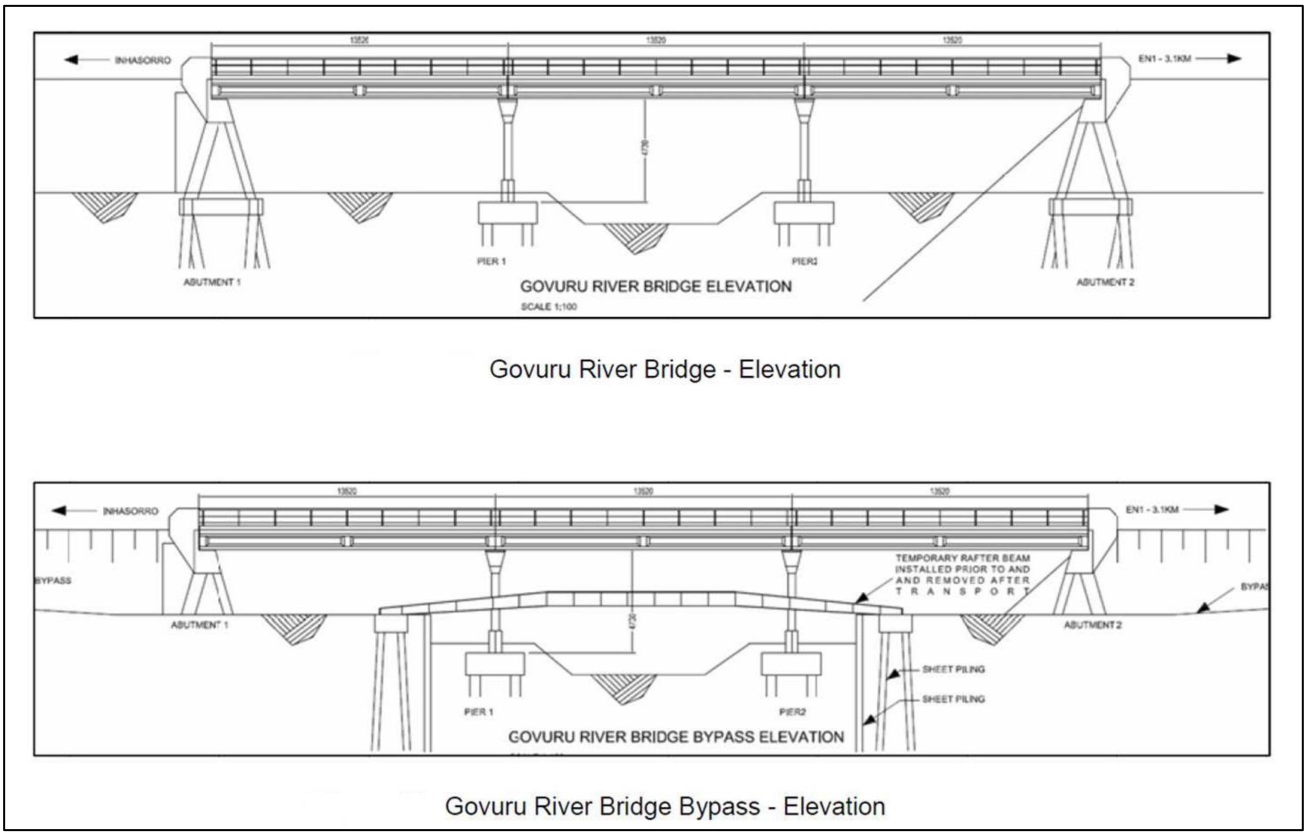


Figure 34: Cross section of existing Govuro River Bridge with temporary Bypass Bridge in foreground

4.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

4.1 Introduction

This section presents the policy, legal, and administrative framework within which the CTT ESIA has been undertaken. It summarizes policies, laws, regulations, standards and guidelines relevant to the environmental management of the proposed Project. National (Mozambican) laws deemed relevant for the successful implementation of all components of the project are presented in this Chapter. Furthermore, the Proponent has committed to comply with international guidelines and standards (the Equator Principles, World Bank Group Operational Policies, International Finance Corporation Performance Standards and other applicable international and regional guidelines) where these are more rigorous or detailed than Mozambican national standards or where Mozambique standards do not exist.

4.2 National Environmental Legislation

Environmental management in its entirety, with the EIA process in particular, is regulated by a number of national laws and regulations, as described in this section.

4.2.1 The Constitution of Mozambique

The Constitution is the supreme law of the land and any act or conduct that is inconsistent with the principles enshrined within the Constitution is considered unlawful. The Constitution provides for the protection of the natural environment and other socio-economic rights under the following articles:

- Article 117(1): "The state shall promote efforts to guarantee the ecological balance and the conservation and preservation of the environment for the betterment of the quality of life of its citizens;"
- Article 111: "In granting titles for the use and enjoyment of land, the State shall recognise and protect rights acquired through inheritance or occupation, unless there is a legal reservation, or the land has been legally attributed to another person or entity;"
- Article 112(2): "The State shall promote the just distribution of the proceeds of labour; and"
- Article 90(1): "All citizens shall have the right to live in, and the duty to defend, a balanced natural environment."

4.2.2 The Environmental Law

The Environmental Law (Decree 20/1997 of 1 October) was passed by the Mozambican Parliament in July 1997. The aim of this law is to provide a legal framework for the use and correct management of the environment and its components. Core principles for environmental management in Mozambique include:

- Citizen's quality of life improvement and protection of the country's biodiversity and ecosystems;
- Recognition and valuing of local communities' traditions and knowledge;
- Polluters responsible for environmental degradation will be liable for rehabilitation measures or compensation costs;
- Prohibition of the discharge of any polluting substances into the soil, subsoil, water or atmosphere or any other form of degradation of the environment, which falls outside the limits stipulated by law;
- Prohibition of the establishment of infrastructure for any purposes which might negatively impact on the environment, especially applicable for coastal environments, wetlands and ecologically sensitive areas among others;

- Prohibition of the importation of dangerous residues or dangerous waste, except as provided for in specific legislation; and
- Prioritisation of preventative systems against environmental degradation.

With their focus on the EIA process, Articles 15 to 17 establish that any activity, which by virtue of its location, design or scale, may cause significant environmental impacts will require an Environmental License from the designated authorities. The authorities will only issue a license, in terms of the final decision, based on the findings of an EIA process.

4.2.3 Regulations on the Environmental Impact Assessment Process

The project has been determined as 'Category A' in the revoked legislation (Decree 45/2008 of 4 November). After engagement with MITADER, it was agreed that the ESIA will be undertaken in accordance Decree 54/2015 of 31 December, which has been in force since April 2016.

For 'Category A' projects, an Environmental and Social Impact Assessment (ESIA) must be prepared by independent consultants as a basis for whether or not environmental authorisation of the project is to be granted, and if so, under what conditions. The final decision maker is the Ministry of Land, Environment and Rural Development *(Ministério da Terra, Ambiente e Desenvolvimento Rural*) (MITADER) through the National Directorate of Environmental Impact Assessment (DINAB). MITADER consults with other relevant government departments prior to making a decision.

4.2.4 General Directive for Environmental Impact Studies

The General Directive for Environmental Impact Studies (Ministerial Diploma 129/2006 of 19 July) establishes the content and information requirements for an EIR. The directive also establishes the minimum requirements of the EIR with respect to information and report structure.

4.2.5 General Directive for the Public Participation Process in the Environmental Impact Assessment Process

The General Directive for the Public Participation Process in the Environmental Impact Assessment Process (Ministerial Diploma 130/2006 of 19 July) expands on the procedural requirements for the public participation process, as established in the EIA Regulations. This directive establishes the norms and general principles that need to be met in undertaking the public participation process.

4.3 Petroleum-related Legislation

Since the Proponent operates in the petroleum sector, the following legislation also applies to the ESIA and project:

- Decree 56/2010 of 22 November – Environmental Regulations for Petroleum Operations. It sets out the EIA process to be implemented for petroleum operations and defines the project activity categories and the environmental assessment level required for each category. These Regulations are used in concert with the Regulations described under section 4.2.3;
- Law 21/2014 of 18 August – Petroleum Law. It establishes the system of allocation of rights to conduct petroleum operations and decommissioning in the country and includes aspects relating to Safety and Environmental Protection and the discharge of contaminated water and oil residues; and
- Decree 34/2015 of 31 December – Regulation for Petroleum Operations. It establishes operational requirements, including aspects related to safety, health and environmental protection and provides a list of environmental issues to consider while conducting petroleum operations.

4.4 Energy-related Legislation

The proposed project will generate energy which will feed into the national power grid. The following energy sector legislation applies to this ESIA:

- Decree 21/97 of 1 October – Electricity Law. This is the basic regulatory instrument for the generation, transmission, distribution and sale of electrical energy in Mozambique. It covers matters pertaining to electricity import and export; and concession regime for these activities. Under this law, the State, its agencies and other public entities have an obligation to promote the development of Mozambique's energy potential; to increase access to the benefits of electricity; and to contribute to the economic and social development of the country;
- Decree 8/2000 of 20 April – Regulations on the Powers and Procedures for the Award of Concessions, and the Import and Export of Energy. These Regulations establish the procedural framework for the award, control and extinguishing of concessions. Provision is made for matters pertaining to production, transport, distribution and commercialization of electric power, as well as their import and export;
- Decree 42/2005 of 29 November – Regulations on the National Power Transmission Network. These Regulations establish the procedural framework for planning, financing, construction, possession, maintenance and operation of production facilities. Further provision is made for matters pertaining to transportation, distribution and electrical energy trading. The Regulation also contains rules and procedures for the management, operation and overall development of National Network for Electric Energy Transport. The Regulation stipulates rules and procedures for conclusion of agreements pertaining to the transmission and distribution of electricity by the concessionaire, and to any final consumer that requires connection to the national grid;
- Decree 48/2007 of 20 October – Regulations to License Electric Installations. This Decree classifies electrical installations in 10 separate categories according to the source of energy and whether the installations include distribution and sale, whether they are for self-consumption or for public use, as well as whether they are temporary or permanent. The decree establishes that each category is subject to a different licensing requirement and is subject to different levels of taxation; and
- Decree 25/2000 of 3 October – Electricity National Council (CNELEC) Statutes. This Regulation provides for the powers and functions of CNELEC which was established under the Electricity Law 21/1997 of 1 October. CNELEC is responsible for mediation and arbitration of disputes arising from aspects of energy supply; pronouncing on policies, projects, concession requests and new technologies; and supervision of tenders. Its broad-based membership includes government representatives, producers, consumer associations, research institutions, the manager of the national grid and concessionaires.

4.4.1 Mozambique Energy Strategies and Policies

The strategies and policies for the Mozambique energy sector are listed below:

- Resolution 5/98 of 3 March – Energy Policy - This resolution aims to promote the establishment of economically viable investment programs for the development of energy resources (hydropower, forests, coal and natural gas); to ensure the reliable supply of energy at the lowest possible cost in order to meet the current levels of consumption and the needs of economic development; and increase availability of energy for the household sector, particularly coal, kerosene, gas and electricity;
- Resolution 62/2009 of 14 October – Renewable Energy Development Policy. This resolution aims to promote technological development of the new and renewable energy subsectors; use of new energy sources and renewables; and provision of new energy services and renewable energy quality at affordable prices, particularly in rural areas;

- Resolution 9/2009 of 10 March – Energy Strategy. This resolution aims to ensure the availability of energy at a national level to meet the challenges of sustainable socio-economic development; diversification of energy sources; sustainable production of biofuels based on local energy resources to substitution of imported fuels; adoption of tariff schemes to reflect actual costs, including the mitigation of adverse environmental impacts; encouraging business and financial sector investment in research and development of new products and technologies; efficient use of energy; institutional coordination and consultation with all stakeholders; participation in international cooperation initiatives in the SADC region; exploitation of the regional market for the viability of large energy enterprises; and take advantage of economies of scale provided by regional energy sector coordination;

- The National Energy Strategy (2014 – 2023). Mozambique's Energy Strategy was designed for a ten-year period (2014 – 2023). It provides a vision and path to respond to the challenges and opportunities in the power sector. The main goals are to reinforce Mozambique's position as an important regional energy producer; to support social development and poverty alleviation; and to promote general economic growth. The strategy contains the following:

i) Regulation – Establishment of an energy authority as the regulator for the entire energy sector, which will include liquid fuel, natural gas (downstream) and renewable energy;

ii) Energy efficiency – To promote habits of reasonable and responsible consumption of energy and to create a legal framework that guarantees these behaviours both in the efficient production and consumption of energy;

iii) Feed-in Tariff – To be approved by the government, the tariff for renewable energy is for projects in which the generation cost is equivalent to the contract cost of natural gas power stations, with an extra incentive on the bidding process and an environmental tax. Special attention will be made so that there are no increases to the EDM operational and maintenance costs, which need to be retained;

iv) The new tariff methodology settlement – Due to the large-scale energy projects in Mozambique, the investments made are significant. Therefore, tariff methodology settlement is an important tool used to help 'bail out' the investor in this sector, especially in operations on the local market. The new tariff needs to take the operation and maintenance cost into account; and

v) Rural and Peri-Urban Electrification – The main challenges are extending grid access, improving the quality of the energy, and improving the capacity of the administrative posts to promote the productive use of energy and to generate more income. The goal is to mobilize USD 200 million every year over the next seven years to expand and improve energy access in the rural and peri-urban areas, achieving 44% universal access by 2021 and 50% grid based access by 2023.

The Government of Mozambique also plans to launch a transmission and distribution grid rehabilitation program for the entire national territory to increase energy quality and efficiency in urban areas. There are also plans to further strengthen the institutional capacity of FUNAE to increase its role in the process of rural electrification.

4.4.2 Southern African Power Pool (SAPP)

Mozambique is part of SAPP, an organization established on 8 December 1995 when the representatives of the power utilities of Botswana, Mozambique, Angola, Malawi, South Africa, Swaziland, the Democratic Republic of Congo, Namibia, Tanzania and Zimbabwe signed the Inter Utility Memorandum of Understanding. All imports and exports of power among these countries lie within the rules and confines of SAPP.

SAPP aims at creating one single interconnected grid in Southern Africa.

4.5 Discipline-specific Legislation, Policy and Strategy

Table 9 below provides a summary of Mozambican legislation, policy and strategy documents relevant to various aspects of this ESIA.

4.6 South African Guidelines/Standards

In two instances where Mozambique regulations do not exist, South African standards have been used. These are described below.

4.6.1 National Dust Control Regulations

The purpose of the National Dust Control Regulations (GN R.827, *GG* 36974, 1 November 2013), is to prescribe general measures for the control of dust in all areas. A standard for the acceptable dust fall-out rate has been determined for residential and non-residential areas. For the purpose of this study, the limit for non-residential areas has been used.

4.6.2 South African National Standard (SANS) 10103

SANS 10103 measures and rates environmental noise as it relates to annoyance and speech communication (https://www.sabs.co.za/sectors-and-services/services/ems/ems_sp.asp).

Table 9: Discipline-specific Mozambican legislation, policy and strategy

Sector	Law/Decree	Title	Description
ENVIRONMENTAL	Law 10/99 of 7 July	Law of Forestry and Wildlife	Establishes the principles with respect to the formalisation of protected areas and the management of forestry and wildlife resources. Article 13 establishes the need for protection of places of historical and cultural value to local communities.
	Decree 11 / 2003 of 25 March	Forestry and Wildlife Regulations	Establishes additional Regulations in support of the Forestry and Wildlife Law. These Regulations provide the guiding principles associated with the management, protection, use and exploitation of forest and wildlife resources.
	Law 16/2014 of 20 June	Biodiversity Conservation Law	Established basic principles and rules for the protection, conservation, restoration and sustainable use of biological diversity in conservation areas, as well as a framework for integrated management in support of sustainable development for the country.
	Decree 25/2011 of 15 June	Regulations on the Process of Environmental Auditing	These Regulations define environmental auditing as a management tool for the systematic, documented and objective evaluation of the operation and organisation of a company’s management system and its environmental protection and control processes.
	Decree 18/2004 of 2 June amended by Decree 67/2010 of 31 December	Regulations on Environmental Quality Standards and Wastewater Emissions	Regulates and ensures effective control and monitoring on the quality of the environment and natural resources. It establishes specific standards and Regulations on water quality, atmospheric emissions and noise.
	Decree 67/2010 of 31 December (amendments to Appendix I and inclusion of	Regulation on Environmental Quality and Effluents' Emissions	This Decree, among other provisions, amends Air Quality Standards and adds Appendices 1A and 1B which cover Organic and Inorganic Carcinogenic Atmospheric Pollutants and Substances with Odorous Properties respectively.

Sector	Law/Decree	Title	Description
	Appendices 1A and 1B to Decree 18/2004 of 2 June)		
	Decree 11/2006 of 15 June	Regulations on Environmental Inspections	Regulates the activities associated with supervision, control and compliance with environmental protection standards at national level.
	Decree 83/2014 of 31 December	Regulation on Hazardous Waste Management	Establishes the legal framework for hazardous waste management in Mozambique to minimise negative impacts on social health and the environment.
	Decree 94/2014 of 31 December	Regulations on Urban Solid Waste Management	Establishes the legal framework for urban solid waste management in Mozambique to minimise negative impacts on social health and the environment. These Regulations set out rules for classification of solid waste, the forms of waste segregation, waste collection and transport, waste treatment and waste disposal.
	Decree 8/2003 of 18 February	Regulation for Biomedical Waste Management	This Regulation establishes the rules pertaining to biomedical waste management, aiming at safeguarding health and safety of the general public and medical service employee. It further makes provision for measure to minimize the impact of biomedical waste on the environment. This Regulation is applicable to medical units, research institutions, companies or people that a) produce or handle biomedical waste; b) transport biomedical waste; c) remove biomedical waste; d) are employed in a medical unit that produces, handles or removes biomedical waste and e) are patients, employees or visitors in a medical unit that produces, handles transports or removes biomedical waste. It requires all medical units, research institutes and companies covered by this Regulation to develop a biomedical waste management plan.

Sector	Law/Decree	Title	Description
	Resolution 63/2009 of 2 November	Protected Areas Conservation policy	The Protected Areas Conservation policy and its implementation strategy regulates activities in Conservation Areas.
	Decree 25/2008 of 1 July	Regulation regarding the Control of Invasive Alien Species	Article 8 of this Decree prohibits restricted activities involving invasive alien species without prior authorization. It states that 'after hearing the Inter-institutional Group for the Control of Invasive Alien Species, the National Authority (MITADER) can prohibit the performance of any activity which, by its nature, may influence the propagation of invasive alien species'. Article 11 of the Decree provides that appropriate methods should be taken to control and eradicate listed invasive alien species.
WATER	Law 16/1991 of 3 August	The Water Law	Establishes the basis for management of water resources and advocates a "user pays" and "polluter pays" policy. This law stipulates, for cases of private water use, that full priority shall be given to water supply to the population (human consumption and heath care needs). Furthermore, it prohibits the private use of water where the provision of such water use will be to the detriment of the environment. Article 18 appoints the Regional Water Administrations as the institutions responsible for the management of surface and underground water resources. It assigns management, control and planning competences including approval of bulk water construction works. In this context, the Regional Water Administration (ARA-Sul) was created for the management of river basins in the southern Mozambique territory. Articles 25 and 26 detail private water use and priorities. In the case of private water use, Article 26 stipulates that water supply must be prioritised for human consumption and fulfilment of sanitary requirements. Furthermore, o private uses will be allowed if they conflict with the water requirements for environmental conservation.

Sector	Law/Decree	Title	Description
			Rights for private water use can be obtained through the provision of a license in terms of the Law and its Regulations (Article 25). This includes activities of a non-permanent character that do not alter riverbeds or banks, lakes, lagoons or swamps (Article 32).
	Decree 18/2012 of 5 July	Regulations on the Prospecting and Extraction of Groundwater	Establishes rules and procedures for licensing by the Regional Water Administration (ARA or Provincial Directorates of the Ministry responsible for water activities, Planning and Infrastructure District Services) in matters pertaining to prospecting, drilling and extraction of groundwater. It further sets out criteria to be observed in drilling holes, wells and other means of extracting water. Article 6 stipulates that drilling must not cause leakage, chemical or bacteriological contamination to the aquifer; all wells or boreholes must be fitted with devices that prevent water wastage; dry boreholes must be closed; land must be restored; and a minimum distance between boreholes of different users must be approved by the Minister in charge of the water sector. The content requirements of the license application for drilling and extraction are specified in these Regulations.
	Decree 43/2007 of 30 October	Regulation regarding water licensing and concessions	The Regulation on water licensing and concessions regulates the process of obtaining the rights for the private use of water. The Regulation specifies which water uses require an EIA, Environmental License or an official exemption to obtain the rights to use water. Effluent discharge is also subject to a specific license or concession. The surface water body or aquifer into which effluent will be discharged must be identified. If the effluent is discharged on the ground the following parameters must be identified: the point of effluent discharge; quantity; volume and frequency; nature and composition per unit of volume; known temperature; treatment methods proposed; and required equipment and methods of discharge.

Sector	Law/Decree	Title	Description
			Proposed methods to measure the effluent, anticipated impacts on the environment, methods to assess and control impacts must also be included.
LAND RIGHTS / ACQUISITION	Law 19/1997 of 1 October	The Land Law	Establishes as a general principle that, in Mozambique, land is the property of the State. The Land Law and its associated Regulations establishes land use rights and the means by which individuals or companies may obtain the rights to use land (referred to as DUAT). Other provisions that merit special attention in the context of this ESIA include: ■ The impacts of the project's existing DUATs; ■ Impacts on zoning and land-use planning for social and economic purposes; ■ Impacts on agriculture; and ■ Impacts on public health due to ecological changes. In respect of biodiversity, the Land Law classifies land in the public domain as total and partial protection zones. Under Article 7, total protection zones are designated as areas reserved for nature conservation, defence and national security activities. Pursuant to Article 8, partial protection zones include, inter alia, the coastline, islands, bays and estuaries up to 100 m inland of the maximum high tide mark. In accordance with Article 9, the use of land in total and partial protection zones requires the issuance of specific licenses.
	Decree 66/98 of 8 December as amended by Decree 1/2003 of 18 November and Decree 43/2010 of 20 October	Land Law Regulations	This Decree sets out Regulations as contemplated in Land Law 19/1997 of 1 October. These Regulations provide for matters related to publicly owned land, land use rights, the land title application process, inspection and taxes. Article 17 contains provisions relating to liability for damages and/or compensation where a land use holder has suffered loss related to actions or activities of public or private investor.

Sector	Law/Decree	Title	Description
			The Land Law outlines the procedures to be followed during application and acquisition of land use rights (DUAT) and establishes the obligation for payment of land taxes. Articles 22 introduces the procedures for land acquisition and the competent authorities that need to be involved.
	Ministerial Diploma 29/2000 of 17 March	Technical Annex to the Land Law Regulations	Defines the approach and implementation mechanisms associated with the title application process. Furthermore, the technical annex contains provisions concerning the rights and duties of local communities.
TERRITORIAL PLANNING	Decree 19 of 2007 of 18 July	Territorial Planning Law	Establishes the principles, objectives and legal framework for land planning in Mozambique. These Regulations outline the measures and regulatory procedures required to improve living standards for the people of Mozambique and to advance the objective of sustainable development.
	Decree 23/2008 of 1 July	Territorial Planning Law Regulations	These Regulations establish procedures to ensure that land occupation, the rational and sustainable use of natural resources, evaluation of the potential of each region, infrastructure, urban systems and promotion of national cohesion and population safety is promoted. It establishes a legal framework for territorial planning. It regulates relationships between different levels of Public Administration and between Public Administration and other public and private parties that represent economic, social and cultural interests, including those of local communities.
RESETTLEMENT	Decree 31/2012 of 8 August	Regulations for the Resettlement Process Resulting from Economic Activities	These Regulations stipulate the basic rules and principles associated with resettlement as a result of public or private economic activities, performed by national or foreign, natural or legal persons. The Regulations aim to promote an acceptable quality of life for citizens and the protection of the environment.

Sector	Law/Decree	Title	Description
	Ministerial Diploma 155/2014 of 19 September	Internal Regulations for the Operation of the Technical Commission for Monitoring and Supervision of the Resettlement Process	Ministerial Orders 155/2014 and 156/2014 are strongly orientated around large-scale resettlement in which significant numbers of people are moved to a host area. The formal consultation required for this process, and Government involvement under the auspices of the Technical Commission for Oversight and Supervision of the Resettlement Process (Ministerial Order 155/2014) is extensive, involving large numbers of Government officials.
	Ministerial Diploma 156/2014 19 September	Technical Directive on the Preparation of Resettlement Plans and the Implementation Process	The Directive requires compliance with goals and commitments included in resettlement action plans; assessment of levels of satisfaction of the resettled persons; technically assessing and validating information received during the plan implementation process.
LABOUR	Law 23/2007 of 1 August	Labour Law	Defines aspects related to the hiring of workers, the rights and responsibilities of workers, including hygiene and health and safety. The law also discusses labour relations between employers and workers and the laws in terms of national and foreign workers.
	Decree 63/2011 of 7 December	Regulation for the Contracting of Foreign Citizens in the Petroleum and Mining Sectors	Establishes the legal regime including mechanisms and procedures for contracting foreign citizens for work purposes in the Petroleum and Mining sectors. It provides, *inter alia*, that the performance of activities in these circumstances must be approved by the competent authority.
HEALTH	Law 25/91 of 31 December	Mozambican National Health Service	A tiered system which includes Primary, Secondary and Tertiary levels of health care service. The Law provides for a referral system. Where patients cannot be adequately attended to at the receiving level, they are forward to the next level.

Sector	Law/Decree	Title	Description
GOVERNANCE	Law 8/2003 of 19 May and Decree 11/2005 of 10 June. Decree 6/2006 of 12 May	Regulations of Local State Bodies	Defines governance structure at District Level. This Law returns State powers to the local authorities.
CULTURAL HERITAGE	Law 10/1988 of 22 December	Cultural Protection Law	Establishes the legal protection for material and immaterial assets associated with Mozambican cultural heritage (existing or yet to be discovered). In relation to this ESIA, Article 13 stipulates the need to communicate any findings of buildings, objects or documents that may potentially be classified as assets of cultural heritage.
	Decree 27/1994 of 20 July	Archaeological Heritage Protection Regulations	Establishes the rights and protection of resources that have archaeological and historical value. Article 21 of these Regulations prohibit the execution of construction and demolition or any other works that may result in physical changes to the protection zones of archaeological property of high scientific value or that are important to preserve for future generations. This Regulations establish, inter alia that finding of artefacts shall be reported to the local authorities (District Administration or Municipal Council) within a period of 48 hours.
TOURISM	Law 4/2004 Ministerial Decree 17/2001 of 12 June	Tourism Law	Establishes the principles of tourism activities in conservation areas, in the context of ecosystem protection and conservation. Decree 17/2001 of 12 June established the Ministry of Tourism as the entity responsible for conservation areas management.
		Tourism Policy and Implementation Strategy	Outlines the tourism objectives, identifies focal areas for intervention and provides guidelines for the promotion and optimisation of tourism in Mozambique.

Sector	Law/Decree	Title	Description
		Strategic Plan for the Development of Tourism in Mozambique (SPDTM) 2015 - 2024	Building on the basis of the previous plan, the 2015 - 2024 SPDTM includes specific and priority strategies for tourism growth. It contains measures to ensure effective implementation and monitoring of strategic objectives. It incorporates a vision for 2020 that Mozambique will be Africa's most vibrant, dynamic and exotic tourism destination, famous for its outstanding beaches and coastal attractions, exciting eco-tourism products and intriguing culture, with a growing and sustainable industry.
	MATIP; World Bank 2012	Mozambique Anchor Tourism Investment Program	The MATIP was initiated in 2007 to assist the Ministry of Tourism and implemented by the World Bank Group's Investment Climate Services through the IFC with the aim of improving the investment climate in the tourism sector by facilitating investments in select protected and coastal areas in Mozambique (World Bank 2012).

4.7 Conventions and Resolutions

Mozambique is signatory to a number of international conventions and agreements (Table 10) relating to environmental management and energy. In certain cases, these instruments have influenced the development of policies, guidelines and regulations. The ESIA process considers these conventions and agreements to ensure compliance as applicable during the planning, construction and operational phases of the project.

Table 10: Conventions and Resolutions ratified by Mozambique

Instrument Name
Environment: General
Convention on the Conservation of Migratory Species of Wild Animals.
Convention on Wetlands of International Importance especially the Water Fowl Habitats of Aquatic Birds (Ramsar Convention) (1975).
United Nations Convention on Biological Diversity (CBD) (1992).
Convention on Tropical Areas of International Importance which serve as Habitats for Aquatic Birds Resolution 45/2003 of 5 November.
African Convention on the Conservation of Nature and Natural Resources, 1968 (Resolution No. 18/81).
Convention on the Conservation of the Migratory Species of Wild Animals ratified in Bonn, Germany, on the 23rd of June 1979 (and corresponding amendments from 1985, "1988, 1991, 1994, 1997, 1999, 2002 and 2005; Resolution No. 9/2008).
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), Ramsar, 1971 (Resolution No. 45/2003).
Convention on Biological Diversity (CBD), Nairobi, 1992 (Resolution No. 2/94).
African Convention on the Conservation of Nature and Natural Resources (CAB/LEG/24.1).
Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (September 2001).
Environment: Climate Change
Vienna Convention for the Protection of the Ozone Layer (1985).
Montreal Protocol to Protect the Ozone Layer (including 1990 and 1999 amendments) (1987).
United Nations Framework Convention on Climate Change (UNFCCC) and the 1992 and 1997 Kyoto Protocol (1992 and 1997).
Hazardous Substances
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998).
Stockholm Convention on Persistent Organic Pollutants (2002).
Waste
Convention on the Ban on the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (Bamako Convention) (1991).

Instrument Name
The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989).
Heritage
Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), Paris, 1972 (Resolution No. 17/82).
Labour
Abolition of Forced Labour Convention, 1957 (No. 105).
Minimum Age Convention, 1973 (No. 138).
Worst Forms of Child Labour Convention, 1999 (No. 182).
Human Rights
Discrimination (Employment and Occupation) Convention, 1958 (No. 111).
International Convention on the Elimination of All Forms of Racial Discrimination :1969.
Convention on the Elimination of All Forms of Discrimination against Women :1981 (CEDAW).
Convention on the Rights of the Child :1990.
International Convention on the Protection of the Rights of All Migrant Workers and Members of their Families: 2003.
Convention on the Rights of Persons with Disabilities :2008 (ICRPD).
Energy
Convention of the African Energy Commission (Date of Ratification: 27/10/2003).

4.8 Institutional System in Mozambique

In terms of institutional responsibilities, there have been considerable changes resulting from changes in the Government of the Republic of Mozambique in 2015. The key institutions and their main roles and responsibilities in relation to environmental protection and the petroleum industry are summarised in Table 11 below.

Table 11: Mozambican Institutional Authorities and their Responsibilities.

Institution	Roles and Responsibilities
Ministério da Terra, Ambiente e Desenvolvimento Rural (MITADER) Ministry of Land, Environment and Rural Development	The Ministry of Land, Environment and Rural Development (MITADER), previously the Ministry of Coordination of Environmental Affairs (MICOA), is responsible for areas of administration; land management and geomatics; forests and wildlife; as well as environment, conservation and rural development (that were previously under responsibility of the Ministries of Agriculture and Tourism). MITADER is responsible for:

Institution	Roles and Responsibilities
	■ Territorial planning for the sustainable development of the country; ■ Formulation of proposals for integrated development policies and strategies related to land, environment, conservation areas, forests, wildlife and rural development; ■ Land administration and management; ■ Administration, management and sustainable use of forests and wildlife; ■ Administration and management of the national network of conservation areas; ■ Planning, promotion and coordination of integrated and sustainable rural development; ■ Promoting the development of knowledge in the field of land, environment, forests, wildlife and rural development; ■ Securing, maintaining and developing cooperation in the area of land, environment, wildlife, forests and rural development; ■ Definition and implementation of strategies for education, awareness and dissemination; and ■ Inter-sectorial coordination and sustainable use of the resources available in support of sustainable development. Among others, the relevant EIA authority is the National Directorate of Environment (DINAB), which is responsible for reviewing EIA Reports and for environmental licensing, whereas the National Environmental Quality Control Agency (AQUA) is the environmental authority responsible for environmental management, monitoring and auditing.
Ministério dos Recursos Minerais e Energia (MIREME) Ministry of Mineral Resources and Energy	The Ministry of Mineral Resources and Energy (MIREME) is responsible for maintaining an inventory of mineral resources within the territory of Mozambique in general and in designated Exclusive Economic Zones (EEZ) in particular. It is also responsible for promoting and controlling prospecting and geological exploration activities; ensuring the rational use of mineral resources; promoting and controlling exploration, production, separation and processing activities for mineral resources, including crude oil and natural gas; and control of the transport of mineral resources to export points or points for commercial sale in the country. The necessary licenses for the extraction of inert materials such as sand or gravel is granted by MIREME at provincial level (Provincial Directorate of Mineral Resources and Energy).
Instituto Nacional de Petróleo (INP) National Petroleum Institute	The INP is the regulatory body responsible for the administration and promotion of petroleum operations, under the oversight of MIREME.

Institution	Roles and Responsibilities
	The INP is responsible for developing guidelines for the participation of public and private sectors in the exploration and exploitation of petroleum products and their derivatives and has the following duties, among others: ■ Regulation and auditing of oil exploration, production and transport activities; ■ Development of policies and standards related to petroleum operations; ■ Safeguarding the public interest and the environment by establishing the required technical, commercial and environmental conditions; ■ Promoting the adoption of practices that encourage the efficient use of resources and the existence of quality standards that contribute to the maintenance and protection of the environment; and ■ Organization, maintenance and consolidation of technical data and information related to activities of the petroleum industry and national oil reserves.
Fundo Nacional de Energia (FUNAE) Energy Fund	FUNAE is the state agency responsible for promoting off-grid energy access and fuel distribution to remote locations. FUNAE operates under the oversight of MIREME. It was created as a fund to supply financial aid and financial guarantees for economically viable projects that are in tune with FUNAE's stated objectives. It has been working as a renewable and rural energy agency through public tenders, and by directly implementing and funding projects.
Electricidade de Moçambique E.P. (EDM) Electricity of Mozambique	Electricidade de Moçambique (EDM) is a vertically-integrated government-owned power company. It has an installed capacity of 140MW in hydropower generation (86 MW operational) and 109 MW (82 MW operational) in thermal power stations. EDM buys most of its power supply (400 MW) from Hidroeléctrica de Cahora Bassa (HCB) 24, which owns and operates the Cahora Bassa plant on the Zambezi (2,075 MW). EDM sells any excess electricity on the Southern Africa short-term energy market. The national transmission grid is currently interconnected with South Africa, Zimbabwe and Swaziland.
Ministério da Saúde (MISAU) Ministry of Health	MISAU's primary objectives are to: ■ Promote and encourage the resolution of health problems; ■ Project and develop programs for promoting and protecting health, and preventing and combating disease; ■ Provide health care to the population through the public health sector; ■ Promote and support health initiatives in the private and not-for-profit sector;

Institution	Roles and Responsibilities
	■ Promote, supervise and support a community system for the provision of health care; and ■ Provide a policy for pharmaceutical formulation and guidance for its implementation.
Ministério do Mar e Aguas Interiores Ministry of the Sea, Inland Waters and Fisheries	The Ministry of the Sea, Inland Waters and Fisheries is responsible for guiding, coordinating, planning and execution of policies, strategies, and plans for fisheries and activities taking place in the sea and inland waters. The following are competencies of the Ministry of the Sea, Inland Waters and Fisheries: ■ Oversight of all affairs pertaining to fisheries and activities in the sea and inland waters; ■ Authorizing and supervising planning, concessions, research and other activities that require the use of the sea, inland waters and respective ecosystems, in coordination with other institutions; ■ Promotion of the use and exploitation of the resources derived from the sea, inland waters, and their ecosystems; and ■ Promotion and coordination of the regulation of the sustainable use of water, prevention and reduction of pollution of the aquatic environment, and improvement of the state of the respective ecosystems.
Caminhos de Ferro de Moçambique (CFM) Mozambique Ports and Railways Company, E.P.	CFM is responsible for operating the ports and railways in Mozambique. Beira Port falls under CFM Central division (CFM-Centro), whereas Maputo Port falls under the Southern Division (CFM-Sul). The oil terminals (berths) in Beira and Maputo (Matola) fall under CFM.
Administração Regional de Águas - ARA Regional Water Administrations	Ara-Sul has jurisdiction from the southernmost region of Mozambique to the Save River. This institution is therefore responsible for the management of water resources in the project area. Its responsibilities include, *inter alia*, analysis of requests for use and benefit of water, discharge of effluent, protection and management of groundwater resources and issuing of permits.

4.9 International Guidelines and Standards

This section describes the most relevant international guidelines and standards. The Proponent is committed to best oil industry practice. Where standards and guidelines are absent in Mozambique law, or are less stringent than equivalent industry guidelines, the Proponent will, wherever possible, comply with the more stringent industry guideline.

4.9.1 The Equator Principles

The Proponent is committed to comply with the Equator Principles ( ) throughout in its Mozambique activities. The Equator Principles (EPs) are a risk management framework which has been adopted by financial institutions for determining, assessing and managing environmental and social risks in projects. They are primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making.

Box 1: The Equator Principles

(www.equator-principles.com)

1) Review and categorisation (Categories A, B and C)
2) Social and environmental assessment (to be conducted in compliance with IFC PS 1, Environmental and Social Sustainability
3) Applicable environmental and social standards
4) Environmental and Social Management System and Equator Principles Action Plan
5) Stakeholder Engagement
6) Grievance mechanism
7) Independent review
8) Covenants
9) Independent monitoring and reporting (post EIA process)
10) Reporting and Transparency

4.9.2 World Bank Group Operational and Safeguard Policies

World Bank funded projects and activities are governed by Operational Policies (OP 4.03) and Safeguard Policies (although not strictly applicable here) designed to ensure that the projects are economically, financially, socially and environmentally sound. For projects that are not seeking financing from the World Bank their policies and procedures serve as relevant standards for international good practice.

The aim of this policy (OP 4.03) is to facilitate Bank financing for private sector led economic development projects by applying environmental and social policy standards that are better suited to the private sector, while enhancing greater policy coherence and cooperation across the World Bank Group.

Box 2: World Bank Safeguard Policies applicable to this ESIA

(http://www.bankinformationcenter.org/our-work/safeguards/)

- Environmental Assessment;
- Natural Habitats;
- Noise Standards for Industrial sites
- Cultural Property; and
- Involuntary Resettlement.

The eight IFC Performance Standards have been adopted by the Bank as the World Bank PerformaStandards for Projects Supported by the Private Sector (“WB Performance Standards”) for application to Bank support for projects (or components thereof) that are designed, owned, constructed and/or operated by a Private Entity (as defined below), in lieu of the World Bank’s safeguard policies (“WB Safeguard Policies”). The eight World Bank Performance Standards are shown in section 4.9.4 below.

4.9.3 The International Finance Corporation

The International Finance Corporation (IFC), a division of the World Bank Group that lends to private investors, uses a Sustainability Framework (IFC, 2012), to promote sound environmental and social practices, encourage transparency and accountability, and contribute to positive development impacts. The Proponent is committed to upholding the requirements of the IFC Sustainability Framework.

4.9.4 IFC Performance Standards

IFC's Performance Standards (PS) ( ), which are part of the Sustainability Framework, have become globally recognised as a benchmark for environmental and social risk management in the private sector.

Box 3: IFC Performance Standards

(www.ifc.org)

- PS 1: Assessment and Management of Environmental and Social Risks and Impacts
- PS 2. Labour and Working Conditions;
- PS 3. Resources Efficiency and Pollution Prevention;
- PS 4. Community, Health, Safety and Security;
- PS 5. Land Acquisition and Involuntary Resettlement;
- PS 6. Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- PS 7. Indigenous Peoples (no indigenous peoples in accordance with the IFC definition in the study area); and
- PS 8. Cultural Heritage.

4.9.5 IFC/World Bank Group General Environmental, Health and Safety Guidelines

The General Environmental, Health and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of good international industry practice. The EHS Guidelines contain the performance levels that are normally acceptable to the IFC and World Bank, and measures that are generally considered to be achievable in new facilities at reasonable costs by existing technology. This information supports actions to avoid, minimise and control EHS impacts during the construction, operation, and decommissioning phases of a project or facility.

The following sector-specific guidelines (in addition to EHS Guidelines) also apply to The Proponent:

- Environmental, Health, and Safety Guidelines for Onshore Oil and Gas Development, 2015;
- Environmental, Health, and Safety Guidelines for Natural Gas Processing, 2007;
- Environmental, Health, and Safety Guidelines for Thermal Power Plants, 2008;
- Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution, 2007; and
- Environmental, Health, and Safety Guidelines for Construction Materials Extraction, 2007.

Box 4: IFC/World Bank Group General EHS Guidelines

(http://www.ifc.org/wps/wcm/connect)

1. Environmental 1.1 Air Emissions and Ambient Air Quality 1.2 Energy Conservation 1.3 Wastewater and Ambient Water Quality 1.4 Water Conservation 1.5 Hazardous Materials Management 1.6 Waste Management 1.7 Noise 1.8 Contaminated Land **2. Occupational Health and Safety** 2.1 General Facility Design and Operation 2.2 Communication and Training 2.3 Physical Hazards 2.4 Chemical Hazards 2.5 Biological Hazards 2.6 Radiological Hazards 2.7 Personal Protective Equipment (PPE) 2.8 Special Hazard Environments 2.9 Monitoring	**3. Community Health and Safety** 3.1 Water Quality and Availability 3.2 Structural Safety of Project Infrastructure 3.3 Life and Fire Safety 3.4 Traffic Safety 3.5 Transport of Hazardous Materials 3.6 Disease Prevention 3.7 Emergency Preparedness and Response **4. Construction and Decommissioning** 4.1 Environment 4.2 Occupational Health and Safety 4.3 Community Health and Safety

4.9.6 The World Health Organisation

The World Health Organisation (WHO) is the directing and coordinating authority on international health within the United Nations' system. The Organisation publishes *Guidelines* for countries and industries to aspire to, as opposed to *Standards.* The WHO Guidelines are particularly useful for countries that do not have their own guidelines or standards. The following WHO guidelines have been used in this ESIA:

- **Air Quality**. The WHO air quality guidelines are designed to offer guidance to reduce the health impacts of air pollution. Air quality guidelines for particulate matter (PM_{10}), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) were used. (http://apps.who.int/iris/ bitstream/10665/69477/1/ WHO_SDE_PHE_OEH_06.02_eng.pdf);
- **Water Quality**. The main purpose of the WHO Guidelines for drinking water quality is the protection of public health. The palatability of water with a TDS level of less than 600 mg/litre is generally considered to be good; drinking-water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/litre. (http://www.who.int/water_sanitation_health/dwq/fulltext.pdf); and
- **Community Noise**. Mozambique has not promulgated its own noise regulations and reference is usually made to other standards and guidelines in cases where noise impacts need to be assessed. The WHO noise guidelines provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments. The World Bank and many other financiers have adopted the WHO guideline and compliance requirements at the CTT CPF are based on it. The WHO recommends a limit of 55 dBA and 45 dBA for residential areas, averaged over the periods of a day (day-time: 06:00 to 22:00) and night (night-time: 22:00 to 06:00), respectively. (http://www.adc40.org/docs/schwela.pdf).

4.9.7 US EPA Integrated Risk Information System

The United States Environmental Protection Agency (US EPA) uses an Integrated Risk Information System (IRIS) to identify and characterise the health hazards of chemicals found in the environment. The inhalation reference concentration (RfC) is the concentration of a chemical that one can breathe every day for a lifetime that is not anticipated to cause harmful non-cancer health effects. The RfC can be compared to an estimate of exposure concentration in mg/m^3 (https://www.epa.gov/iris/basic-information-about-integrated-risk-information-system).

4.9.8 African Development Bank Integrated Safeguards System

The African Development Bank's (AfDB) Integrated Safeguards System (ISS) is designed to promote the sustainability of project outcomes by protecting the environment and people from the potentially adverse impacts of projects. The safeguards aim to:

- Avoid adverse impacts of projects on the environment and affected people, while maximising potential development benefits to the extent possible;
- Minimise, mitigate, and/or compensate for adverse impacts on the environment and affected people when avoidance is not possible; and
- Help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

The AfDB requires that borrowers/clients comply with these safeguards requirements during project preparation and implementation. The Integrated Safeguards Policy Statement sets out the basic tenets that guide and underpin the AfDB's approach to environmental safeguards.

5.0 THE ESIA PROCESS AND PUBLIC PARTICIPATION

5.1 Introduction

This Chapter provides a summary of the ESIA and Public Particiaption process that is being followed for the CTT project. Environmental Impact Assessment is a legally required process, regulated under Mozambican Environmental Law by specific EIA Regulations (Decree 54/2015 of 31 December) and by the Petroleum Regulations of 2010 (Decree 56/2010 of 22 November) under the Petroleum Law.

The process also complies with the IFC performance standards, which are a widely recognised international guide to good environmental practice. Furthermore, the ESIA has been undertaken in accordance with World Bank Environmental and Social Safeguard Policies.

5.2 The ESIA Process

The ESIA baseline specialist studies and Environmental Scope Definition Report (EPDA), and Terms of Reference (ToR) document was concluded by Golder Associados Moçambique Limitada under Decree 45/2004 of 29 September 2004, amended by Decree 42/2008 of 4 November 2008, and approved by MITADER (previously referred to as MICOA), on 9 June 2015 (Ref nr 1096/180/DGA/DPCAI/14). The ESIA was placed on hold directly thereafter as a result of various factors including market fundamentals, issues of gas allocation for the CTT project, development of the associated transmission line to evacuate power from the CTT project and the activity to bring in a third-party investor to partner with EDM as an additional sponsor in the CTT project.

EDM, on behalf of the project sponsors, maintained regular engagement with National Directorate of Environment (DINAB) during this period, and a formal suspension of the effective period for the submission of the ESIA was approved by DINAB on 25 August 2017 (Ref number MITADER/1733/DINAB/GDN/183/17).

The above circumstances previously causing the ESIA to be put on hold have now substantially been resolved to the extent that the ESIA study for the CTT project can move forward. The ESIA will be completed using the current regulations that were approved since the completion of the EPDA, being Decree 54/2015 of 31 December. MITADER's comments contained in the approval letter for the EPDA and ToR will be addressed as part of the ESIA. Table 12 below provides a summary of authorisations and authority correspondence received to date.

Table 12: Authorisations and authority engagements

Authority	Authority Reference Number	Date of Authorisation	Details of Authorisation
Provincia De Inhambane Governo Do Distrito De Inhassoro Gabinete Do Administrador	125/GDI/GADI/313/2014	20 August 2014	Authorisation to proceed with bush clearing.
Provincial Government of Inhambane Provincial Directorate for the Coordination of Environmental Affairs	1096/180/DGA/DPCAI14	26 September 2014	Confirmation of conclusion of pre-assessment and classification of project as a Category-A project. Confirmation that EPDA and ToR required.
MICOA	1096/180/DGA/DPCAI/14	9 June 2015	EPDA and ToR approved.
MITADER	MITADER/1733/DINAB/GDN/183/17	25 August 2017	Formal suspension of the effective period for the submission of the ESIA approved.
MITADER	MITADER/ 1704/DINAB/GDN/252/18	24 July 2018	Suspension on ESIA lifted. Permission to proceed with ESIA granted.

Figure 35 provides an overview of the stages of the ESIA process, from pre-assessment to decision making. Public participation is an integral part of the process during both the scope definition phase and once the Draft ESIA is completed.

The EIA Process and how stakeholders can contribute

In accordance with Decree 54/2015 of 31 December (amending Decrees 45/2004 of 29 September and 42/2008 of 4 November), Regulation on the Environmental Impact Assessment Process, and Decree 56/2010 of 22 November, Environmental Regulations for Petroleum Operations

Phase	Purpose	Public Participation
Pre-assessment	Pre-assessment by the Ministry of Land, Environment and Rural Development (MITADER). MITADER has categorised this project as a Category A project, meaning a full EIA must be done.	
Define scope of EIA	Determine which environmental components may be affected by the proposed development and must be evaluated in the EIA. Specialists do Baseline Reports. An Environmental Pre-viability Report and Scope Definition (EPDA) report and Terms of Reference (TOR) of the specialist studies are produced.	Stakeholders comment on the EPDA and TOR. A simplified summary with the main issues, conclusions and proposals will be used at meetings and verbally explained and left with stakeholders. Stakeholder comments will be reflected in a Comments and Response Report and submitted to MITADER.
Environmental impact Report (EIR) and Environmental Management Plan (EMP)	Specialists analyse the consequences of the proposed project and recommend ways to avoid or reduce negative impacts and enhance benefits. Findings are presented in individual specialist reports, and are integrated in the EIR and EMP. The EMP specifies the standards the developer must achieve and how to monitor compliance with the standards.	Stakeholders comment on the specialist studies, EIR and EMP. A simplified summary illustrating the main issues, conclusions and proposals will be used at meetings and verbally explained. Summaries will be left with stakeholders. Stakeholder comments will be reflected in a Comments and Response Report and submitted to MITADER.
Decision-making	MITADER, in consultation with the National Petroleum Institute and other relevant government agencies, reviews the reports and decides if the project may go ahead, and under which conditions.	Stakeholders will be advised of the decision and the opportunity to appeal the decision.

Figure 35: ESIA process to be followed in accordance with Decree 54/02015 and Decree 56/201

5.3 Specialist Baseline Studies

The baseline of the ESIA describes aspects of the existing bio-physical and social-cultural environment that are relevant in order to make an assessment of the impacts of the proposed project activities. The purpose of the baseline is described in below.

Box 5: Purpose of an environmental baseline

- Identify the key conditions and sensitivities in areas potentially affected by the project;
- Provide a basis for extrapolation of the current situation and the development of future scenarios without the project;
- Provide data to aid the prediction and evaluation of possible impacts of the project;
- Provide the underpinning to understand stakeholder concerns, perceptions and expectations regarding the project;
- Facilitate the development of appropriate mitigation measures later in the ESIA process; and
- Provide a benchmark against which future changes and the effectiveness of mitigation measures can be assessed.

For the present study, the baseline has been informed by:

- Scoping, which involves consultation with stakeholders to understand their concerns;
- Work done for other projects in the study area. There are an accumulating number of studies that have been undertaken in the study area or parts of the study area.

These studies have all added to the knowledge base about the area and they are extensively referred to by the specialists responsible for the present baseline studies. Where previous work has provided sufficient insight into baseline conditions, it has not been repeated; and

- Field work, to fill in gaps in the study team's understanding of the existing environment and to include areas and aspects which have not been previously included in baseline studies. It is worth mentioning that since the last baseline fieldwork was conducted for the CTT project in 2015, it was decided at the recommencement of this ESIA to conduct a rapid baseline survey in order to investigate and report on any material changes to the baseline conditions compared to the baseline that was assessed in 2015. This exercise has ensured that the impact predication as part of this ESIA is conducted against an accurate and robust baseline for the study area.

5.4 ESIA Report and ESMPs

The results of the baseline specialist studies are integrated into the ESIA Report and provide input into the development of the ESMPs. Specialist's participated in the preparation of the impact assessment studies and chapters of the ESIA, set out in this report.

5.5 Public Participation Process

This Chapter presents a summary of the stakeholder engagement activities that were undertaken during the Environmental Pre-feasibility and Scope Definition Phase (*Estudo de Pré-viabilidade Ambiental e Definição de Âmbito)* (EPDA) and the impact assessment phase of the ESIA process. During the EPDA Phase, Public Participation Process (PPP) was undertaken in accordance with the following Mozambican legislated instruments:

- Regulations on the Environmental Impact Assessment Process, Decree n˚ 54/2015 of 31 December 2015 (amending decrees n˚ 45/2004 of 29 September 2004 and n˚ 42/2008 of 4 November 2008).
- Environmental Regulations for Petroleum Operations, Decree n˚ 56/2010 of 22 November 2010.
- General Directive for the Public Participation Process in the Environmental Impact Assessment Process, Ministerial Diploma 130/2006 of 19 July.

The PPP was intended to be transparent and participatory allowing Interested and Affected Parties (IAPs) to fully understand the project activities and the potential implications on the natural and social environment, and to enable them to identify and raise issues of concern that should be considered in the EIA. Stakeholder engagement activities undertaken during the EPDA and EIA phases of this ESIA Process are summarised here. A full description of the PPP and the issues raised are contained in the Appendices of this Report.

5.5.1 Approach to Public Participation

The PPP associated with the ESIA process has been undertaken using a staged approach in line with the various phases of the EIA process detailed in Figure 35. The engagement process involved the following key phases:

- Identification of Stakeholders (IAPs); and
- Public Participation during the Scoping Phase (EPDA) and Impact Assessment Phase.

A summary of the activities undertaken during the EPDA Phase in 2015 and the Impact Assessment Phase in 2019 is presented in Table 13.

Table 13: Summary of the Public Participation Process

Public Participation Activity	Purpose of Activity	Timeline
EPDA Phase		
Introductory discussions with villagers by Sasol CLO during bush clearing and de-mining activities.	Identify stakeholders to be included in the consultation process.	October – December 2014.
Compilation of stakeholder database.	Identify stakeholders to be included in the consultation process,	Prior to disclosure of EPDA Report,
Advertisements in *Savana, Noticias* and on Vilanculos and Govuro community radio stations on availability of documents and dates of meetings.	To invite stakeholders to public meetings,	Friday 16 and Monday 19 January 2015,
Draft EPDA and TORs, summary NTS available and placed on the Golder Web Site. Hard copies and CD copies handed personally to key government and key stakeholders. Also, displayed in public places in and around the study area and Maputo. Summaries also distributed in villages.	Provide information on the EIA process, the proposed project and dates of public meetings,	Monday 19 January 2015,
Public meeting with visual displays in Maputo, 09:00 – 12:00. Focus groups in the afternoon.	To present the proposed project and associated EIA process to the public and to allow the public to identify issues of concern,	Thursday 5 February 2015,
Meetings with village leaders in Temane area (Mangungumete) and Inhassoro area (Mapanzene) with leaders from Mabime, Chipongo, Mangarelane, Mapanzene, Maimelane, Temane, Mangungumete, Litlau, Chitsotso, Manusse, Chimadjane and Munavalate	To present the proposed project and associated EIA process to the public and to allow the public to identify issues of concern,	Tuesday 10 and Wednesday 11 February 2015,
Public meeting with visual displays in Inhambane, 09:00 – 12:00. Focus groups in the afternoon	To present the proposed project and associated EIA process to the public and to allow the public to identify issues of concern,	Thursday 12 February 2015,
End of comment period on EPDA and TORs. Completion of Comment and Response Report thereafter, to be	Consolidation of stakeholder comments in final EPDA and TOR for submission.	Tuesday 17 February 2015,

Public Participation Activity	Purpose of Activity	Timeline
included in Final EPDA to be submitted to MICOA.		
Impact Assessment Phase		
An advert was placed in the national newspaper *Notícias* on 21 December 2018	To invite stakeholders to public meetings	21 December 2018
Invitation Letters were hand delivered (Maputo, Inhambane, Inhassoro and Vilankulos) and emailed to Key stakeholders, such as key government departments and influential business and civil society organisations,	A short letter of invitation containing information similar to that in the advertisement and encouraging their participation.	3 January 2019
Key stakeholders were contacted by telephone in advance of meetings	Key stakeholders were contacted by telephone about a week prior to each public meeting to remind them of the meeting and encourage their attendance	3 January 2019
Village announcements: The Sasol CPF Community Liaison Officer (CLO), Ezequiel Chambe, advised the leaders of the 12 nearby villages of the EIA, and that there would be public participation meetings	To invite stakeholders to public meetings,	3 January 2019
Public meeting in Inhassoro with visual displays (posters and powerpoint presentation).	To present the findings of the ESIA to the stakeholders	16 January 2019
Meetings with village leaders in Maimelane with viaual dispays (posters). Leaders from the various nearby villages were in attendance as well as representatives of woman and youth groups	To present the findings of the ESIA to the stakeholders	17 January 2019
Public meeting in Inhamabne with visual displays (posters and powerpoint presentation). Provincial authorities and other stakeholders	To present the findings of the ESIA to the stakeholders	18 January 2019
End of comment period on ESIA phase. Completion of Comment and Response Report thereafter, to be included in Final	Consolidation of stakeholder comments in final ESIA	30 January 2019

Public Participation Activity	Purpose of Activity	Timeline
ESIA to be submitted to MITADER / DINAB.		

6.0 THE RECEIVING ENVIRONMENT

This chapter describes the current (pre-project) environmental and social conditions in the study area, also referred to as the "baseline conditions". It is important to fully describe and understand the baseline before making an evaluation of the potential impacts of the proposed project on the biophysical and socio-economic and socio-cultural environment.

This chapter describes the baseline in terms of four broad areas:

- Physical Environment;
- Biological Environment;
- Socio-Economic Environment; and
- Socio-Cultural Environment.

The chapter summarises the baseline, with more detailed information presented in the specialist reports contained in Volume 3.

6.1 Physical Environment

The physical environment covers climate and air quality, greenhouse gases, geology, topography, groundwater, surface water and soils and ambient noise levels.

6.1.1 Climate

The CTT Project site area falls within a sub-tropical climate. The climate in this region is moderately humid with annual rainfall dominated by two climate systems, which are the Indian Ocean Subtropical Anticyclone System and the East African Monsoonal system. The rainy season is in summer (October to March), with winds and frequent thunderstorms. The summers are warm, often with high humidity. The winters are mild and dry. Rainfall is more abundant along the coast.

6.1.1.1 Temperature

Minimum temperatures in the area average between 14.2ºC in winter and 23.5ºC in summer, and the average maximum temperatures range from 25.2ºC in winter to 30.9ºC in summer. The mean annual temperature is 24ºC and the relative humidity is fairly constant ranging from a low of 70% during October to a high of 80% in January. The diurnal and monthly temperature trends are presented in Figure 36.

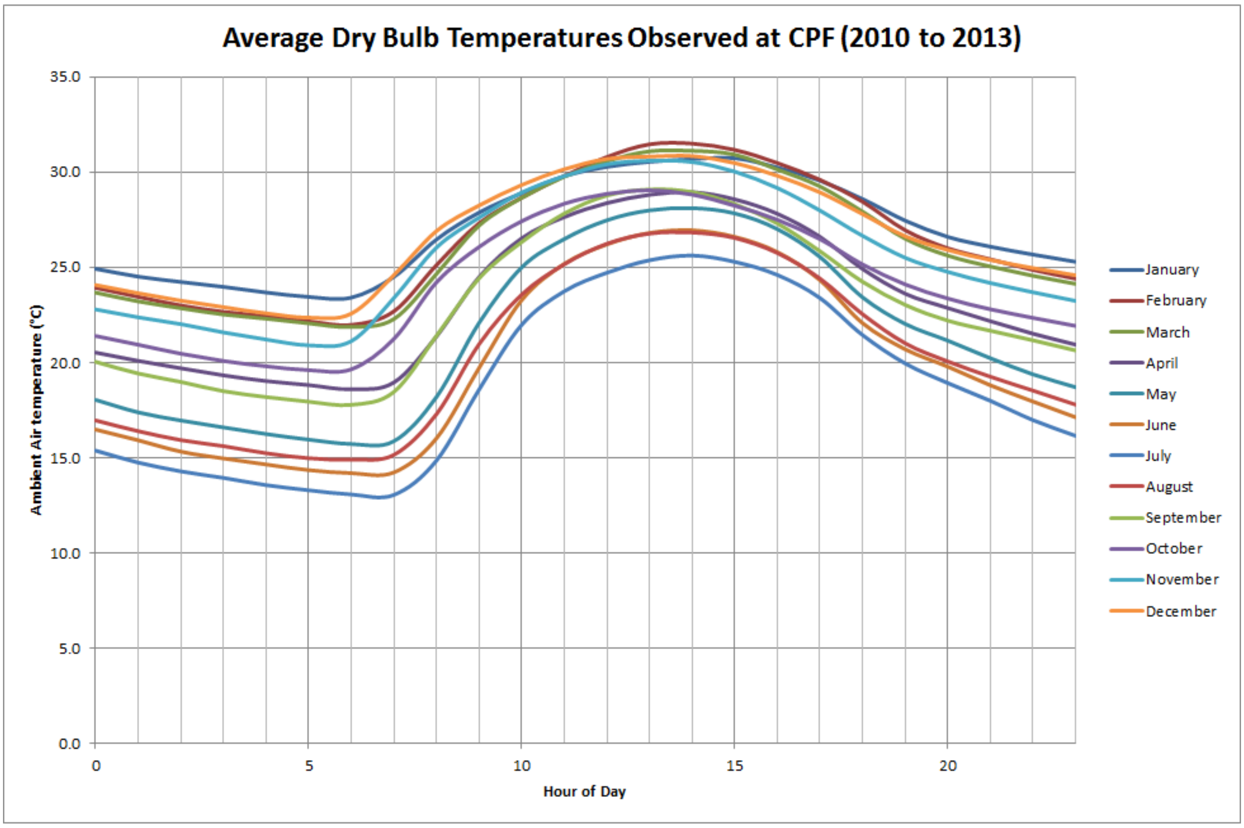


Figure 36: Monthly and Diurnal temperature profile (CPF site 2010 to 2013)

Table 14 shows the maximum, minimum and average monthly temperature profiles for the site during the period January 2009 to December 2011. Temperatures typically range between 20°C and 28°C. The highest temperatures occur from December to April (Golder Associates Africa, Mark Wood Consulting and Airshed (2014)).

Table 14: Minimum, maximum and mean temperature (CPF site 2010 to 2013)

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	19.2	19.0	17.9	14.0	10.6	4.9	7.7	8.8	9.7	13.8	14.9	17.2
Average	27.0	26.4	26.2	23.3	21.4	19.9	18.8	20.3	22.9	24.1	25.6	26.6
Maximum	35.0	36.1	35.4	32.9	33.8	32.3	31.0	32.5	37.1	35.3	37.3	35.6

6.1.1.2 Precipitation

The catchment rainfall has seasonal variability during the year with an average annual precipitation in the order of 800 mm (inland) to 1,000 mm (in the coastal area). The wet season lasts from November to April, *i.e*. the warmer months, with 71% of annual rainfall occurring during these months. Annual and monthly rainfall varies from month to month and year to year, strongly influenced by the variation in wind and sea surface temperatures. Annual average rainfall at the CTT project site is 851 mm, with the maximum recorded in a 24 hour period being 370 mm (Sasol, 2014).

Due to cyclones in this part of the country, extreme annual rainfall has been up to 1,130 mm (recorded in 2014), nearly 48% higher than the annual average. Figure 37 shows the monthly average rainfall data as observed at the CPF for the period 2010 (October) to 2013.

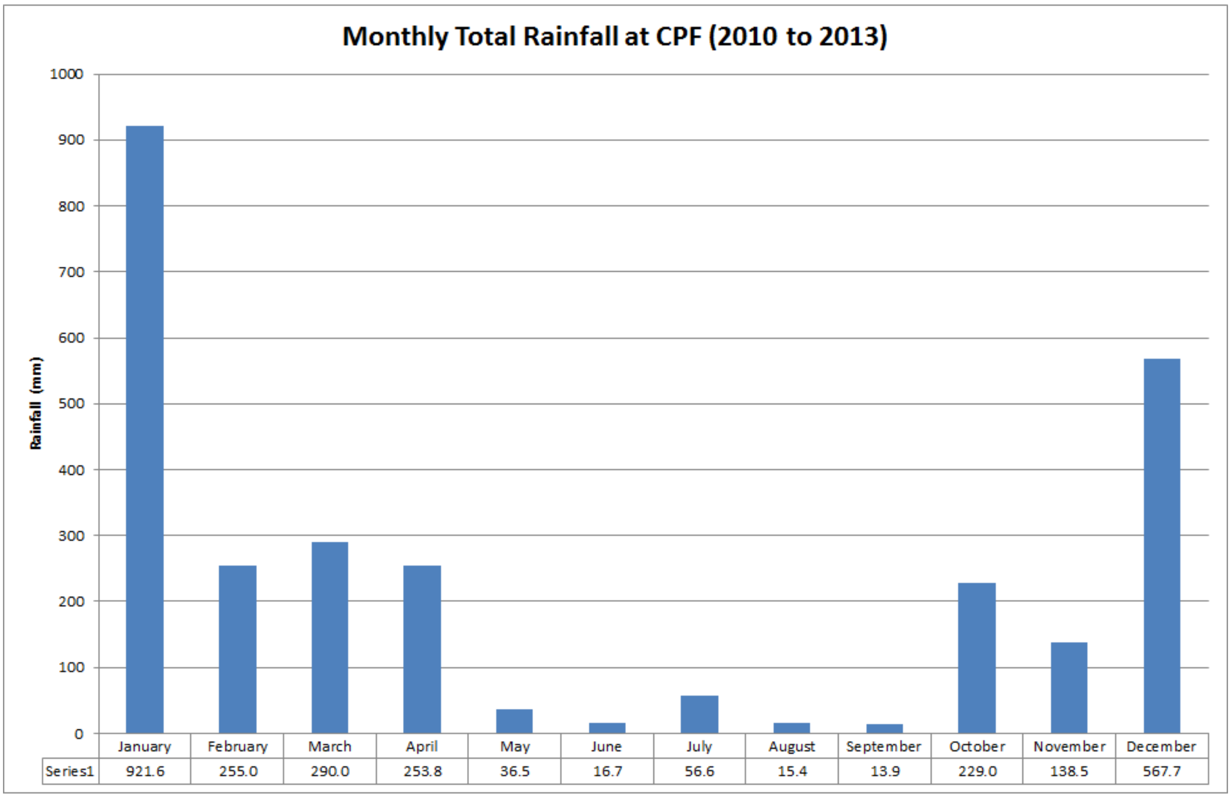


Figure 37: Rainfall data (CPF site 2010 to 2013)

6.1.1.3 Evaporation

Potential evaporation as a climatic parameter is not available for Mozambique. A study undertaken by the National Institute of Agronomic Investment in Maputo, Mozambique to determine spatial distribution of climatic parameters in order to understand climatic zones for crop production, calculated the evapotranspiration in Inhambane using the Penman Monteith equation to be 1,300 mm/annum (Reddy, 1984).

6.1.1.4 Wind and Storms

The project area is influenced by the Indian Ocean Anti-cyclonic Zone. In the Vilanculos and Inhassoro region, winds are predominantly from the southern to eastern quadrants and strengthen in the afternoon. Between January and August, winds are predominantly from the south while the predominant wind direction between September and December is from the east. Average wind velocity is 2.88 m/s.

During January/February the northern and central part of Mozambique is typically subject to cyclonal weather. The cyclones generate strong storms and heavy rainfall followed by strong winds, with speeds of up to a 100 km/h or more. The area in Temane is prone to cyclone activities (4 to 5 per year). During the period from 1975 to 2008, the region was hit by several cyclones and tropical storms of different magnitude. The cyclone season in this region extends from December to March, peaking in December and January, and typically resulting in seasonal flooding.

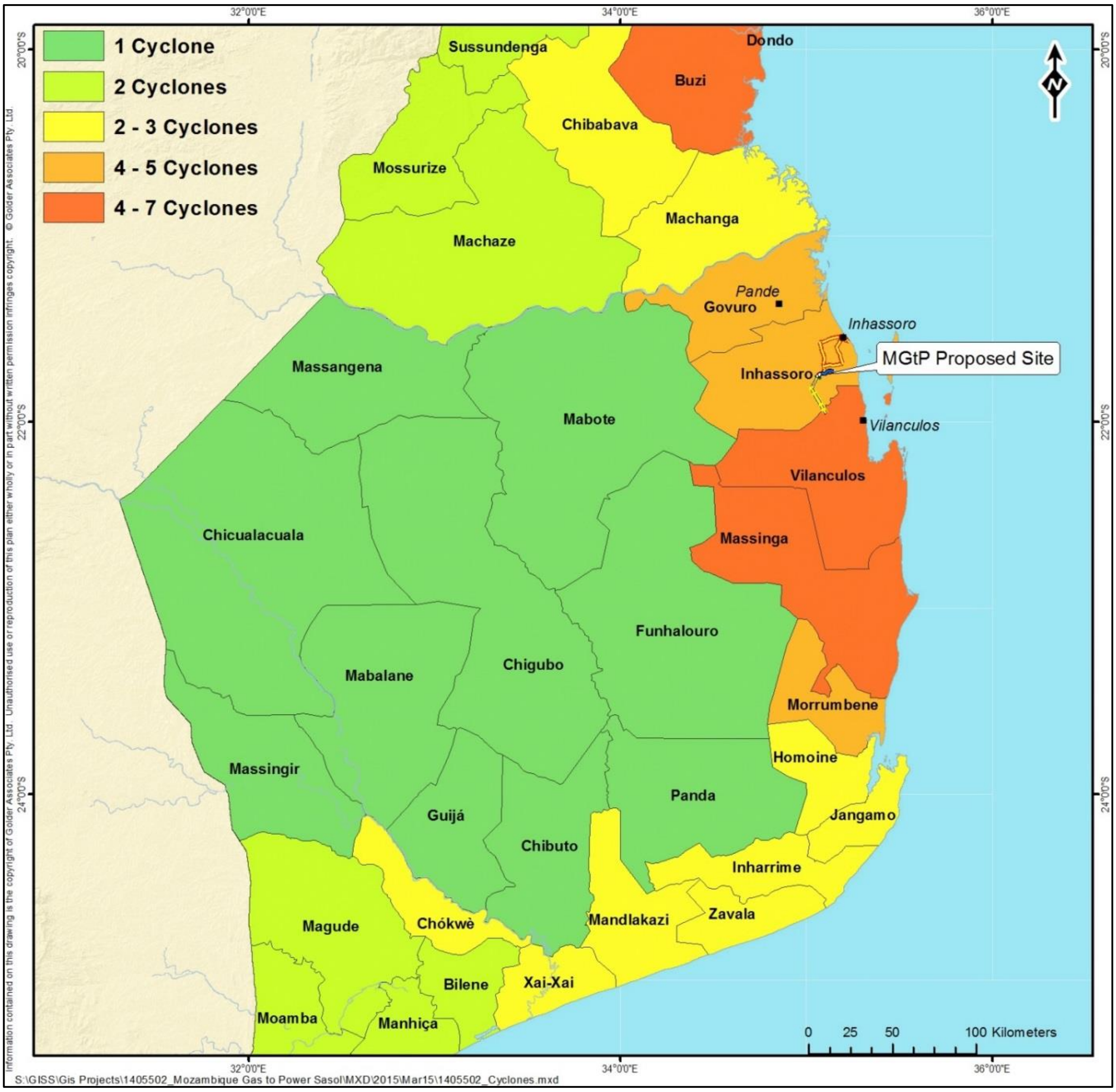


Figure 38: Occurrences of tropical cyclones in Southern Mozambique from 1970 to 2000 (INAM, 2006)

Air Quality

The assessment of the ambient air quality is based on available ambient air quality information and baseline air quality monitoring data identified in the literature review and modelled MM5 meteorological data.

The baseline air quality assessment included:

- A review of applicable legislation, policy and standards;
- The analysis of site-specific modelled meteorological (MM5[2]) data;
- The identification of local emission sources; and

[2] The MM5 (short for Fifth-Generation Penn State/NCAR Meso-scale Model) is a regional meso-scale model used for creating weather forecasts and climate projections. It is a community model maintained by Penn State University and the National Centre for Atmospheric Research.

- The identification and discussion of the potential health effects associated with applicable atmospheric emissions.

Dispersion modelling is an effective tool in predicting the ambient atmospheric concentration of pollutants emitted to the atmosphere from a variety of processes, including power generation. Similarly, modelling is effective at determining the distribution of concentrations from existing sources. Based on the configuration of the existing sources adjacent to the proposed Project, a model capable of dealing with a range of area, volume and point sources will be required for the assessment.

In characterising the baseline air quality, reference is made to details concerning atmospheric dispersion potential of the study area and other potential sources of atmospheric emissions in the area. The consideration of the existing air quality is important so as to facilitate the assessment of the potential for cumulative air pollutant concentrations arising due to proposed developments.

6.1.1.5 Boundary Layer Properties and Atmospheric Stability

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere and is directly affected by the earth's surface. During the day, the atmospheric boundary layer is characterised by thermal heating of the earth's surface, converging heated air parcels and the generation of thermal turbulence, leading to the extension of the mixing layer to the lowest elevated inversion. These conditions are normally associated with elevated wind speeds, hence a greater dilution potential for the atmospheric pollutants.

During the night, radiative flux divergence is dominant due to the loss of heat from the earth's surface. This usually results in the establishment of ground-based temperature inversions and the erosion of the mixing layer. As a result, night-time is characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds, hence less dilution potential Table 15).

Table 15: Atmospheric stability classes

Designation	Stability Class	Atmospheric Condition
A	Very unstable	Calm wind, clear skies, hot daytime conditions
B	Moderately unstable	Clear skies, daytime conditions
C	Unstable	Moderate wind slightly overcast daytime conditions
D	Neutral	High winds or cloudy days and nights
E	Stable	Moderate wind slightly overcast night-time conditions
F	Very stable	Low winds, clear skies, cold night-time conditions

6.1.1.6 Wind direction and speed

Wind roses were constructed using onsite hourly surface wind data as well as the MM5 data for the same location. Wind roses comprise 16 spokes, which represent the directions from which winds blow during a specific period. The colours used in the wind roses below reflect the different wind speed categories. The dotted circles provide information regarding the frequency of occurrence of wind speed and wind direction. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are indicted above the respective wind roses. The comparison of wind roses based on measurement at the CPF Figure 39) shows fair correlation with the MM5 data (Figure 40 and Figure 41. The wind field is characterised by dominant southerly and easterly winds.

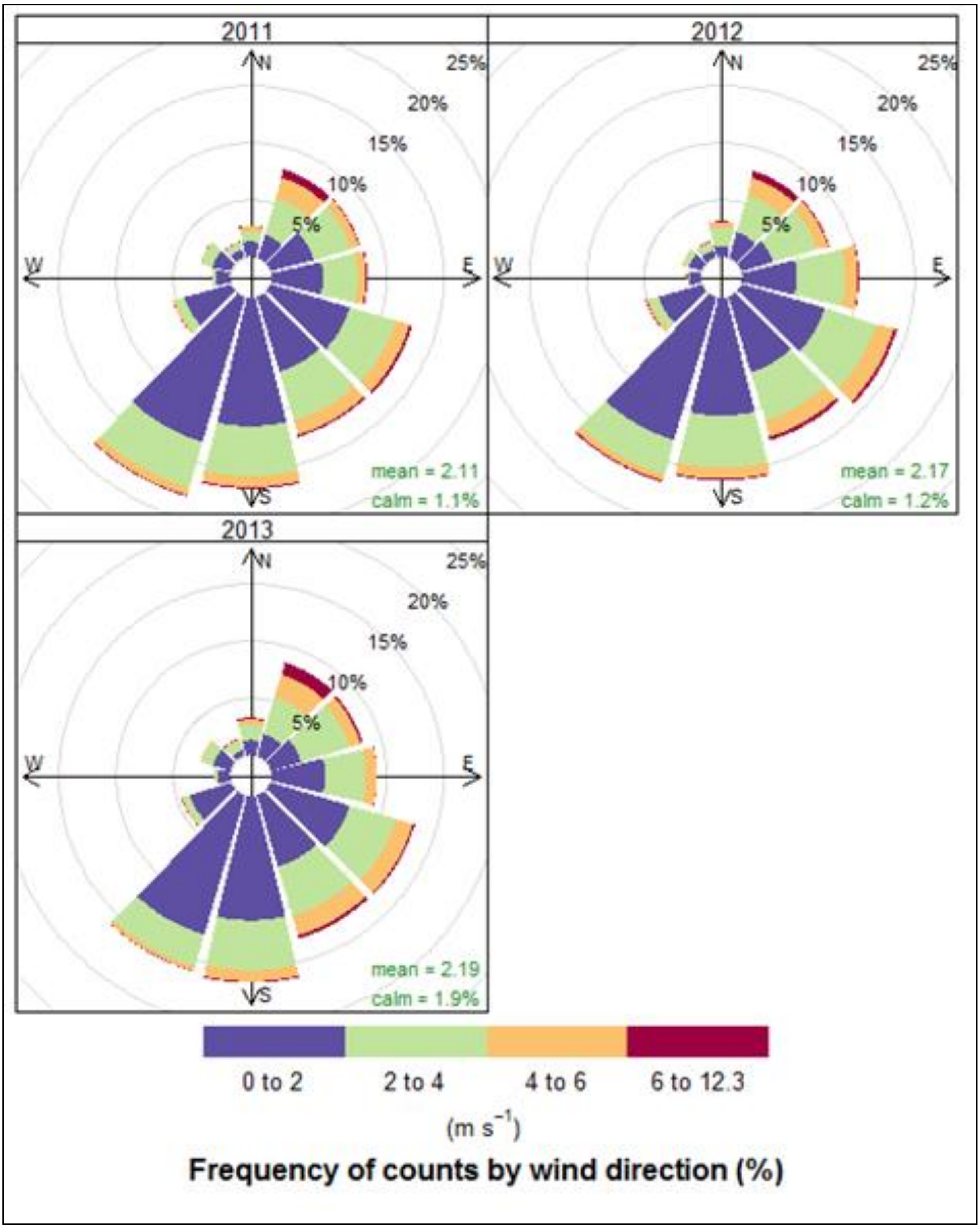
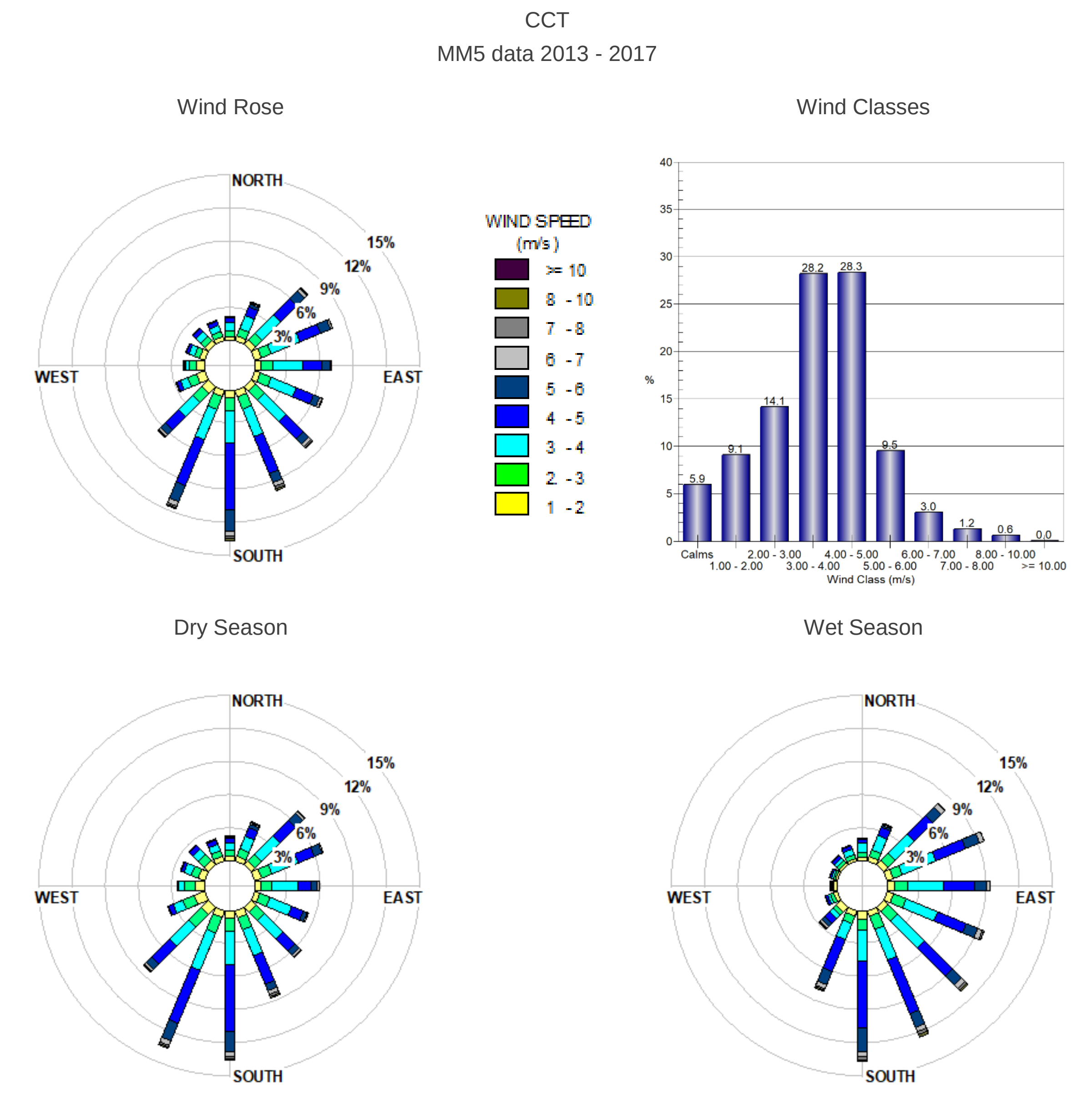
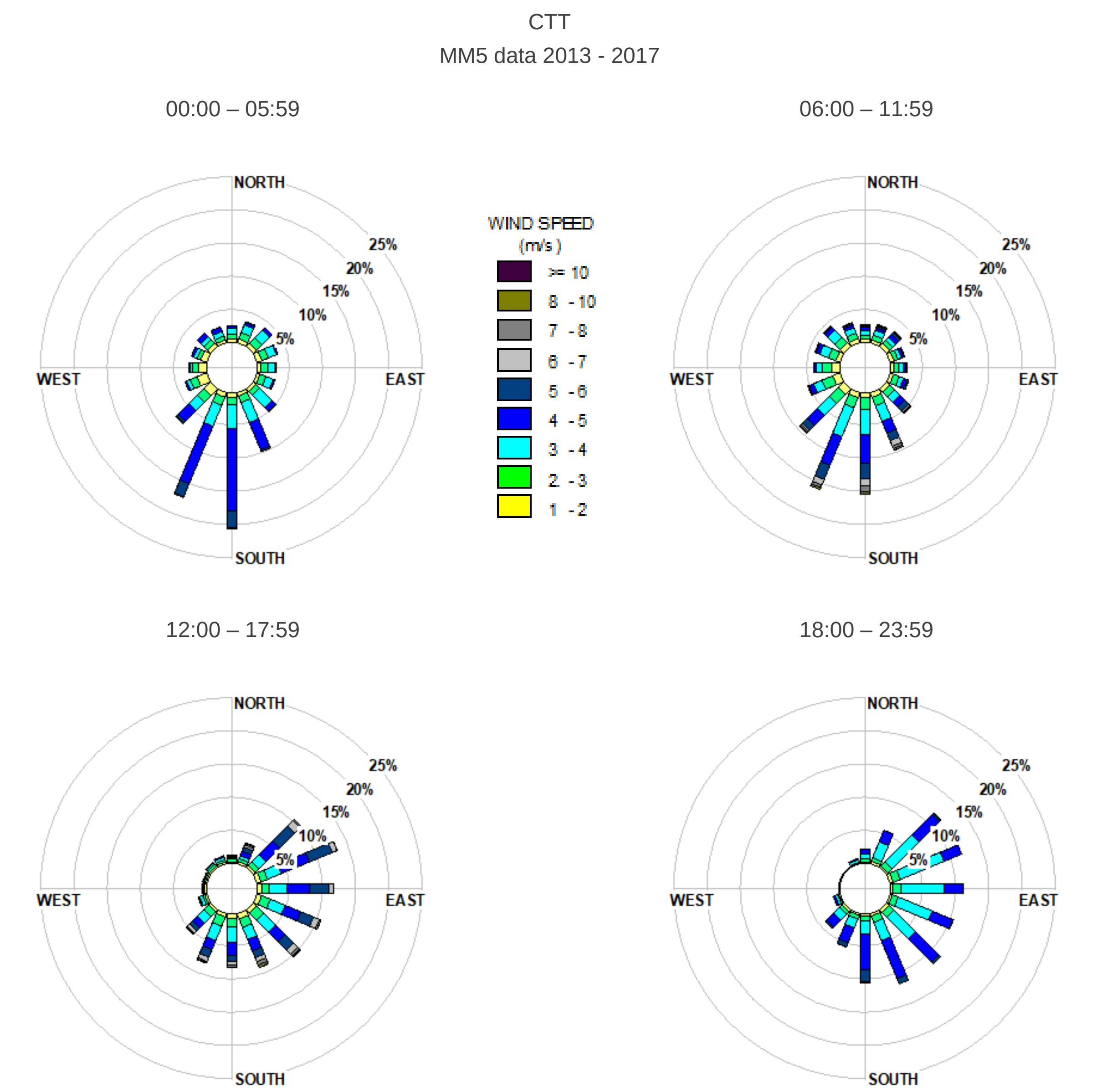


Figure 39: Period wind roses for the CPF (2011-2013)



Month	Wind Speed	Dominant Sector		Dominant Sector		Calms	Missing
2013 - 2017	3.5 m/s	NE-SW	82%	0	0%	6%	0%
Wet (Dec - Mar)	3.7 m/s	NE-SSW	85%	0	0%	5%	0%
Dry (Apr-Nov)	3.4 m/s	NE-ENE	14%	SE-WSW	53%	6%	0%

Figure 40: CTT period and seasonal wind roses (2013-2017)



Month	Wind Speed	Dominant Sector		Dominant Sector		Calms	Missing
00-05	3.1 m/s	SSE-SW	59%	0	0%	8%	0%
06-11	3.6 m/s	SSE-SW	54%	0	0%	8%	0%
12-17	3.9 m/s	NE-SSW	84%	0	0%	5%	0%
18-23	3.5 m/s	NE-S	80%	0	0%	3%	0%

Figure 41: CTT diurnal wind roses (2013-2017)

6.1.1.7 Emission sources within the airshed

Potential activities and sources of air pollution which may impact on the ambient air quality within the airshed include:

- Agricultural activities;
- Mining activities (sand and aggregate);
- Oil and gas extraction and processing;
- Domestic fuel burning;
- Biomass burning;
- Vehicle emissions (tailpipe and entrained emissions);
- Paved roads; and
- Unpaved roads.

Key atmospheric pollutants are solid particles, liquid droplets, and/or gases in the air that could, when in high enough concentration, cause the degeneration of health in animals, humans, vegetation, and/or soil, contaminate and/or damage materials. Key atmospheric pollutants may be released from the proposed Project activities and/or from emission sources within the airshed. Key atmospheric pollutants applicable to the propose project and emission sources within the airshed are envisioned to include:

- Sulphur Dioxide (SO_2);
- Nitrogen Dioxide (NO_2); and
- Particulate Matter (mainly PM_{10}).

Baseline air quality monitoring was conducted in the area by Golder in 2014; the campaign lasted for 3 months (April to June) with monitoring at 11 locations as shown in Figure 42. Dust fallout and passive diffuse samplers (NO_2, SO_2, H_2S and BTEX) were installed at all sampling locations and particulate samplers at Well Pads T-12 and T-16.

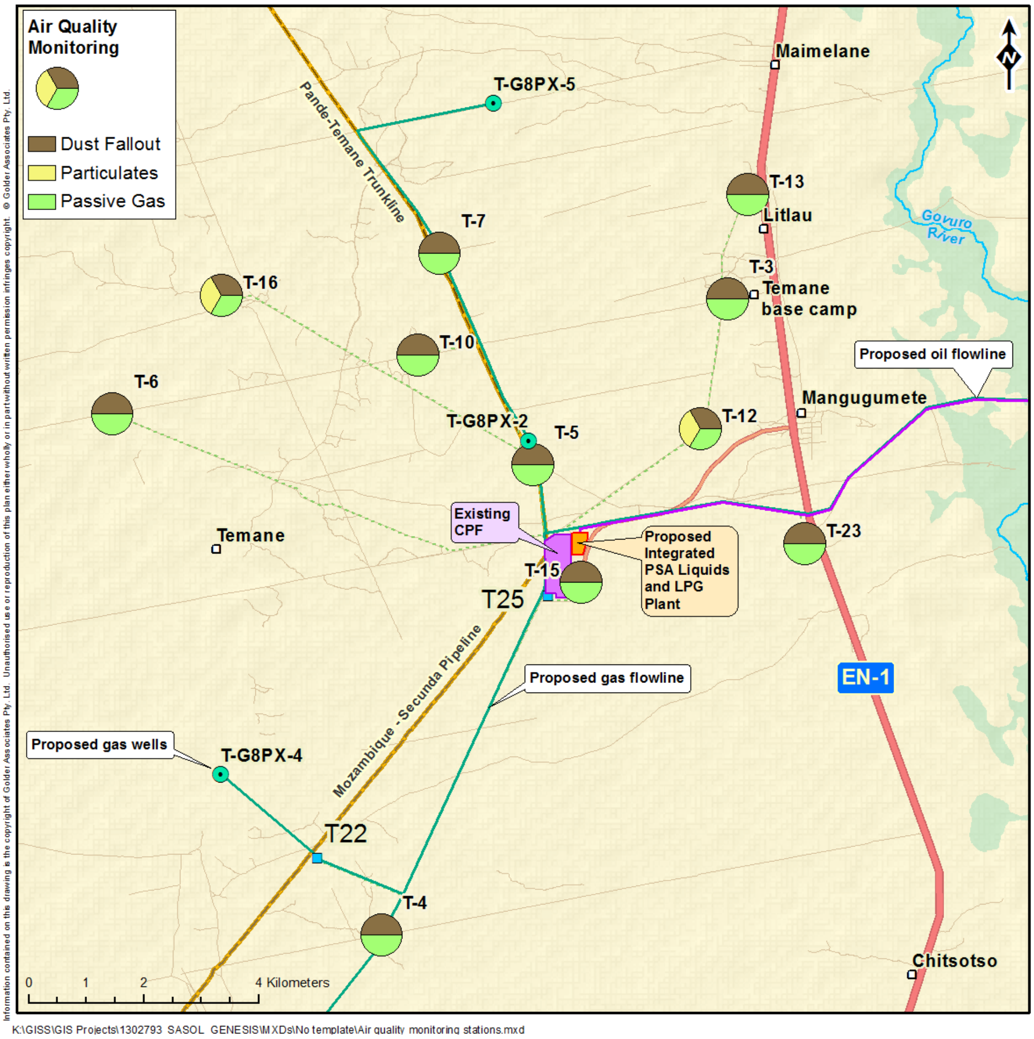


Figure 42: Sampling locations (April and June 2014)

Dust fallout monitoring was undertaken during April, May and June 2014 with dust fallout levels not exceeding 200 mg/m^2/day, the RSA residential standard is 600 mg/m^2/day. PM_{10} sampling was conducted at the CPF by means of MetOne E-samplers and the monitored concentrations were verified gravimetrically. Particulate levels did not exceed the IFC daily guideline (50 µg/m^3).

During the same period, NO_2 concentrations did not exceed the IFC annual guideline (40 µg/m^3). SO_2 concentrations did not exceed the IFC daily (20 µg/m^3); this is also the IFC annual guideline. Radiello passive sampling tubes were used to measure Hydrogen Sulphide (H_2S); all measurements were below the detection limit for the method (0.01 µg/m^3).

6.1.1.8 Summary of the regional air quality

Current air quality was assessed based on:

- Local sources identified and the anticipated emissions thereof; as well as
- Ambient air quality monitoring conducted in the area.

The conclusion of this assessment is that that current air quality in the project area is not degraded and thus the project is not within a degraded airshed as defined by the IFC.

6.1.2 Green House Gases

A Green House Gas (GHG) assessment was undertaken in accordance with the GHG Protocol *Corporate Accounting and Reporting Standard* (herewith referred to as the standard), as well as the requirements of IFC (2012) Performance Standard 3 and the Equator Principles (2013). Relevant Mozambican policies and programmes are also considered.

The following are the Scope 1 and 2 emission sources that were included in the assessment:

- Stationary combustion (e.g. diesel generators, gas engines/turbines); and
- Mobile combustion (e.g. fleet vehicles, barges and tugs, construction vehicles and heavy goods vehicles).

In 2013, the total GHG emissions of Mozambique was estimated to be 66.8 MtCO_2e (USAID, 2017). If global GHG emissions at the time was approximately 48,257 MtCO_2e, Mozambique's contribution to the world total GHG emissions was 0.14%.

Mozambique's GHG profile was dominated by the emissions from Land Use, Land Use Change and Forestry (LULUCF), which accounted for 58.8% of total emissions. Agriculture was the second largest contributor with 26.8%, followed by energy (8.9%), waste (4%), and industrial processes (1.5%). On average, Mozambique's GHG emissions increased by 1% per annum from 55.1 MtCO_2e in 1990 to 66.8 MtCO_2e (11.7 MtCO_2e increase). During this period, GHG emissions from LULUCF increased by on average 0.5% per annum, agriculture (1.5%), energy (2.2%), waste (7.9%), and industrial processes (26%).

The standard covers the six GHGs covered by the Kyoto Protocol. This includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

Table 16: Summary of GHG emissions sources included in the assessment

Scope	Site preparation and construction	Operational	Decommissioning and Closure
1	■ Fleet vehicles (mobile combustion); ■ Diesel generators (stationary combustion); and ■ Water supply (stationary combustion).	■ Gas engines/turbines (stationary combustion); ■ Fleet vehicles (mobile combustion); ■ Diesel generators (stationary combustion); and ■ Water supply (stationary combustion).	■ Fleet vehicles (mobile combustion); ■ Diesel generators (stationary combustion); and ■ Water supply (stationary combustion).
2	■ n/a	■ n/a	■ n/a
3	■ Barges and tugs (mobile combustion); ■ Heavy good vehicles between beach landing and site (mobile combustion);	■ n/a	■ Barges and tugs (mobile combustion); ■ Heavy good vehicles between site and beach landing (mobile combustion); and

Scope	Site preparation and construction	Operational	Decommissioning and Closure
	■ Construction vehicles (mobile combustion); and ■ Heavy goods vehicles delivery locally-sourced construction materials.		■ Construction vehicles (mobile combustion).

6.1.3 Topography

The study area is situated along the coastal plain of Mozambique, approximately 20 km inland of the coastline and about 30 m above mean sea level. The topography of the study area ranges from flat to undulating. A low, north-south trending dune ridge runs between the coast and the Govuro River, and acts as a natural watershed. The Govuro River lies at 13 m above sea level (masl). Land to the west of the river rises to 58 masl, while that to the south rises to 68 masl.

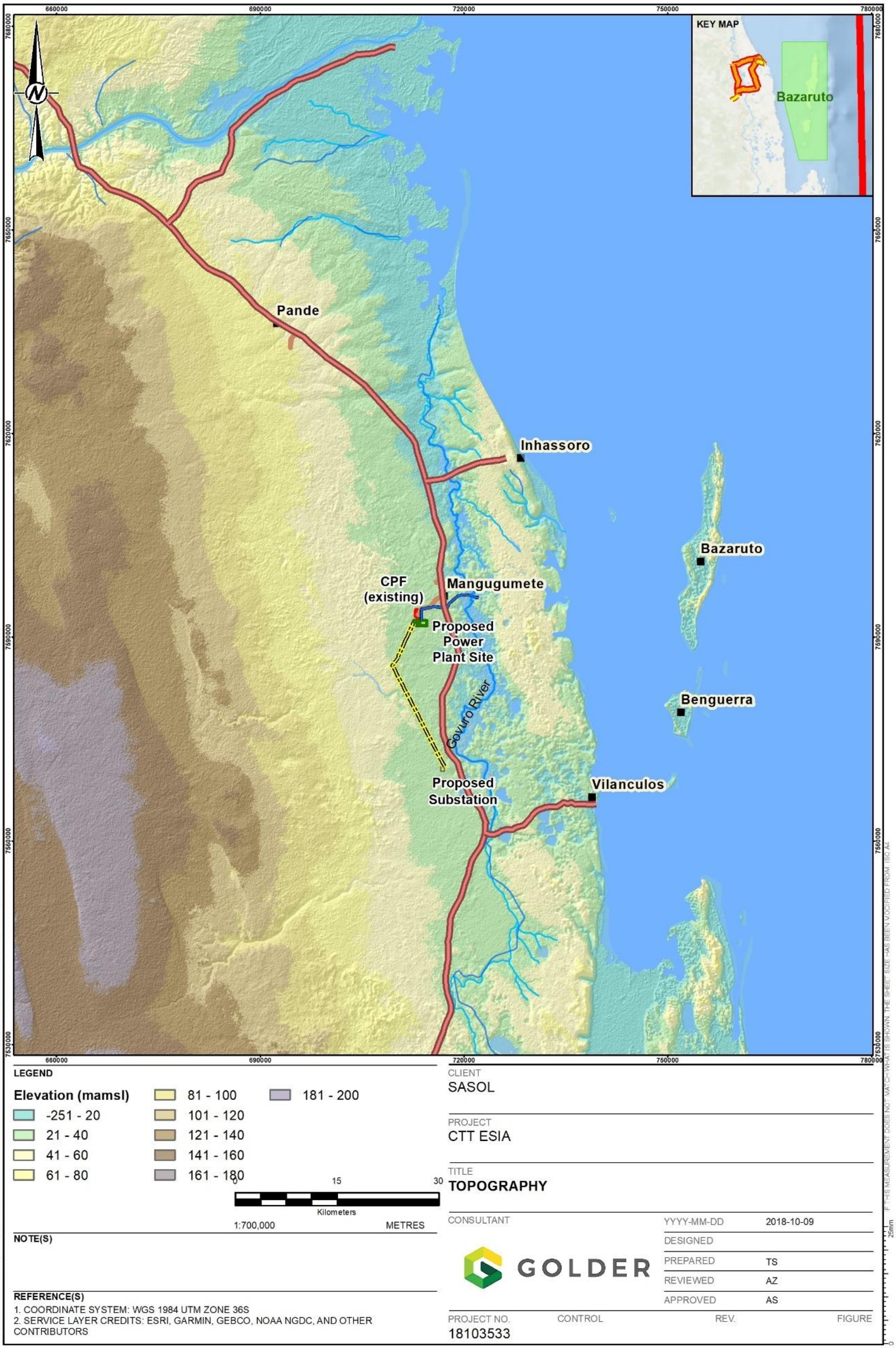


Figure 43: Topography of the CTT study area

6.1.4 Hydrogeology

The aim of the hydrogeology investigation is to:

- Characterise prevailing groundwater conditions in the study area;
- Define the water bearing strata in the area;
- Determine current groundwater level distribution, flow directions, and baseline groundwater quality; and
- Define all potential impacts from the project activities on the groundwater regime in the affected area.

Relevant documentation was reviewed in order to build up the hydrogeological understanding and knowledge specific to the project area. The baseline information was established through review of existing groundwater information that included results from 2014 field investigations that included an extensive hydrocensus and on-site drilling and testing (Figure 44). A total of 92 groundwater points were recorded during the first phase hydrocensus. Of these, 67 groundwater points belong to Sasol and the remaining 25 are either privately owned or they belong to a rural community. Five of the 25 private/community hydrocensus points are not actual boreholes but rather hand dug wells that do not penetrate deeper than 1 metre below ground level (mbgl). Only 10 of the remaining 20 boreholes were in use. During the second phase hydrocensus 59, groundwater points were recorded at 39 different sites. Of the boreholes recorded 19 are privately owned and the remaining 30 were all located at Sasol's well pads.

It can thus be concluded that the data reviewed from the hydrocensus covered a large geographical area and can be used to establish the groundwater baseline and impact assessment of the area potentially impacted on by the CTT Project area. The groundwater baseline and Site Conceptual Model (SCM) for the CTT Project was established based on existing information collected. The data was used to establish the groundwater users, lithological sequence, aquifer parameters, water quality, groundwater levels and flow directions, and define the aquifer systems for the project site.

6.1.4.1 Aquifer types

Four main hydrogeological units have been identified in the CTT Project study area based on their physical properties and relative geological age, namely:

- The unconfined shallow (perched) weathered Jofane aquifer;
- The deep confined Jofane karst aquifer;
- The unconfined alluvial aquifer along the Govuro River (quaternary deposits); and
- The unconfined unconsolidated coastal aquifer (quaternary deposits).

For the CTT power plant site the underlying geohydrological regime can be described in short as follows:

- Drilling of monitoring boreholes (at the CPF) (Figure 44) has revealed that an unconfined perched aquifer exists below the site to a depth of 14 – 20 mbgl. This aquifer is considered to be minor and exists within highly weathered and leached Jofane Limestone. The base of the aquifer is defined by a uniform impermeable clay layer that varies in thickness, attaining a maximum thickness of 6 m. This system cannot be considered to be a source of useable groundwater and will only be of significance at the CTT plant site for water quality monitoring. Any contamination detected in the system will be a first order warning against pollution of the viable Jofane Limestone aquifer.

The confined karst aquifer within the Jofane Limestone Formation. Drilling has shown that this aquifer consists of weathered and leached limestone but becomes more competent with depth. The more competent parts are often associated with cavernous/honeycomb formation. Water levels range between 12 to 17 mbgl but can vary considerably as they are controlled by rainfall events.

The Jofane limestone aquifer is the main source of water for communities in the Temane area. Water quality of this system is generally regarded as having high salinity levels. However, there is evidence of areas within the aquifer that are characterised by fresher water, most likely linked to higher recharge zones. The system is considered to be vulnerable to potential pollution especially in areas where the clay layer is absent.

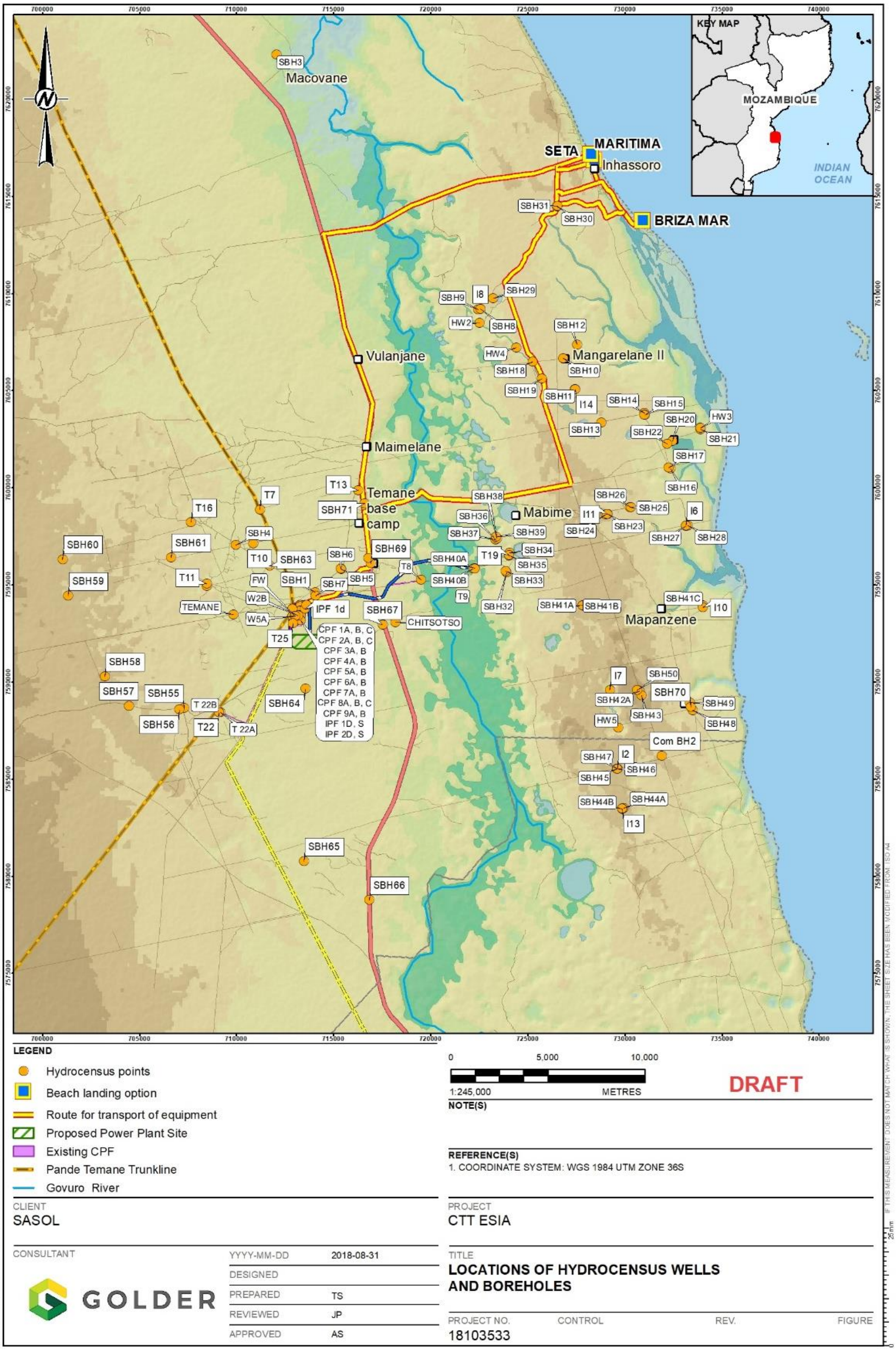


Figure 44: Location of 2014 hydrocensus boreholes relative to the CTT Project footprint

Table 17 below provides a summary of the aquifer types and properties associated with the groundwater occurrence in the study area:

Table 17: Aquifer types and properties

Depth (mbs)	Average water level (mbgl)	Aquifer parameters (T)	Water quality	Importance
Unconfined shallow (perched) weathered Jofane aquifer				
14 - 20	3 - 4	15 m^2/day	120 mS/m	No water supply significance but early warning for potential contamination
Confined Jofane karst aquifer				
20 - 60	12 - 17	90 to 700 m^2/day	85 to 280 mS/m	Main source of water for communities in the Temane area
Unconfined alluvial aquifer along the Govuro River				
<30	<15	1,000 m^2/day	25 to 50 mS/m	highly vulnerable to contamination due to the high permeability of the unconsolidated formations and unconfined character of the aquifer
Unconfined unconsolidated coastal aquifer				
10 - 50	20 - 35	100 to 200 m^2/day	10 to 40 mS/m	Contains fresh groundwater, due to rainfall recharge; not equally developed across area

6.1.4.2 Hydrochemistry

The Sasol CPF at Temane has been conducting a groundwater quality monitoring program since 2006. Groundwater samples are collected bi-annually according to the prescribed Sasol sampling protocol. Results are compared against the Mozambique domestic water supply guideline's (2004) and to the baseline water quality range, specifically for the area.

Generally, the groundwater quality is within acceptable ranges with some exceptions. With regards to pH all sites fall within the acceptable ranges and with regards to salinity (measured as Electrical Conductivity), sites T9, PC-8201C, PC-8201B, PC-8201A, T25, and Temane exceed the provided background range of 170 mS/m but not the domestic supply guideline of 200 mS/m.

The only parameters that are problematic are the nitrate with CPF5A, CPF7A, and CPF6A showing consistently elevated levels. Extensive groundwater quality testing shows that groundwater quality in the study area is virtually unaffected by human activity. Except for a few localised cases, the regional water quality is largely unchanged. While the groundwater quality is saline, especially in inland areas, due to the Jofane aquifer being situated on limestone, groundwater is generally potable.

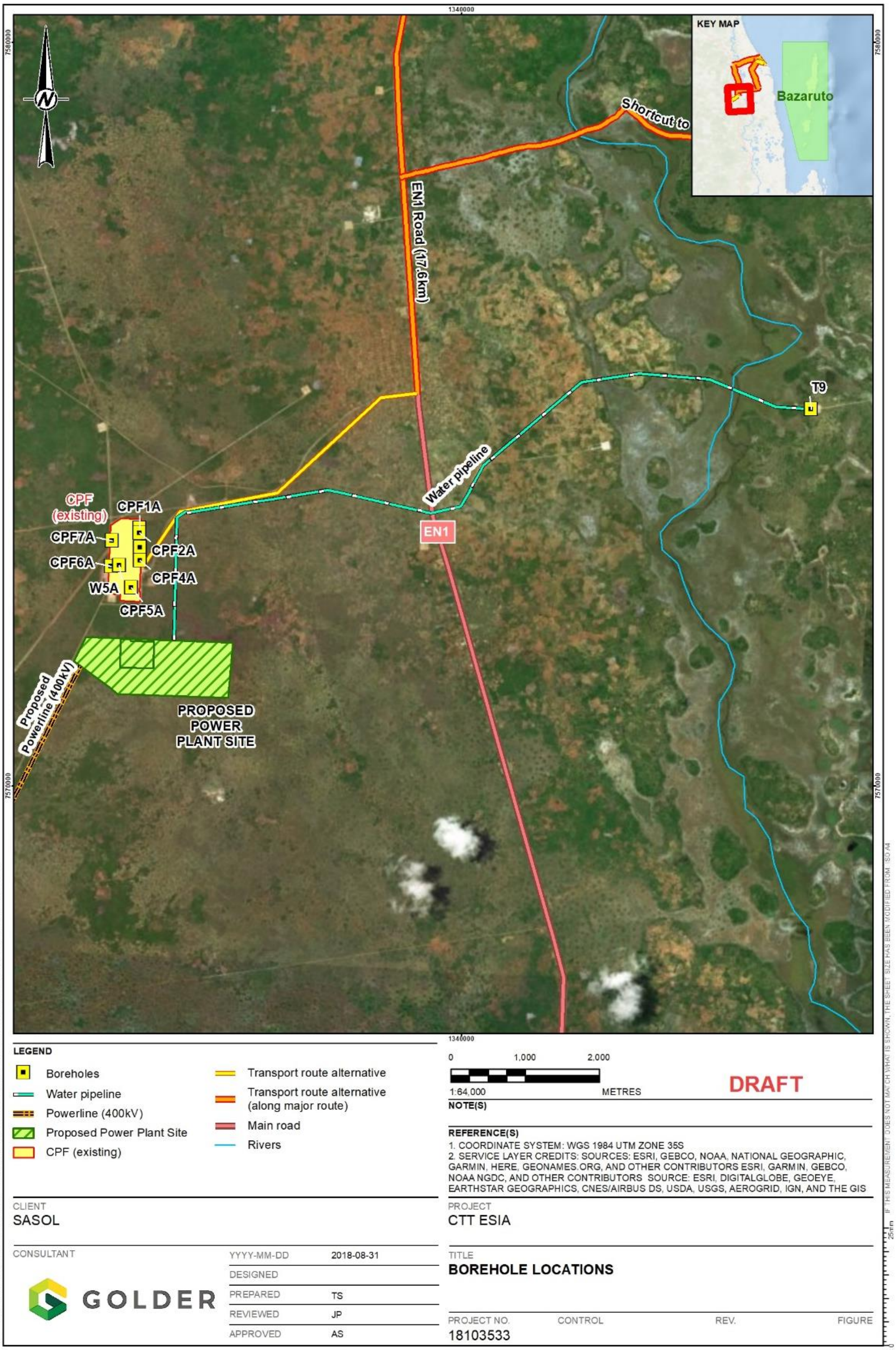


Figure 45: Location of CPF monitoring and water supply boreholes

6.1.4.3 Groundwater levels

Water levels have been measured bi-annually at all Sasol monitoring boreholes around the CPF over a period of 10 years, showing a generally decreasing trend in borehole water levels since 2003. The floods in 2000 recharged the groundwater (Rison 2014a &b) after which the levels gradually decreased, dropping during dry seasons and rising during and after rainy seasons. This is shown in Figure 46 and Figure 47 shows water levels for the complete study area.

Measured water levels range between 0.2 to 38.7 m below ground level (mbgl). The average water level measured is 16.5 mbgl. The shallow water levels up to 2 mbgl are all at hand dug wells near or within alluvial deposits. Deeper water levels (>20 mbgl) are often encountered towards the coast under the coastal dune system or where deeper wells were installed alongside gas/oil well installations.

A borehole 6 km from the CPF (T22B) shows the same trends as the other boreholes, illustrating that the small amounts of abstraction done at the CPF does not materially influence the groundwater levels.

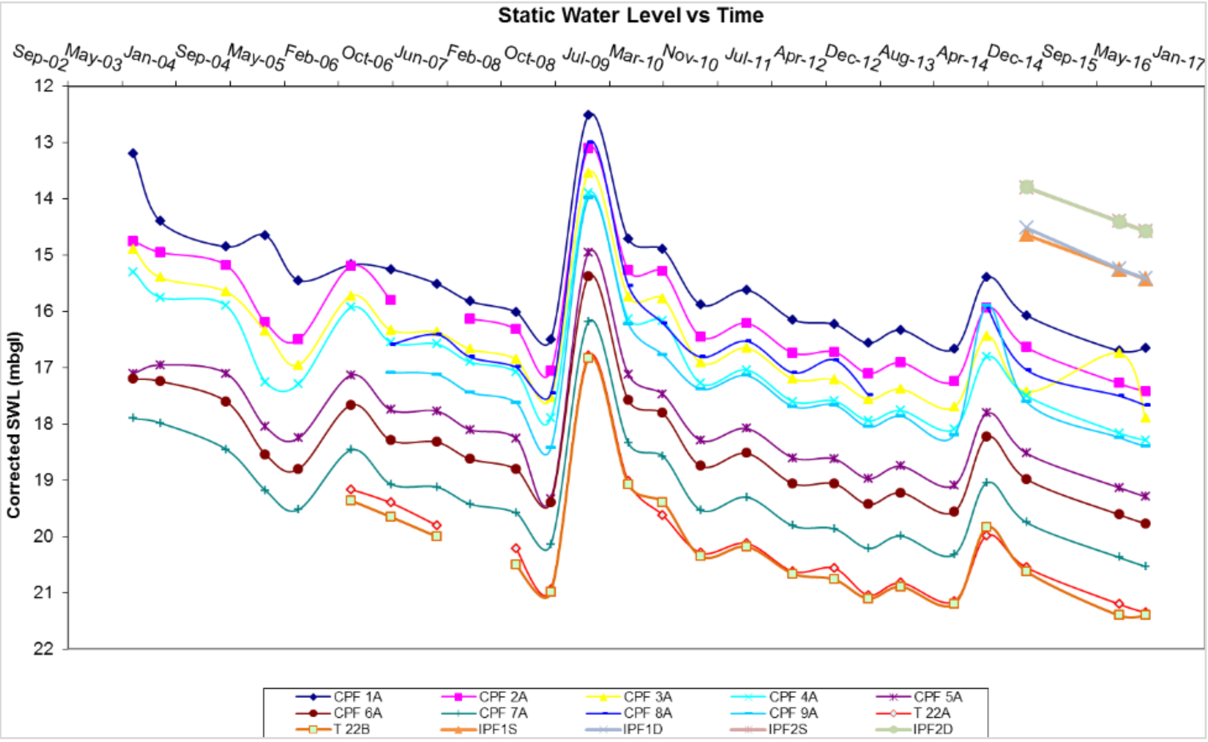


Figure 46: Time series of changes in groundwater levels in boreholes around the CPF (2003 – 2016)

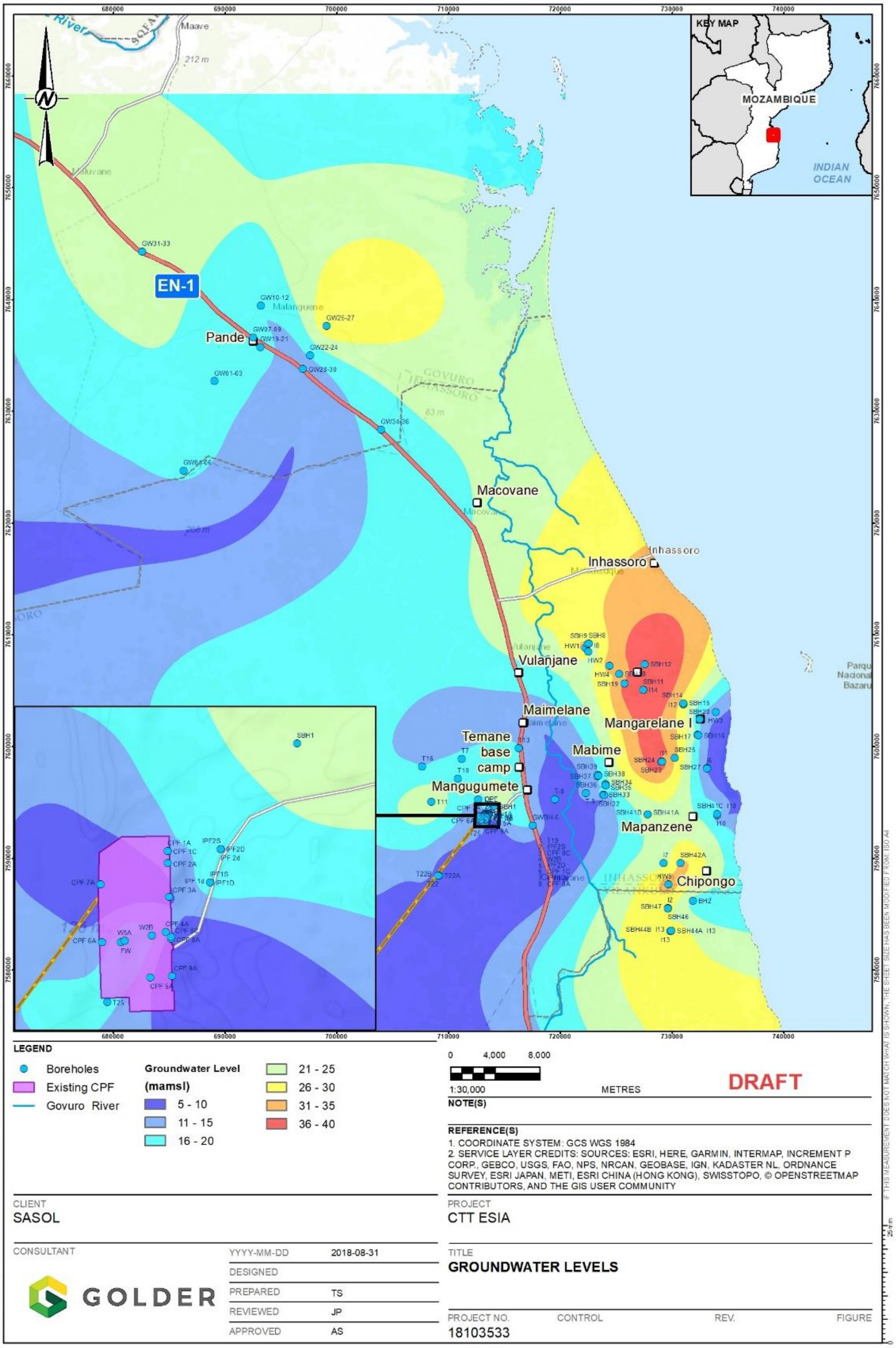


Figure 47: Average groundwater levels (mbgl) for the study area

6.1.4.4 Groundwater Flow

It can be seen that the Temane area has a general water level elevation of 16 to 25 mamsl, with flow towards the Govuro River to the east. The well fields to the northeast towards Inhassoro are characterised by deeper water level elevations (>31 mamasl), creating a localised water divide between the coastal dunes and the Govuro river. A similar situation occurs towards the south eastern coastal area (Chipongo area).

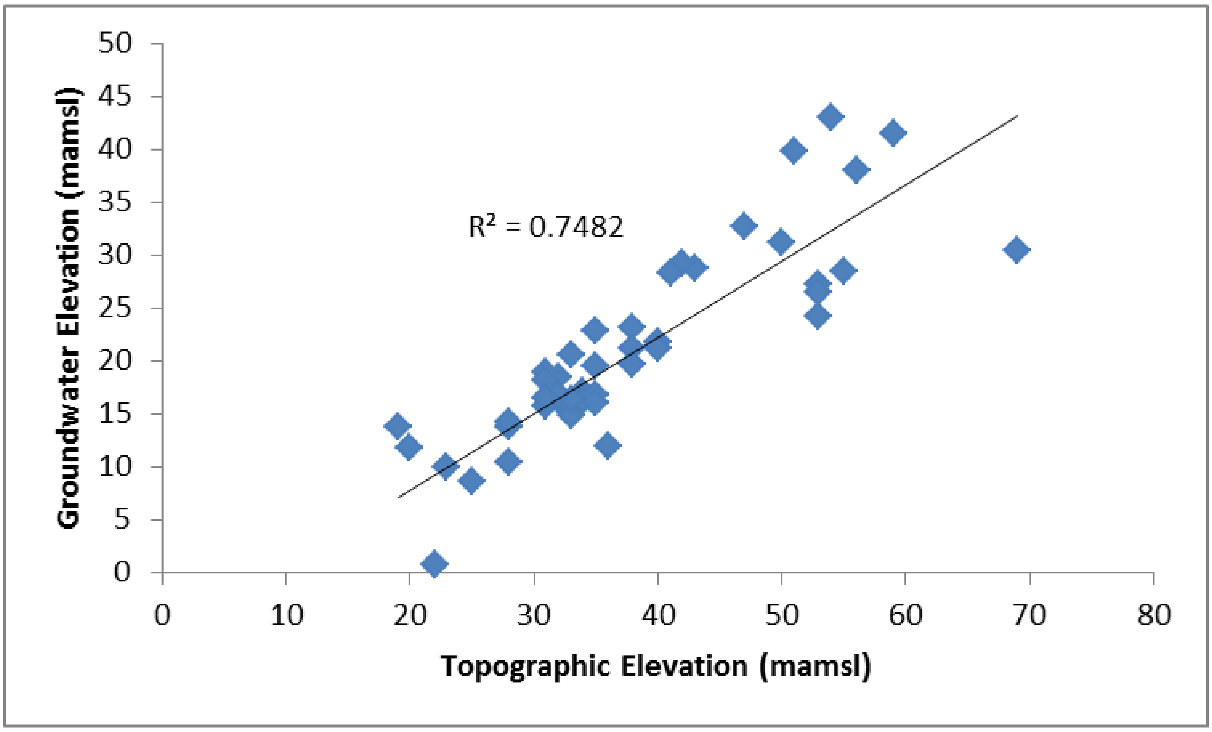


Figure 48: A 75% correlation between topographic and groundwater elevation

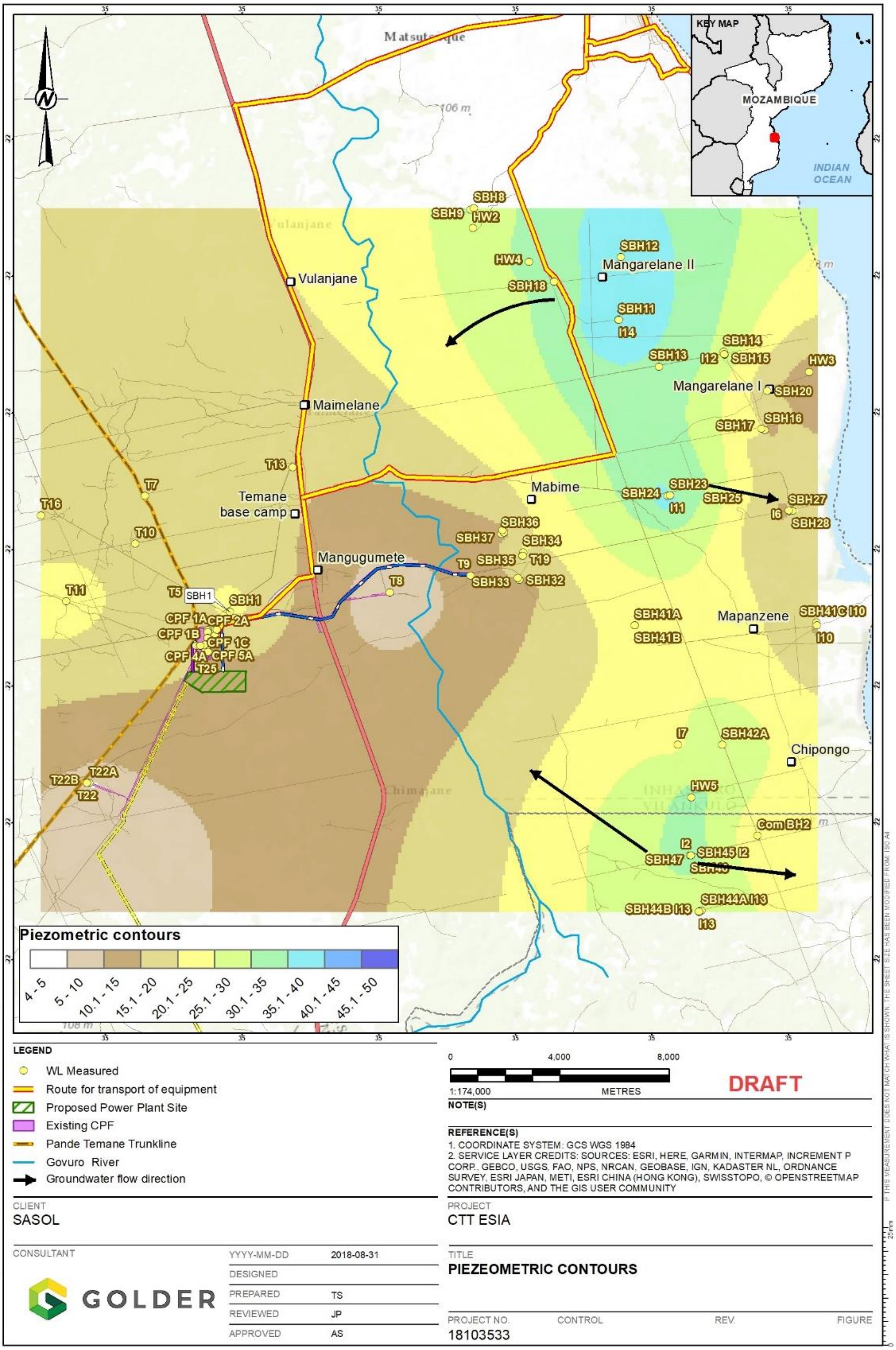


Figure 49: Piezometric contours (mamsl) for the general project area

6.1.5 Surface Hydrology

The proposed CTT plant site is situated in the Inhambane Province, within the Govuro River catchment (Figure 50). The Govuro River has a catchment of 11 169 km^2 of which almost all is located to the west of the river, with only short drainage channels flowing from the east. Most of the catchment to the west of the river is governed by rifting, *i.e*. the southern limits of the Great African Rift Valley, and these low-lying rifts disturb the normal surface run-off towards the Govuro River by intercepting and attenuating the surface run-off. For this reason, most of these drainage channels are ephemeral and only flow during extreme rainfall conditions. The bulk of the catchment of the Govuro River is comprised of Bushveld vegetation (Figure 50).

The catchment is fairly rounded and storm events with comparatively short times of concentration will produce the maximum flood peaks. This however, is only true for large storms, *i.e*. storms having return periods of 50- to 100-years. Due to the ephemeral nature of most of the streams in its western catchment, smaller storms will be attenuated, and/or the water would simply be absorbed by the soil and geological formations covering this catchment.

The Govuro catchment area encompasses two distinct drainage areas. The eastern drainage area is located east of the Govuro River. This area will typically drain towards the immediate coastal line south of Inhassoro. The drainage and surface flows of the western drainage area (includes the CTT site area) primarily located west of the EN-1 national road will be slow and drain typically towards the Govuro River.

A wide variety of aquatic and wetland habitats are present in the eastern Govuro area. These areas are considered sensitive habitats. In this area several seasonal streams occur in the rainy season, which feed the coastal lakes and the wetlands. These are used by local communities for consumption and agriculture. Inhabitants in the area primarily use surface water for domestic purposes. The water resource is abundant in summer, however becomes constrained in winter. Due to the seasonality of the surface water resources, groundwater is the main source of water in the project area. Water quality of the Govuro River is considered to be good as it is currently unaffected by significant abstraction or effluent discharge.

6.1.5.1 Flow and water quality

Based on recordings at a flow station close to its source, the average annual flow of the Govuro River is 121 Mm^3/yr. Hydrometric station data shows that water levels can vary between 0.5 m to 3 m in a year. The maximum registered daily average flow was 26 m^3/s.

In terms of the surface water baseline study (2014 and 2018 update), the analysis of the data of the present state of the water in the Govuro River reflects that quality of the water is good. Compliance was assessed against WHO, IFC and Mozambican standards as well as South African water quality guidelines. The water quality is indicative of a fairly natural state (limited anthropogenic influence) with relatively low concentrations of general water quality parameters assessed.

Most inorganic parameters are within guideline limits, the trace metals present are compliant with Mozambican effluent/discharge standards and the pH of the water is within the acceptable guidelines and can be described as slightly basic. The nutrient (nitrate and ortho-phosphate) concentrations in the river are low. The Govuro River water is typical of hard water (>300 mg/l). However, salinity levels are elevated and increase along the river towards the lower reaches (tidal influence). While the source of raw water for the CTT plant will be groundwater, increasing salinity and total hardness of the Govuro River would be factors for consideration should it be considered as a supplementary water source.

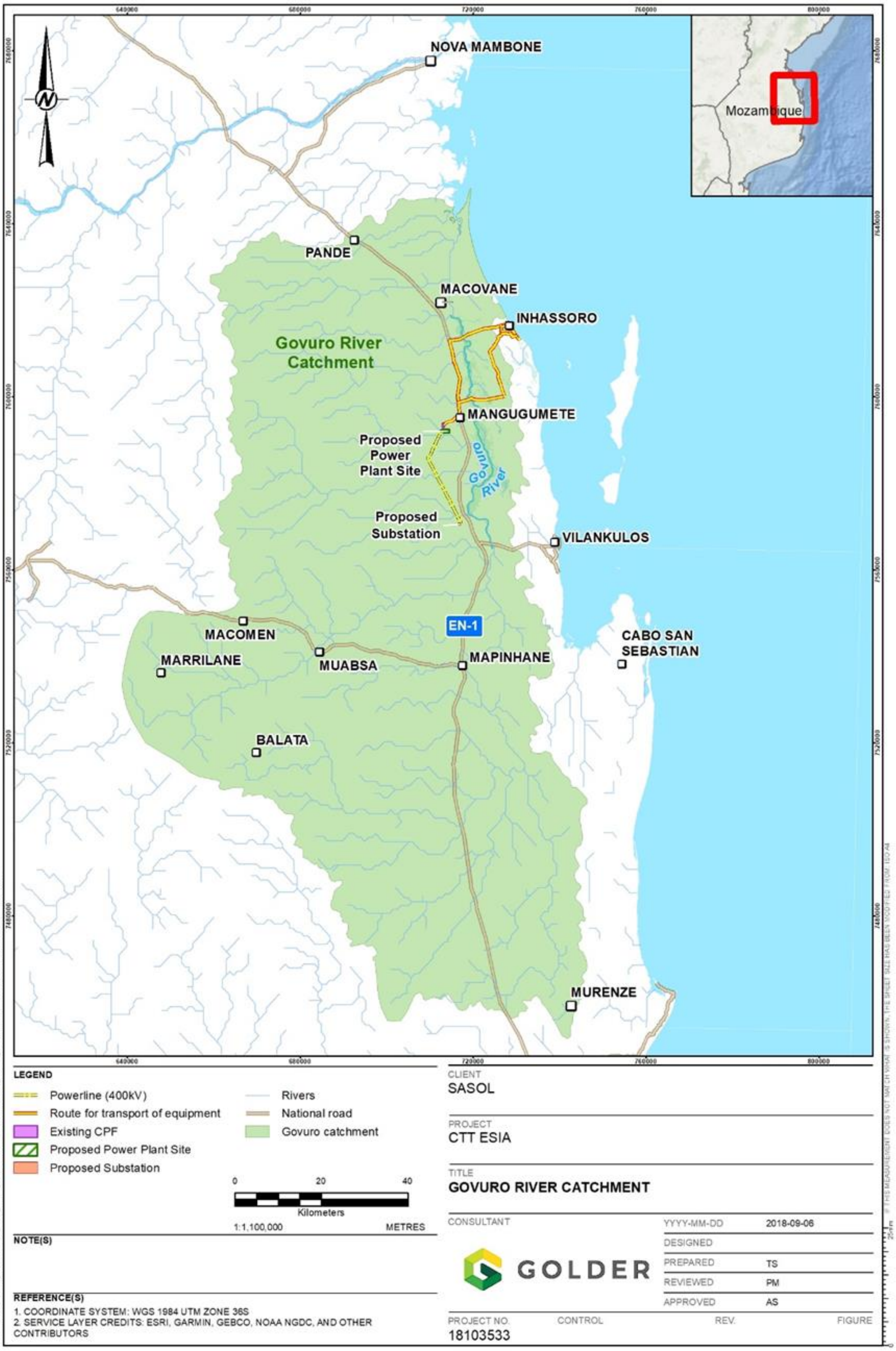


Figure 50: Govuro River Catchment

6.1.5.2 Flood Modelling

Flood modelling was done on the Govuro River and the Temane Drainage Line during the concept engineering/pre-feasibility phase during 2014. A series of storms with return periods of 100 years were modelled. In the case of the Govuro River, a 14-hour storm (*i.e.*, a storm with a time of concentration of 14 hours) produced the highest peak flow. The discharge was 3,262 m^3/s for the 100-year recurrence interval. For the Temane drainage line a 4-hour storm produced the highest discharge *i.e.* 322.4 m^3/s for the 100-year flood line. The effect of the oceans and its tides on the flood line elevations of the Govuro River was also assessed.

The floodline determination study found that the 100-year flood in the Govuro River will not reach the proposed CTT site, and the floodwaters will not come closer than ~5 km to the site, and thus will not impact on the CTT Project infrastructure. There will be a vertical elevation difference between the 100-year flood line and the ground level at the entrance gate of the Temane CPF of ~12.0 m. This elevation difference should be sufficient to also ensure that even if a 100-year flood occurs together with an onshore ocean surge or a very high ocean tide (which has a probability of occurring every 19 years), the proposed site will still be higher than the 100-year flood lines of the Govuro River (Coffey, 2014). Refer to Figure 51 and Figure 52 for a visual illustration of the flood lines.

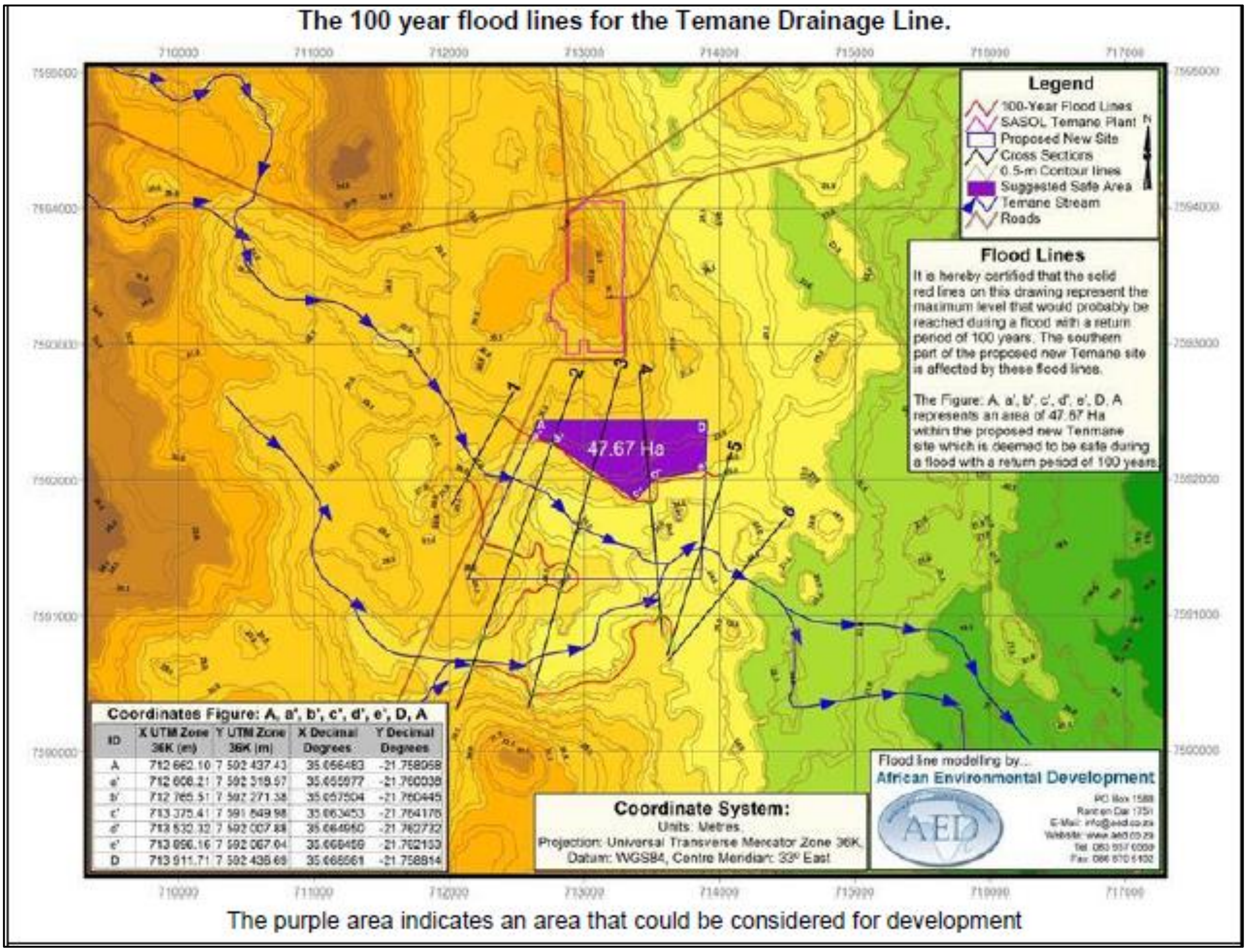


Figure 51: The 100-year flood lines for the Govuro River

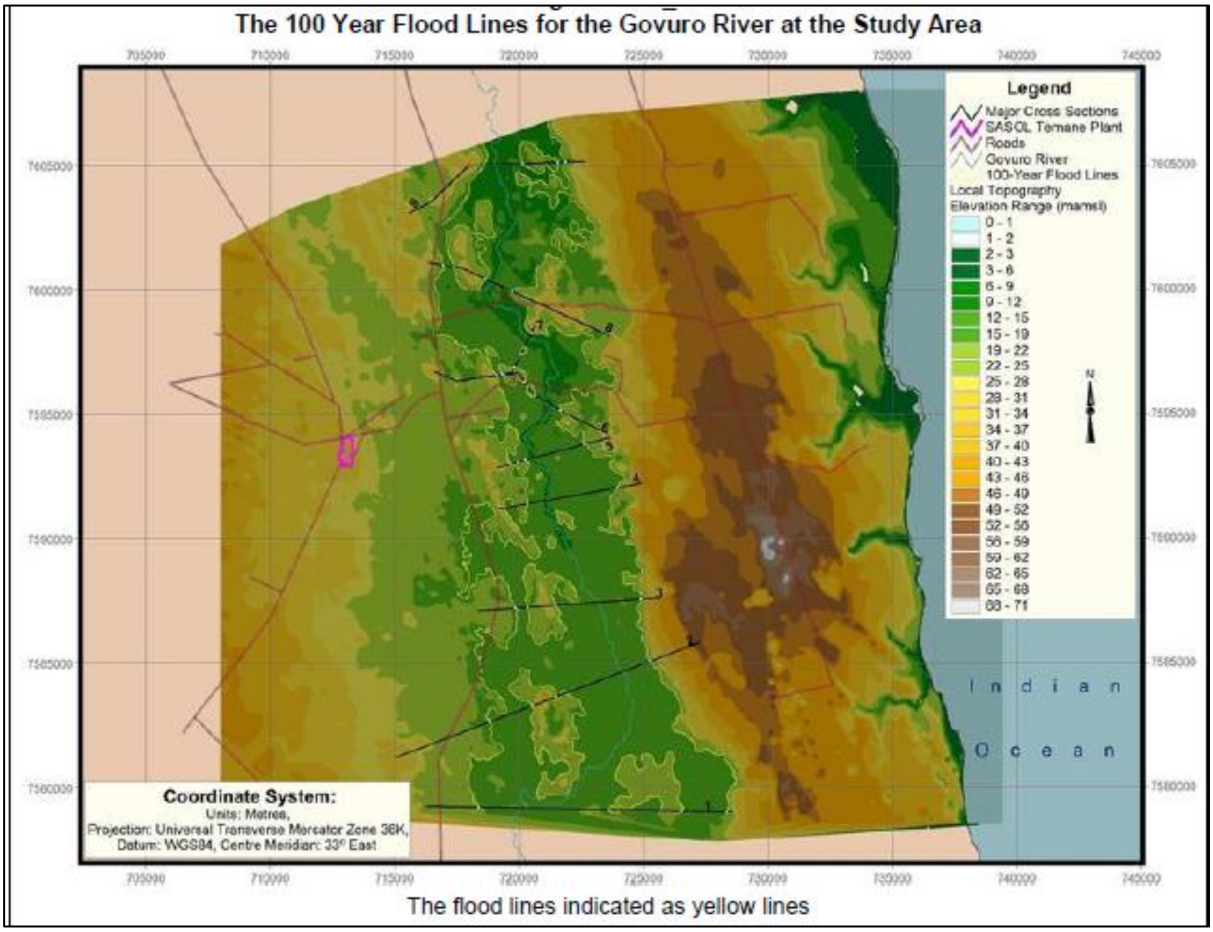


Figure 52: The 100-year flood lines for the Temane Drainage Line

6.1.6 Soils

A Soil baseline assessment was conducted to determine the current soil conditions on site. Figure 53 shows the broad soil types that have been identified within the project area. Top-soils and subsoils were sampled at twenty representative sites (Figure 54). From these, ten sites were selected for analysis (shown in bold in Table 18). In order to strengthen and expand the soil baseline established for the area by Schoeman and Verster (2014) the samples from the selected ten sites were subjected to exhaustive chemical analysis at the Jones Environmental and Forensic laboratories in the United Kingdom (UK).

6.1.6.1 Soil types

Broad soil group A

A number of sub-types of the broad soil types were encountered during the fieldwork phase. Within the red loam soil area, the following were encountered:

- Modal, or commonly occurring, deep red apedal sandy clay loams or clay loams, referred to below as soil type 1;
- Similar soils in which large limestone remnants protrude into the soil profile, resulting in shallow and very deep profiles occurring in close proximity to each other. These are referred to as soil type 2;
- Weakly or moderately structured, darker coloured, red-brown sandy clay loams or clay loams of drainage depressions.

Some members show a marked clay increase from the top-soil to the subsoil while others show signs of having been reworked by fluvial processes. These variants are referred to as soil type 3. These soils appear to be preferred for cultivation within the red soil area; and

- Relatively sandy variants that appear to be transitional to the sandier areas towards the coast. These red or yellow-brown, apedal sandy loams or loamy sands, referred to below as soil type 4, contain about 10 to 18% clay in the subsoils. They are widely used for cultivation (Figure 53).

Broad soil group B

The soils of broad soil type B (occupying flood plains associated with the Govuro River and other drainage depressions) encountered in the study area all exhibit dark grey silt loam top-soils underlain by grey, mottled, loamy sand or sandy loam E horizons. They range from temporary to permanent wetlands (see below). The main morphological expression of increased wetness is an increased darkening of the top-soils by organic matter. No sub-types were identified. They are referred to as soil type 5.

Broad soil group C

In the sandy areas to the east of the Govuro River, two sub-types were identified:

- Soils with thin, grey, sandy top-soils overlying yellow-grey or pale yellow, sandy, subsoils in which the colour increases slightly with depth. The subsoil clay percentage is less than 10.They are terrestrial soils (upland topography) and do not constitute wetlands. They are intensively cultivated. They are referred to as soil type 6; and
- White coastal sands, occurring in close proximity to the coast, referred to as soil type 7.

Figure 55 to Figure 58 visually outlines the various soil types found along the project component sites.

Table 18: Sampling sites

Sample ID	Sampling depth (cm)	Area	Soil type	South African soil form	WRB soil Reference Group	Field clay (%)	Colour	Structure	Coordinates
45A	0-20	Trans-mission line	1	Hutton	Haplic Luvisol (Rhodic)	25	Red-brown	Massive	-21.84676 35.04223
45B	90-110					29	Red	Apedal	
67A	0-20	Trans-mission line	3	Oakleaf	Haplic Luvisol (Rhodic)	25	Red-brown	Weak blocky	-21.89926 35.07224
67B	100-120					29	Red-brown	Weak blocky	
79A	0-20	Trans-mission line	1	Hutton	Haplic Luvisol (Rhodic)	21	Red-brown	Massive	-21.92819 35.08870
79B	80-100					27	Red	Apedal	
85A	0-20	Trans-mission line	3	Valsrivier	Cutanic Luvisol (Rhodic)	20	Red-brown	Massive	-21.94246 35.09685
85B	80-100					35	Red-brown	Moderate blocky	
104A	0-20	Water pipeline	2	Plooysburg	Haplic Luvisol (Rhodic)	25	Red-brown	Massive	-21.75354 35.06742
104B	60-80					30	Red	Apedal	
109A	0-20	CTT plant site	2	Plooysburg	Haplic Luvisol (Rhodic)	25	Red-brown	Massive	-21.76004 35.06641
109B	60-80					29	Red	Apedal	
115A	0-20	CTT plant site	1	Hutton	Haplic Luvisol (Rhodic)	26	Red-brown	Massive	-21.75991 35.06049
115B	90-110					31	Red	Apedal	
145A	0-20	CTT plant	1	Hutton	Haplic Luvisol	20	Red-brown	Massive	-21.76292

Sample ID	Sampling depth (cm)	Area	Soil type	South African soil form	WRB soil Reference Group	Field clay (%)	Colour	Structure	Coordinates
145B	90-110	site			(Rhodic)	23	Red	Apedal	35.06444
153A	0-20	Water pipeline	4	Clovelly	Hypoluvic Arenosol	10	Yellow-brown	Massive	-21.72878 35.11324
153B	110-120					12	Yellow-brown	Apedal	
157A	0-20	Water pipeline	5	Dundee	Gleyic Fluvisol (Arenic)	14	Dark grey-brown	Massive	-21.72404 35.12096
157C	100-120					11	Yellow-grey	Massive	
159A	0-20	Water pipeline	4	Clovelly	Haplic Arenosol	11	Grey-brown	Massive	-21.72335 35.12925
159B	100-120					12	Yellow-brown	Apedal	
165A	0-20	Beach landing alternatives	6	Hutton	Haplic Arenosol	8	Grey-brown	Massive	-25.54267 35.20563
165B	100-120					8	Pale red	Apedal	
185A	0-20	Beach landing alternatives	5	Unclassifiable	Haplic Gleysol (epi-Arenic)	26	Dark grey-black	Weak blocky	-25.55819 35.18679
185E	60-80					2	Grey	Single grain	
187A	0-20	Temporary road	6	Fernwood	Haplic Arenosol	5	Grey-brown	Massive	-21.56009 35.18677
187E	90-110					4	Pale yellow-grey	Single grain	
205A	0-15	Temporary road	6	Fernwood	Haplic Arenosol	6	Grey-brown	Massive	-21.59604 35.16266
205E	90-110					6	Pale yellow-grey	Massive	
211A	0-15		6	Vilafontes	Endogleyic	5	Dark grey-brown	Massive	-21.61115

Sample ID	Sampling depth (cm)	Area	Soil type	South African soil form	WRB soil Reference Group	Field clay (%)	Colour	Structure	Coordinates
211B	90-110	Temporary road			Arenosol	7	Pale yellow	Massive	35.16823
225A	0-15	Temporary road	6	Clovelly	Haplic Arenosol	6	Grey-brown	Massive	-21.64608 35.18175
225B	100-120					6	Pale yellow	Apedal	
246A	0-15	Temporary road	6	Clovelly	Haplic Arenosol	4	Grey	Single grain	-21.68827 35.19096
246B	100-120					6	Pale yellow	Apedal	
270A	0-20	Temporary road	5	Fernwood	Haplic Gleysol (Arenic)	22	Dark grey	Massive	-21.69340 35.12253
270E	80-100					12	Grey	Massive	
276A	0-20	Temporary road	5	Tukulu	Gleyic Fluvisol (Arenic)	10	Dark grey-brown	Massive	-21.69881 3510354
276B	100-120					12	Pale yellow-brown	Massive	

Figure 53: Broad soil types in project area

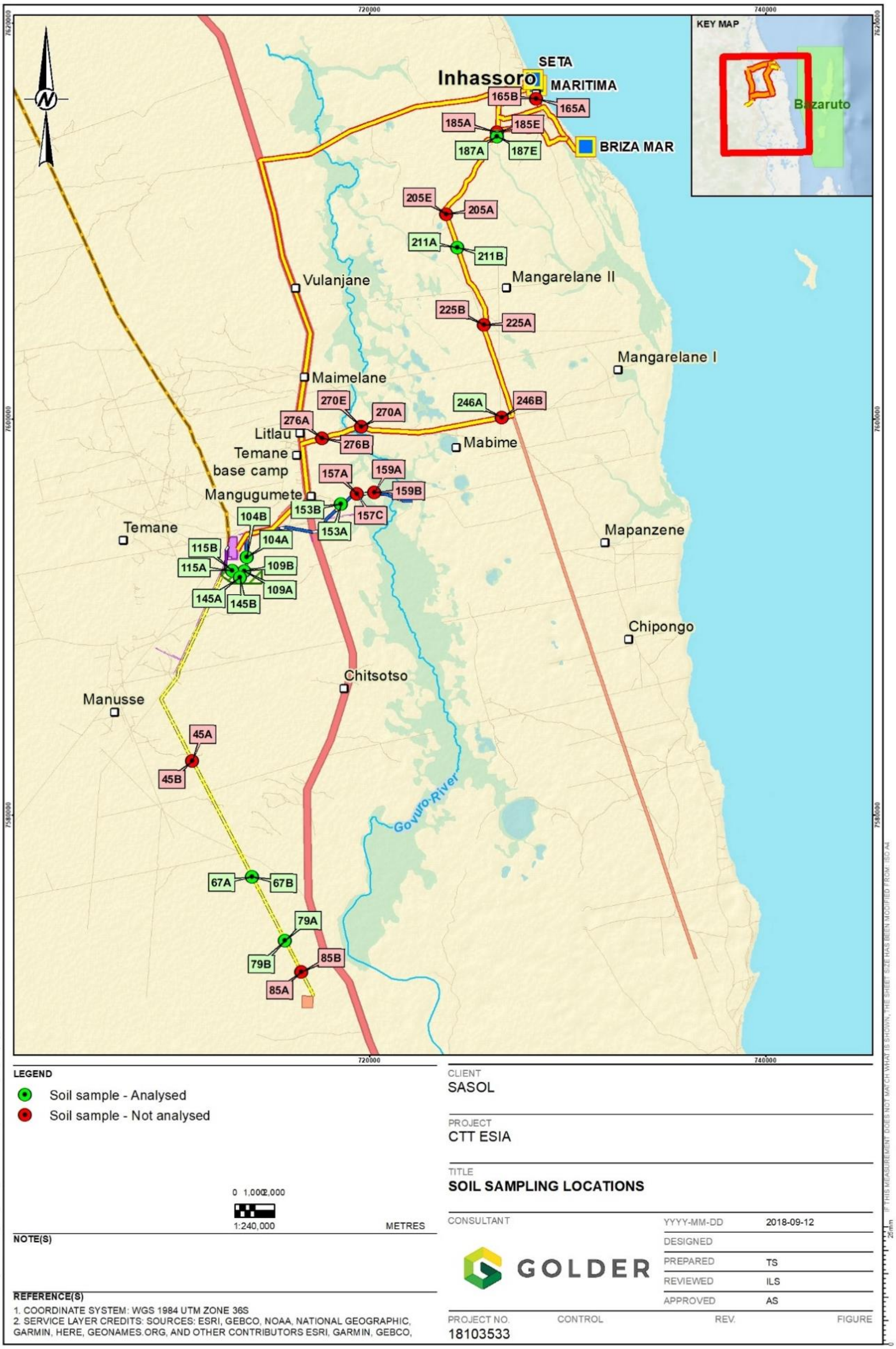


Figure 54: Soil sampling locations

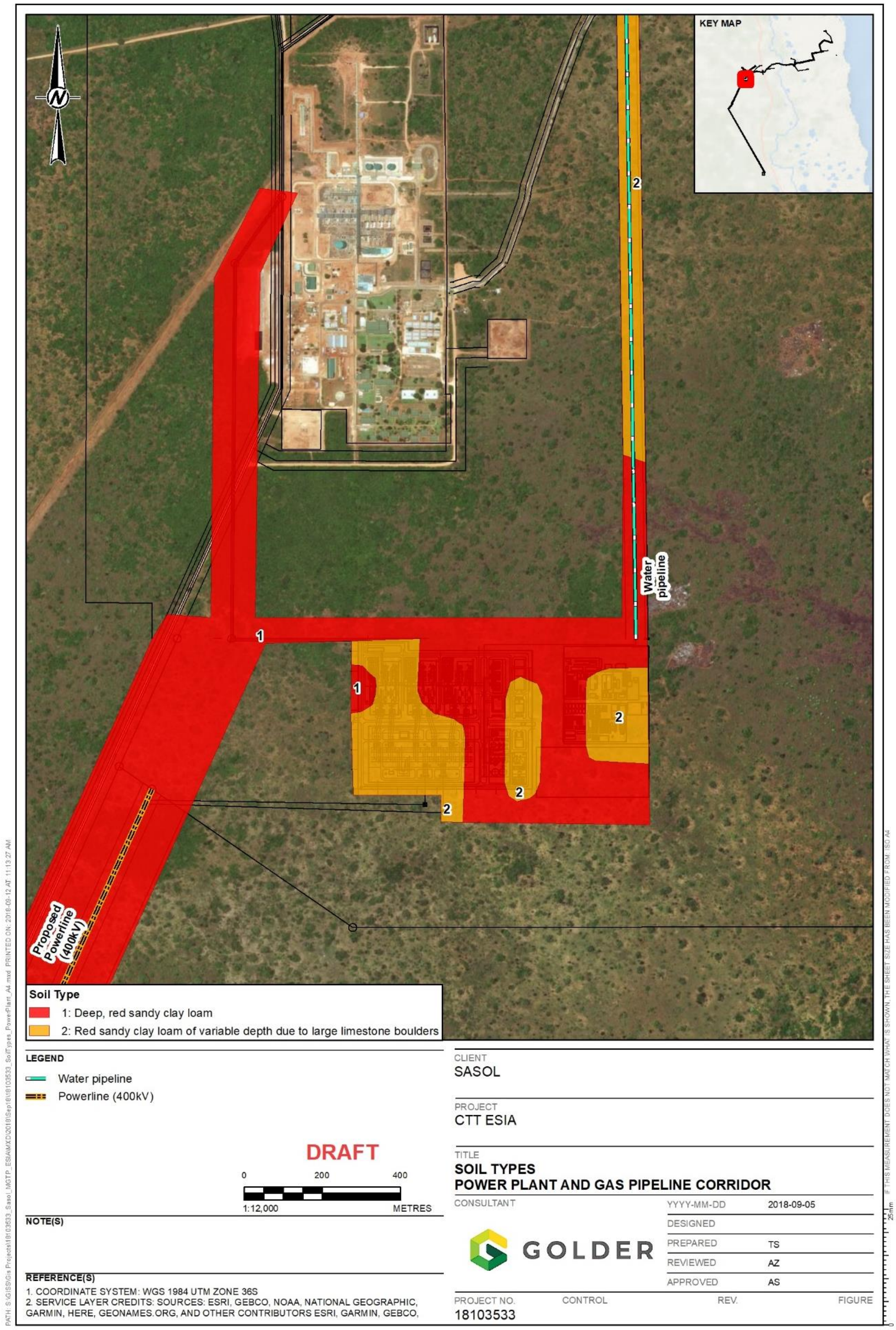


Figure 55: Soil types identified in CTT plant site and gas pipeline corridor

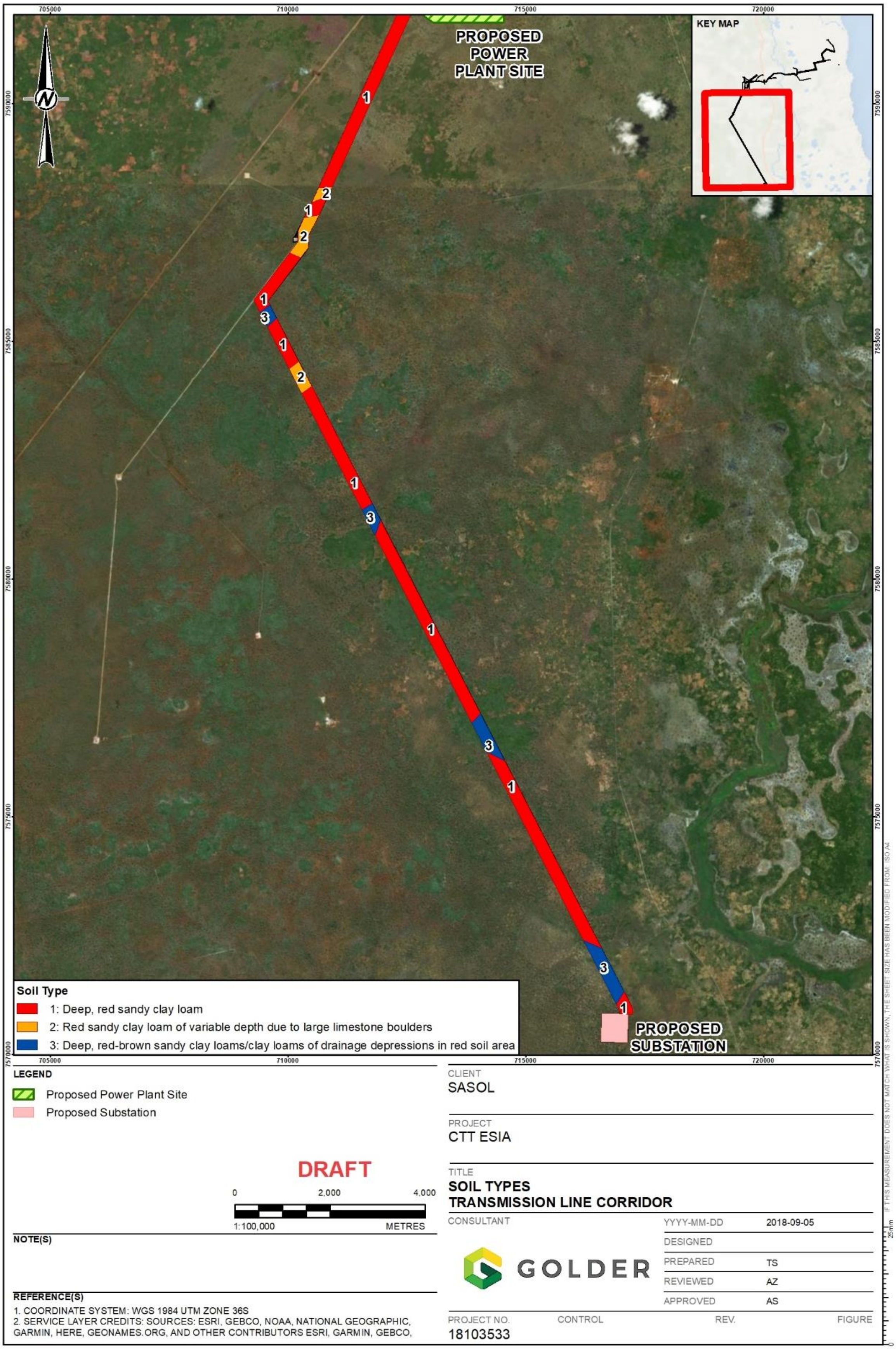


Figure 56: Soil types identified in transmission line corridor

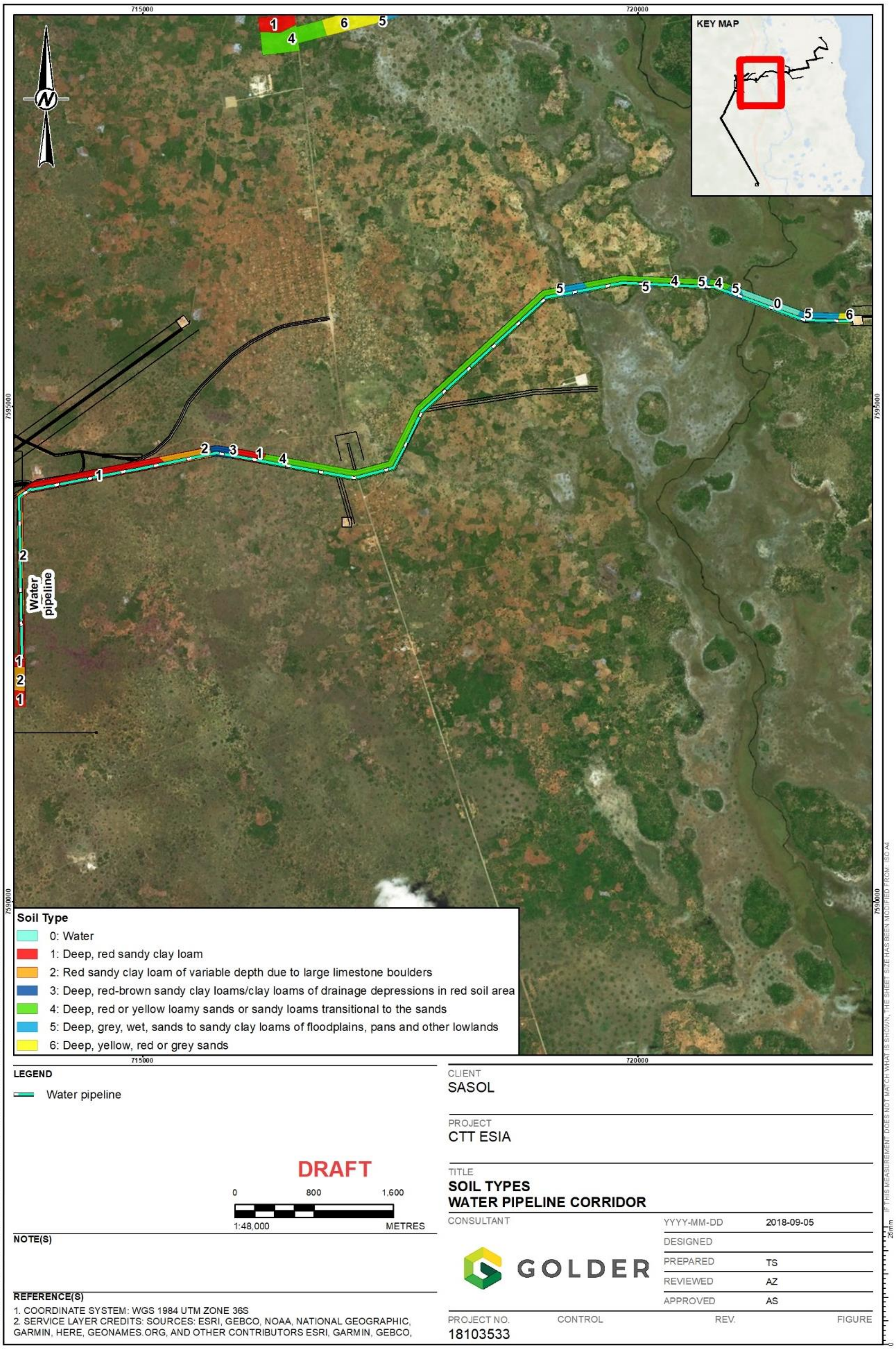


Figure 57: Soil types identified in water pipeline corridor

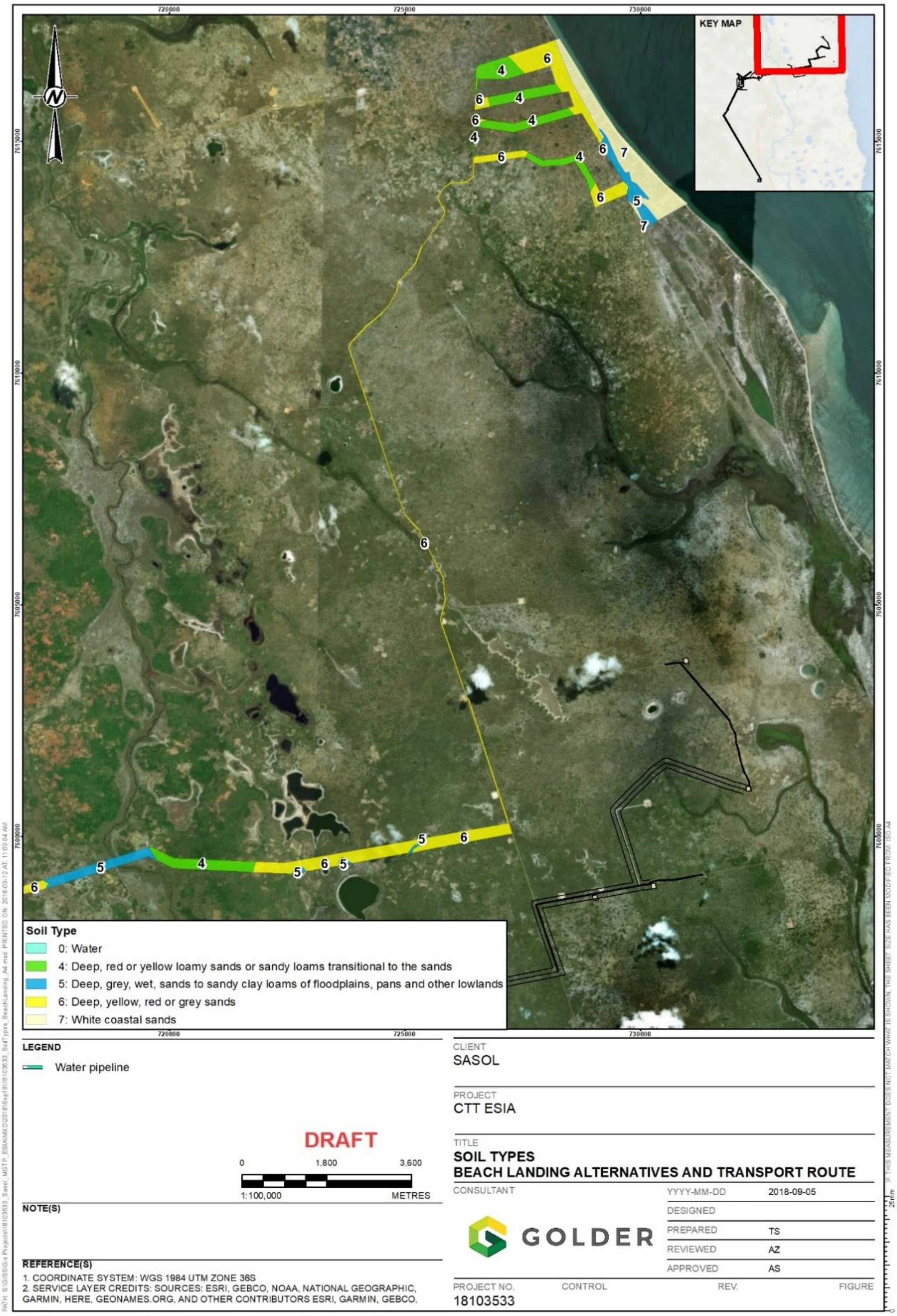


Figure 58: Soil types identified at beach landing alternative and transport route

6.1.6.2 Soil Fertility Properties

- The soils are of high base status, with little or no natural acidity, but with slight alkalinity in places towards the coast;
- They are low in magnesium and, in places, in potassium. At relatively high calcium levels, this causes imbalances and deficiencies;
- The phosphorus status is very low, in both the top-soils and subsoils; and
- The overall natural fertility can be described as low to moderate.

6.1.6.3 Inorganic Analysis

From the results it was observed that Arsenic (As) concentrations were found to exceed the industrial and risk-based SSL values in the majority of the soils and exceed the risk-based SSL in two soils along the water pipeline. Iron concentrations exceed the risk-based SSL for the samples collected at the plant site, transmission line and water pipeline. Manganese exceeds the risk-based SSL in some samples collected at the plant site and one at the water pipeline. The concentrations are higher in the red soils and low in the coastal sands.

6.1.6.4 Organic Analysis

The results indicate the following:

- The following organic constituents are present at levels of two units or more above the detection limit of 2 - 3 µg/kg:
  - Toluene was found above the reporting limit in one of the surface samples taken at the CTT site; and
  - Ethylbenzene and styrene were found to exceed the reporting limit in 2 samples analysed in the CTT vicinity and one in the water pipeline area.

Although values are below the screening values, the occurrence at surface could indicate impacts resulting from the operations. The potential for increased levels of toluene over time and in closer proximity to the plant site may exist and should be monitored in future.

Table 19 below outlines the interpretive soil properties for the soil types identified, with Table 20 providing the land capability and restrictions for each of the soil types. From the investigations the following were found and concluded:

- Soil types occurring in the CTT plant area, the gas pipeline area, most of the transmission line area and the southern part of the water pipeline area have considerable resilience with respect to water and wind erosion as well as chemical pollution but are somewhat susceptible to compaction and surface crusting. The agricultural potential is moderate and the land capability Class III;
- Soil type transitions occur roughly between the EN1 road and the Govuro lowlands along the water pipeline route. These soils are widely used for cultivation, although they have soil fertility limitations in places. They are susceptible to water erosion, compaction and surface crusting to a degree. The agricultural potential is moderate and the land capability Class III;
- The Govuro lowlands are encountered in the water pipeline corridor and the potential access road *via* the pipe bridge. Where not under water they are occupied by deep, wet, grey sands or loamy sands with organic-rich top-soils. These wetland soil areas are not regularly used for arable agriculture. The land capability is Class V;

- Between the Govuro lowlands soils are very widely used for cultivation, particularly around Inhassoro town and are the main arable soils of the area. These soils are susceptible to wind and water erosion, as well as compaction. The agricultural potential is moderate and the land capability Class III;
- A narrow strip of white coastal sand lines the beach at Inhassoro town and will be encountered in the potential beach landing sites. It has no arable potential and the land capability is Class VII (low grazing capacity) or VIII (wilderness land);
- The main soil analytical dataset for 10 of the 20 sites sampled (consisting of 19 samples) from the Jones Environmental and Forensic Laboratories provide what are expected to be the baseline values, for a limited range of inorganic elements. Toluene, ethylbenzene and styrene were found to be above the reporting limits in the surface soils analysed in the vicinity of the CTT plant site and water pipeline; and
- The main potential impacts with regards to soils will likely only occur during the construction and decommissioning phases. These are (i) disturbance of soil, resulting in increased decomposition of soil organic matter from topsoil; (ii) contamination of soils by hydrocarbon pollutants; (iii) loss/change of land use; (iv) loss of potentially arable land; (v) soil compaction due to increased vehicle traffic and earth moving activities; and (v) soil loss due to erosion. Of these impacts, the disturbance of soil (including soil compaction); loss/change of land use; and loss of potentially arable land were rated as having a moderate significance. The impacts remain of having a moderate significance even if the mitigation measures are implemented. Since the land (and soil) will have permanent infrastructure (roads, transmission lines) constructed, resulting in a change to industrial land use.

Table 19: Interpretive soil properties

Soil Type		Susceptibility to erosion[3]		Susceptibility to compaction[1]	Susceptibility to surface crusting[2]	Absorption capacity for pollutants[2]	Dust Potential[2]	Agricultural potential (rainfed)[3]
		Water	Wind					
1	Red loam	Low	Low	Moderate	Moderate	High	Moderate	Moderate
2	Red loam on hardpan carbonate	Low	Low	Moderate	Moderate	High	Moderate	Low
3	Red-brown loam/clay loam of drainage depressions	Low	Low	Moderate	Moderate	High	Moderate	Moderate
4	Red or yellow-brown loamy sand/ sandy loam (subsoil clay ≥10%)	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate
5	Dark grey/grey silt loam/loamy sand/sand of drainage depressions (sandy areas)	High	Moderate	High	High	Moderate	Moderate	Low
6	Grey or pale yellow sand or loamy sand (subsoil clay <10%)	High	High	High	Low	Low	Moderate to high	Moderate
7	White coastal sand	High	High	High	Low	Low	Moderate to high	Low

[1] Intrinsic soil susceptibilities without considering soil cover and slope factors. Largely based on soil textural, organic matter and drainage properties.
[2] Based on soil textural properties, derived clay mineralogy and organic matter.
[3] Taking climatic limitations into account

Table 20: Land capability

Soil Type		Land capability		
		Class	Description	Key limitations
1	Red loam	III	Moderate capability to sustain rainfed arable land-use	Moderate to moderately low rainfall; occurrence of drought
2	Red loam on hardpan carbonate	IV	Marginal capability to sustain mechanised rainfed arable land-use	As for soil type 1 but with mechanical restrictions
3	Red-brown loam/clay loam of drainage depressions	III	As for Class III	As for soil type 1; in addition, susceptibility to flooding
4	Red or yellow-brown loamy sand/sandy loam (subsoil clay ≥10%)	III	As for Class III	Moderate rainfall; occurrence of drought
5	Dark grey/grey silt loam/loamy sand/sand of drainage depressions (sandy areas)	V	Low or no capability for rainfed arable land-use due to soil wetness and/or flooding	Little or no arable potential due to seasonal/periodic hydric soil conditions; susceptibility to flooding
6	Grey or pale-yellow sand or loamy sand (subsoil clay <10%)	III	As for III	Moderate rainfall, but higher towards the coast; occurrence of drought; susceptibility to wind erosion; low nutrient reserves
7	White coastal sand	VII-VIII	Wilderness land (Class VIII) or land with low grazing capacity (Class VII)	General instability and fragility

6.1.7 Ambient Sound Levels

Comprehensive site visits and ambient noise level measurements have been carried out between 2009 and 2014 for the Sasol CPF (and surrounding areas), which is located just north of the CTT site. Additional spot measurements for noise were undertaken in 2018 in order to detect if these ambient noise levels had changed. The existing data on the environment and noise measurement results were used to develop a reliable assessment of baseline conditions for the CTT Project. The reports that were studied are:

- FMAC Report No. 09/1/3, Noise Impact Study for the Inhassoro Project In Mozambique, April 2009[6];
- FMAC Report No. 14/1/1, Environmental Noise Assessment for the Phase 1 and Phase 2 PSA Inhassoro Early Oil Project (IEOP) in Mozambique, April 2014[7];

- FMAC Report No. 14/1/1/2, Noise Impact Study for the Sasol Temane PSA LPG Project In Mozambique, June 2014[8]; and
- Nershco Report No. 13SHSSASMOZ702.1.1, An Environmental Noise Survey conducted at Sasol Petroleum Temane, December 2013 [9].

6.1.7.1 Methodology

All measurements were taken in accordance with the procedures specified in SANS 10103 5. These are in line with internationally accepted best measurement practice.

The measurement results indicated that at a number of the measurement points other sources of noise had made very significant impacts on noise levels. These primarily were natural sources, e.g. insects and frogs, especially at locations far away from the CPF.

The noise energy caused by insects and frogs is concentrated at the high frequency end of the audible spectrum, i.e. typically from around 2 kHz upwards to as far as 16 kHz. The human hearing capacity is such that it is at its most sensitive to sound at around 4 kHz and far less so at the lower end of the frequency spectrum. The A-weighting of a noise measurement simulates this frequency-dependent human hearing characteristic, i.e. noise in the lower frequency bands are weighted much heavier more than those at the higher end.

In contrast industrial plants typically emit noise energy in the lower range of the audible frequency spectrum. This is why bird calls, insects and frogs that emit significant levels of high frequency sound in close proximity to the measurement point can totally dominate the noise emissions from a faraway industrial source of noise when measured on the A-weighted scale. This happens even though the actual noise energy emitted by the industrial plant is vastly more than that of all the insect and other natural noise sources added together. Natural sources of noise such as birds, insects and frogs are subjectively perceived as part of the natural environment. Therefore, their noise is generally not regarded as disturbing.

The cumulative effect of these observations is that the assessment of measurement results will be based on noise levels higher, and in many instances very much higher, than what they subjectively are perceived to be. By removing the high frequency energy caused by birds, insects and frogs in close proximity to the measuring instrument, an estimate of what the ambient noise levels would be if there were no natural sources that could skew the results is provided. In reality this typically is the case during the dry season.

6.1.7.2 Results

Table 21: Summary of the processed FMAC and unprocessed Nershco measurement results

Measurement Point	Measured noise levels, dBA	
	Day-time	**Night-time**
P1	54.1	56.6
P2	56.9	63.8
P3	45.3	52.3
P4	47.5	48.1
P5	47.8	55.6

Measurement Point	Measured noise levels, dBA	
P6	47.5	52.7
P7	62.3	64.2
P8	47.5	42.9
P9	68.1	60.3
P10	60.8	48.2
P11	-	47.7
P12	50.4*	49.9
P13	54.7*	47.2
P14	48.2*	27.5
P15	39.0*	38.1
P16	-	36.8
P17	-	32.3
P18	39.5*	38.1*
P19	43.1*	38.6*

* Note: The marked measurement results were obtained from Nershco Report No. 13SHSSASMOZ702.1.1 [9].

In order to estimate realistic reference noise levels for day- and night-time conditions the averages were calculated for measurement points falling outside the PPZ-boundary. For day-time these were P14, P15, P18, P19 (42.5 dBA) and for night-time P14 to P17 (33.7 dBA). P18 and P19 were excluded from the night-time average since these measurements were taken a considerable time before those at P14 to P17 and could not be further processed due to the absence of frequency spectra.

The general day and night averages of 42.5 dBA and 33.7 dBA, respectively, compare very well with the corresponding ambient noise levels 45 dBA and 35 dBA listed by SANS 10103[5] as typical for 'rural districts. The noise levels of 42.5 dBA and 33.7 dBA were used as reference to calculate the resulting total ambient noise levels caused by the noise emissions from the existing CPF and EDM plants.

During the June 2018 rapid survey, spot measurements were taken at various locations that confirm these general daytime and nigh-time averages.

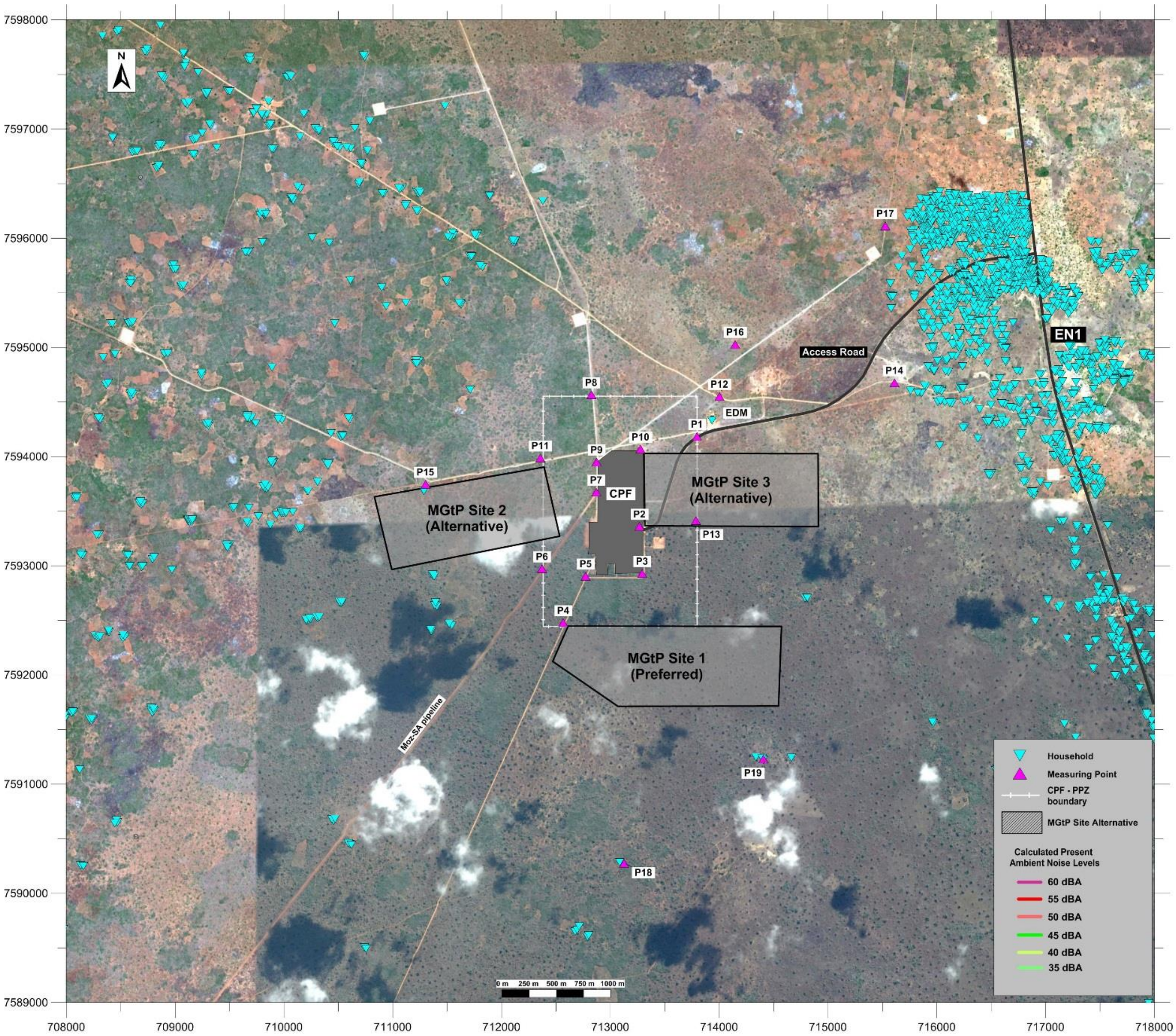


Figure 59: Satellite image showing the locations of the measurement points

The CTT baseline ambient noise levels during the day and night are reproduced for reference purposes in Figure 60 and Figure 61.

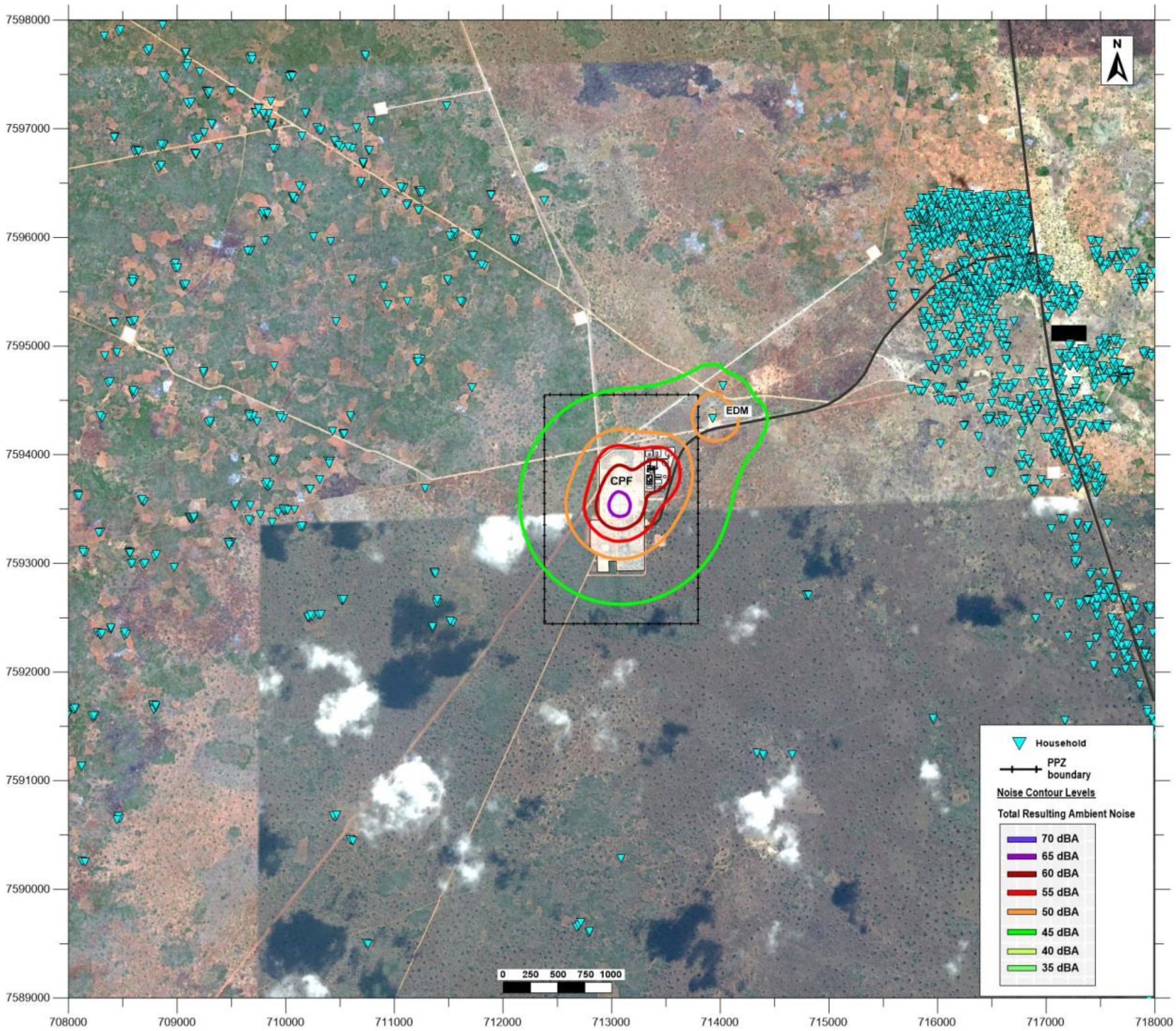


Figure 60: CTT baseline ambient noise levels during the day

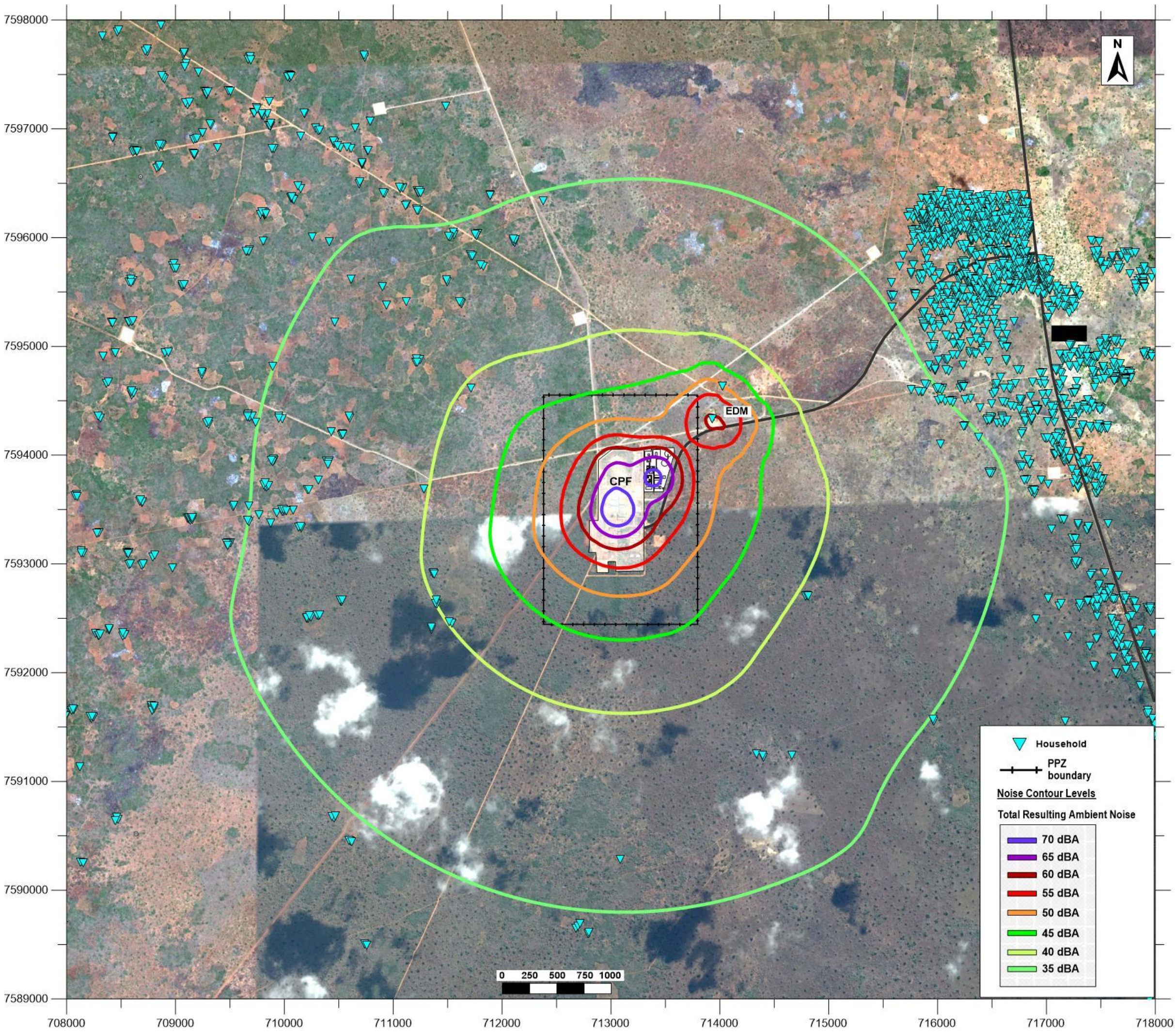


Figure 61: CTT baseline ambient noise levels during the night

6.2 Biological Environment

The ecological attributes of the region surrounding Inhassoro have been comprehensively studied as part of Sasol's gas exploration and production programmes for over a decade. Data from these studies were augmented with the findings of two targeted field inspections of proposed infrastructure footprints (conducted in 2015 and 2018) and used to develop the baseline ecological characterisation for the impact assessment. The study area falls within Swahilian/Maputaland Regional Transitional Zone. As the name suggests, this area is defined by a botanical transition, containing elements of both the Swahilian Regional Centre of Endemism, which extends from the north, and the Maputaland-Pondoland Regional Mosaic which extends from the south. The study area is dominated by three main landscape units, namely Southern Coastal Plains, Govuro Floodplain and Western Plains.

6.2.1 Habitat, Vegetation and Flora

The following five (5) broad-scale vegetation/ habitat units (Figure 62) are particularly relevant to the proposed CTT project:

- Mixed Woodland and Thicket Mosaic;
- *Julbernardia – Brachystegia* Short Woodland and Thicket;
- Govuro River Floodplain;

- Ephemeral Drainage Lines; and
- Barrier Lakes.

These vegetation units can be broken down into the following vegetation communities (Figure 63):

- Open and Closed Woodland;
- Low Thicket; and
- Permanent and Seasonal Wetlands.

The permanent and seasonal wetlands have a biodiversity value rated as "high" followed by the low thicket which is rated as "medium-high" and then lastly the open and closed woodlands rated as "medium" (Table 23). Fourteen plant species of conservation concern are known to occur in the broader project region (Table 22).

Table 22: Red List flora species

Scientific Name	Red List Status
Afzelia quanzensis	Lower Risk – Near Threatened
Brachylaena huilensis	Near Threatened
Bivinia jalbertii	Near Threatened
Croton inhambanensis	Vulnerable
Dalbergia melanoxylon	Lower Risk – Near Threatened
Dolichandrone alba	Vulnerable
Encephalartos ferox subsp. *emersus*	Critically Endangered
Encephalartos ferox subsp. *ferox*	Near Threatened
Euphorbia lividiflora	Vulnerable
Milicia excelsa	Lower Risk – Near Threatened
Paropsia braunii	Near Threatened
Pavetta gracillima	Data Deficient
Pterocarpus angolensis	Near Threatened
Xylia mendoncae	Vulnerable DD

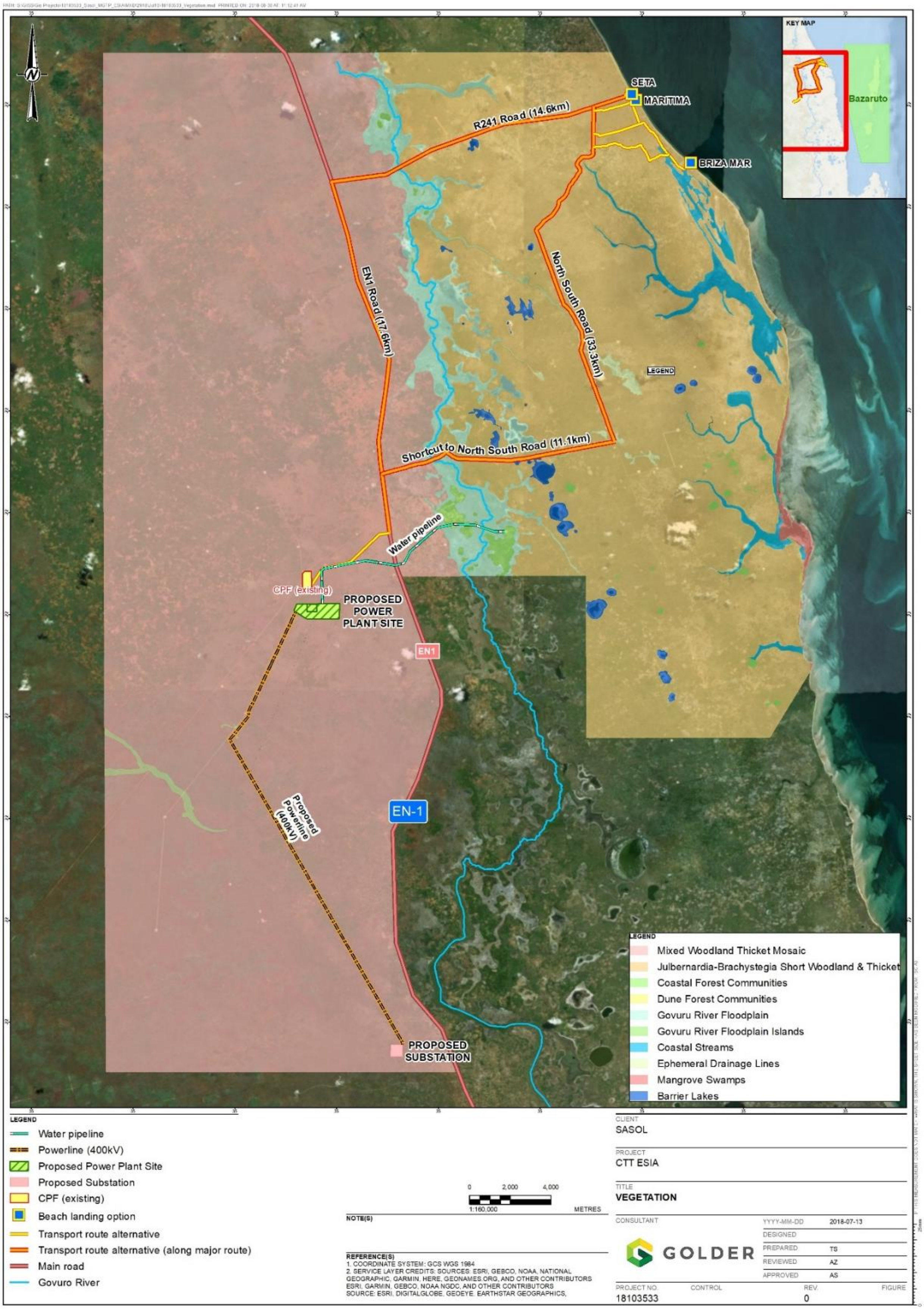


Figure 62: Broad-scale habitat units associated with the study area (De Castro and Brits, 2014)

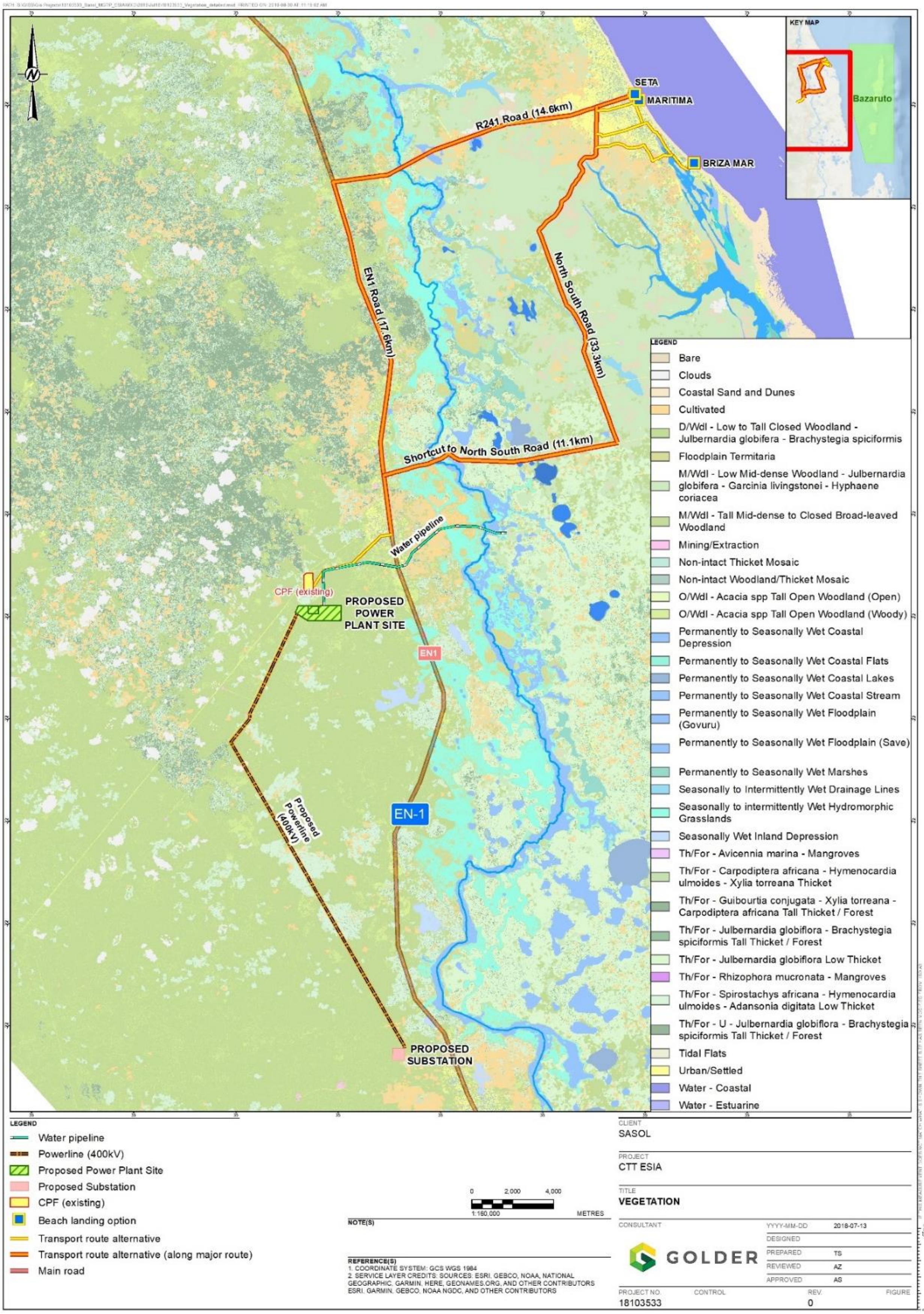


Figure 63: Finer-scale vegetation communities associated with the study area (Golder, 2015a)

6.2.2 Classification of Modified and Natural Habitat

IFC GN6 (2012) recognises that natural and modified habitats exist on a continuum that ranges from largely untouched, pristine, natural habitat to intensively-managed transformed habitats.

For this study, natural habitats were defined as those habitats where key processes, composition, and structure were largely intact. Areas displaying moderate degrees of disturbance, yet that are likely to return to, or at least approximate, reference conditions in the short- to medium term, were also delineated as natural.

Modified habitats were defined as areas that have been altered by human activity and may contain large portions of non-native plants and animals (e.g. agricultural landscapes). These areas were deemed unlikely to return to their 'natural' state due persistent and long-term anthropogenic pressure.

Based on the detailed vegetation map developed by Golder (2015a) the cultivated, mining/extraction and settled/urban mapping units were classified as 'modified' habitat in terms of (IFC PS6, 2012). All other vegetation communities were classified as 'natural' habitat – refer to Figure 63. Modified habitat associated with urban areas is strongly linked to the main transport routes, while cultivated fields are located throughout the area.

6.2.3 Biodiversity Value of Vegetation Communities

The biodiversity value of vegetation communities that are likely to be affected by the proposed CTT project, as per Golder (2017), are listed in Table 23.

Table 23: Biodiversity value of vegetation communities affected by the proposed CTT project

Vegetation Formations (Primary Class)	Modified/Natural Habitat	Biodiversity Value
Open and Closed Woodland	Natural	Medium
Low Thicket	Natural	Medium-high
Tall Forest/Tall Thicket	Natural	High
Wetlands (Permanent and Seasonal, incl. rivers and pans)	Natural	High
Urban	Modified	Low
Cultivation	Modified	Low
Source: Golder (2017)		

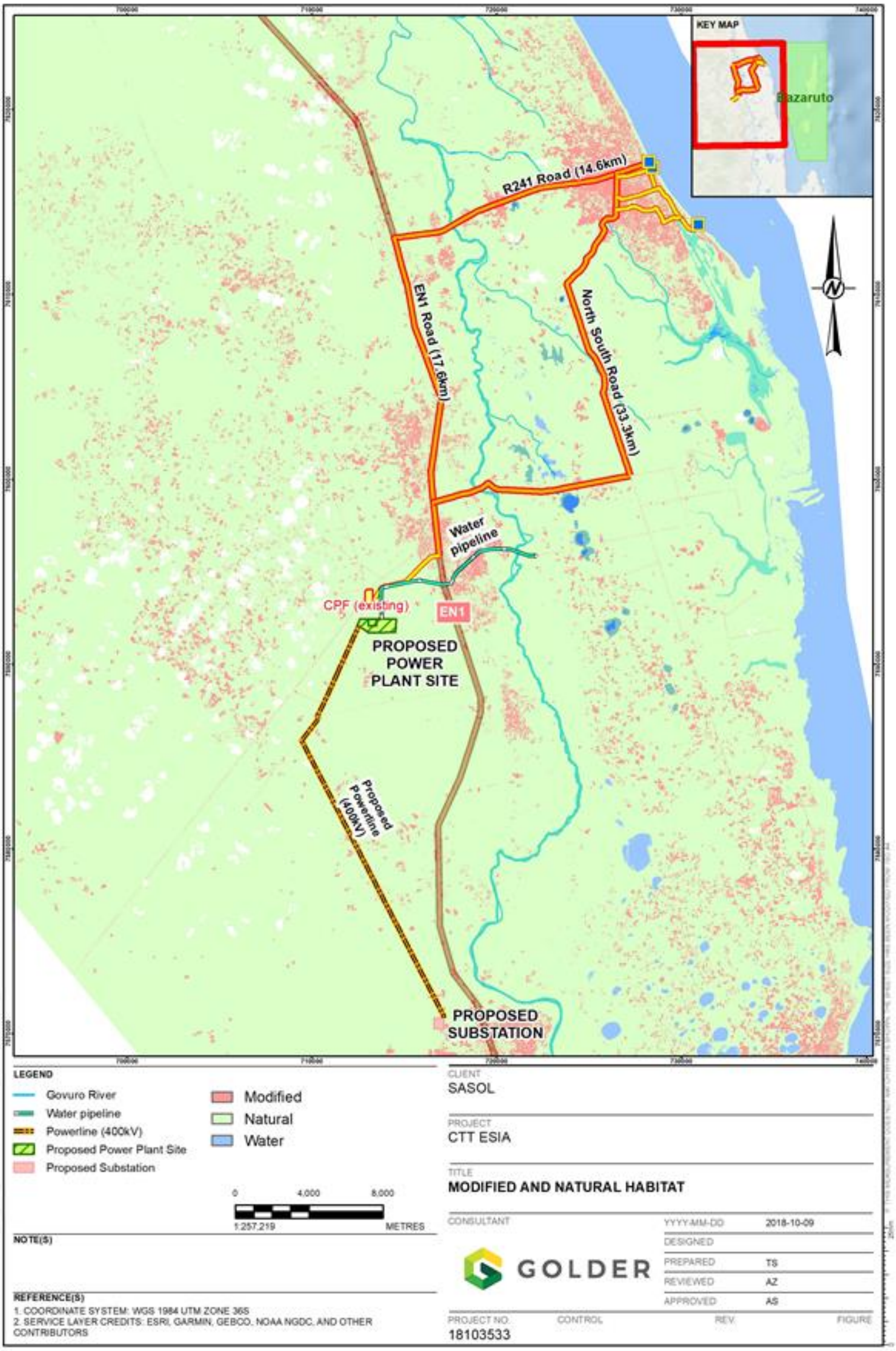


Figure 64: Delineation of natural and modified habitat

6.2.4 Identification of Critical Habitat

According to the IFC guidelines for 'Biodiversity Conservation and Sustainable Management of Living Natural Resources (IUCN Performance Standard 6), Critical Habitats are areas with high biodiversity value (IFC PS6, 2012), including:

- Habitat or significant importance to Critically Endangered and/or Endangered species;
- Habitat of significant importance to endemic and/or restricted-range species;
- Habitat supporting globally significant concentrations or migratory species and/or congregatory species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

During the critical habitat screening conducted for the regional biodiversity studies, two areas were identified as potential critical habitat in the broader region (Golder, 2017). These are discussed in more detail below, with Figure 65 showing their location in relation to proposed project infrastructure:

- The **Govuro River Floodplain Critical Habitat** was identified in the study area in 2015 by ERM and confirmed by further field assessment in 2016 (Golder, 2017). This area of 71 ha consists of about 47 colonies of approximately 550 critically endangered cycads -*Encephalartos ferox* subsp. *emersus* (Golder, 2017). The Govuro River Floodplain Critical Habitat is located close to the mouth of the Govuro River well to the north of proposed project infrastructure (also shown in Figure 65), and therefore will also not be impacted by the proposed project; and
- The second area that was initially proposed as potential critical habitat by De Castro and Brits (2014) is referred to as the **Nhangonzo Critical Habitat.** It is located to the east of the intersection of the proposed route of the North-South Road and Shortcut Road (shown in Figure 65). It was first identified in 2014 during the field work for the PSA Development and LPG Project EIA based on a number of key characteristics on which the assessment of critical habitat is based (Golder, 2017). Additional field work was conducted by EOH for the PSA and LPG Project EIA in 2015, which focused on the Nhangonzo area and confirmed its critical habitat status as 'provisional'. However, a reassessment of all data was conducted for an Area Categorisation study by Impacto in 2018 and is ongoing. This study has determined that most (over 85%) of the Nhangonzo area that was provisionally described as critical habitat does not qualify as critical habitat, in terms of IFC PS6 (2012) (Impacto, unpublished). Rather, the Area Categorisation study indicated that only 64 ha of Coastal Dune Thicket/Forest occurring in a narrow strip along the coastal foredunes and secondary dunes within the Nhangonzo area could be designated as critical habitat (Impacto, unpublished) (also shown in Figure 65).

Both the Govuro River Floodplain Critical Habitat and 64 ha of Coastal Dune Thicket/Forest in the Nhangonzo area are located outside of project infrastructure footprints, and therefore will not be impacted by the proposed project activities.

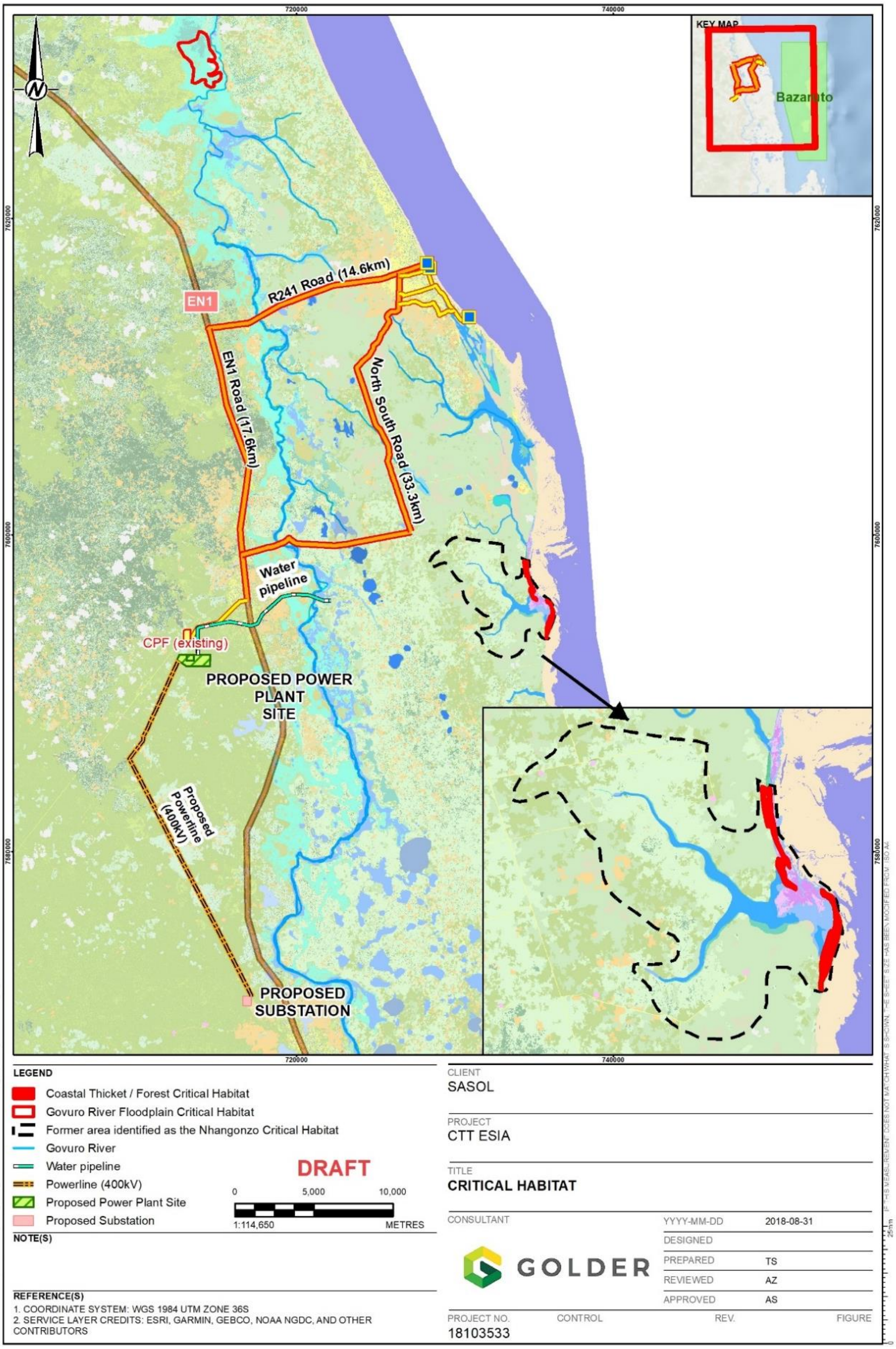


Figure 65: The Govuro River Floodplain Critical Habitat (cycads) (north) in relation to proposed project infrastructure and the potential Nhangonzo Critical Habitat

6.2.5 Habitat characteristics of Key infrastructure

6.2.5.1 CTT site, Powerline Corridor to Vilancous Substation

These infrastructure sites are located to the west of the Govuro River and fall within the Open and Closed Woodland, with scattered patches of Low Thicket. These habitats are considered to have medium- and medium-high biodiversity value respectively.

As part of demining activities, the CTT plant site was largely cleared of vegetation prior to the February 2015 field visit for purposes of facilitating safe access to the consultant. At the time, vegetation thus comprised only scattered large trees, isolated thickets associated with termitaria, as well as pioneer herbaceous regrowth throughout (Figure 66 and Figure 67). During the 2018 field survey it was evident that vegetation at the site is recovering, with significant regeneration of the herbaceous component (Figure 68 and Figure 69).

February 2015

Figure 66: Interior of the Power Plant Site

Figure 67: Access track adjacent to the Power Plant Site

June 2018

Figure 68: Interior of the Power Plant Site

Figure 69: Power Plant Site, note emergence of scattered woody plants

The proposed powerline route is 25 km long and traverses on a north-south orientation from the proposed Vilanculos substation site to the Power Plant site, through areas also comprising Open and Closed Woodland and patches of Low Thicket. Like the proposed Power Plant site, vegetation in the powerline corridor had been cleared during 2015 (Figure 70 and Figure 71), and as a result at the time of the 2015 field visit it was characterised by only emergent grasses and herbs, and a few woody plants. During the 2018 field survey, it was noted that vegetation had re-established substantially (Figure 72 and Figure 73).

February 2015

Figure 70: Cleared powerline corridor through woodland

Figure 71: Cleared powerline corridor through area thicket

June 2018

Figure 72: Relatively open powerline corridor, dominated by grasses

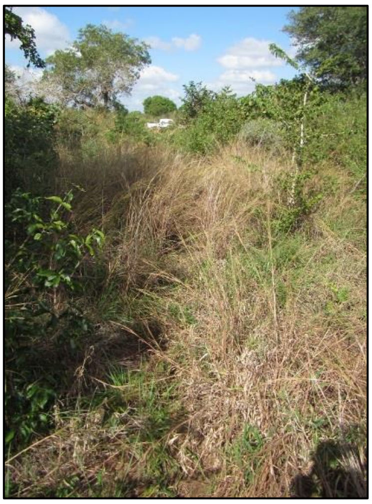


Figure 73: Densely re-vegetated portion of the powerline corridor (Note establishment of woody taxa)

6.2.5.2 Proposed Transportation Route Alternatives to the CTT Site

The proposed vehicle access routes from the coast and Inhassoro inland to the Power Plant are all existing roads that are used extensively by people living in the region and travelling through it. Across the study area the EN1 traverses mostly through the Open and Closed Woodland and patches of Low Thicket vegetation communities (Figure 74). The density of human habitation along the road is high, particularly in the vicinity of Maimelane and Jofane villages. Land adjacent to the southern portion of the road (i.e. immediately north of the CPF entrance road) is heavily disturbed, with large areas transformed for farming and classified as cultivated. Non-transformed land along the road is mostly classified as Tall Mid-Dense to Closed Broad-leaved Woodland.

In terms of floristic composition and species dominance along the R241, the terrestrial vegetation adjacent to the road differs markedly on either side of the Govuro River. The land adjacent to the road along its entire length is heavily disturbed by current or historic cultivation, with only small patches of natural vegetation remaining. In the vicinity of Inhassoro, human habitation increases and the adjacent land is completely transformed. The R241 road crosses the Govuro River approximately 10 km west of from Inhassoro. Although at the bridge crossing, the river channel is relatively narrow, both immediately up and down stream of the bridge, the river is characterised by a broad, open floodplain comprising hydrophytic grasses, sedges and rushes (Figure 75). The Govuro River Floodplain is considered to have high biodiversity value and is therefore an important and sensitive habitat.

Figure 74: The EN1 in 2018

Figure 75: The double lane R241 Inhassoro road as it crosses the Govuro River in 2018

6.2.5.3 Alternative Route

The alternative transport route traverses through the Short Woodland and Thicket vegetation/habitat unit. Close to Inhassoro, the vegetation adjacent to the road is mostly transformed. Beyond the limits of the town, vegetation is less disturbed, although small scattered patches of cultivation were noted. The vehicle track crosses a dry ephemeral drainage line, which drains into an adjacent inland depression/pan. The drainage line is grass dominated and fringed by *Julbernardia* and *Brachystegia* trees (Figure 76). The track also bypasses an inland depression/pan. Like the Govuro River, these wetland features are considered high biodiversity value, and are therefore both important and sensitive. The vehicle track also crosses the Govuro River at a point where the river is characterised by a broad floodplain, with a reed-dominated channel (Figure 77).

Figure 76: Vehicle track running through Julbernardia-Brachystegia Short Woodland (2018)

Figure 77: Vehicle track as it crosses the Govuro River (2018)

6.2.5.4 Proposed Beach Landing Sites

The three proposed beach landing sites are all located in the town of Inhassoro. The town is a small coastal settlement characterised by various commercial and administrative operations and residential houses.

The land surrounding the road access routes varies from being typical urban in the town itself, to more peri-urban and agricultural landscapes beyond the town confines. Similarly, the access corridors and approaches to all three beach landings sites are transformed.

6.2.6 Terrestrial Fauna

6.2.6.1 Mammals

Literature indicates that up to 109 terrestrial mammal species potentially occur in the region. Of these, 39 species were documented for the study area, with seven (7) being of conservation concern of which two (2) species have been documented on site (Table 24).

Table 24: Terrestrial mammal species of conservation concern recorded and potentially occurring in the study area

	Species Name	IUCN (2018-1)	Probability of Occurence
Dugongidae	Dugong (*Dugong dugon*)	Vulnerable	Possible
Hippopotamidae	Hippopotamus (*Hippopotamus amphibius*)	Vulnerable	Possible
Hipposideridae	Striped Leaf-nosed Bat (*Hipposideros vittatus*)	Near Threatened	Recorded
Felidae	Leopard (*Panthera pardus*)	Vulnerable	Unlikely
Pteropdidae	African Straw-coloured Fruit Bat (*Eidolon helvum*)	Near Threatened	Recorded
Mustelidae	Cape Clawless Otter (*Aonyx capensis*)	Near Threatened	Probable
Mantidae	Ground Pangolin (*Manis temminckii*)	Vulnerable	Unlikely
Source: Golder (2015a) and Golder (2017)			

6.2.6.2 Birds

There have been approximately 356 bird species recorded within the greater area of the site of which eleven (11) are of conservation concern with eight (8) recorded on site as outlined in Table 25 below.

Table 25: Birds of conservation concern recorded or potentially occurring in the study area

Family	Species Name	IUCN (2018-1)	Probability of Occurence
Accipitridae	White-backed Vulture (*Gyps africanus*)	Critically Endangered	Probable
	Hooded Vulture (*Necrosyrtes monachus*)	Critically Endangered	Recorded
	Martial Eagle (*Polemaetus bellicosus*)	Vulnerable	Recorded
	White-headed Vulture (*Trigonoceps occipitalis*)	Critically Endangered	Possible

Family	Species Name	IUCN (2018-1)	Probability of Occurence
	Crowned Eagle (*Stephanoaetus coronatus*)	Near Threatened	Recorded
	Bateleur (*Terathopius ecaudatus*)	Near Threatened	Recorded
Falconidae	Sooty Falcon (*Falco concolor*)	Vulnerable	Recorded
Phoenicopteridae	Lesser Flamingo (*Phoeniconaisas minor*)	Near Threatened	Recorded
Nectariniidae	Neergaard's Sunbird (*Cinnyris neergaardi*)	Near Threatened	Possible
	Plain-backed Sunbird (*Anthreptes reichenowi*)	Near Threatened	Recorded
Gruidae	Wattled Crane (*Bugeranus carunculatus*)	Vulnerable	Recorded

6.2.6.3 Herpetofauna (Reptiles and Amphibians)

Literature indicates that up to 89 reptile species and 40 amphibian species potentially occur in the study area. Of these, field surveys over the last five years documented 49 species of reptile and 27 species of amphibian. No terrestrial reptiles recorded or potentially occurring in the study area are of conservation concern. However, five marine turtles that are of conservation concern are known to occur off-shore (Table 26). Of amphibians previously documented for the study area, none are of conservation importance. It should be noted however, that the Giant Leaf-folding Frog (*Afrixalus fornasinii*) is a range restricted species.

Table 26: Marine reptiles of conservation concern potentially occurring off-shore

Family	Species Name	IUCN (2018-1)
Cheloniidae	Green turtle (*Chelonia mydas*)	Endangered
	Hawksbill Sea Turtle (*Eretmochelys imbricata*)	Critically Endangered
	Olive Ridley Turtle (*Lepidochelys olivacea*)	Vulnerable
	Loggerhead Turtle (*Caretta caretta*)	Vulnerable
Dermochelyidae	Leatherback Turtle (*Dermochelys coriacea*)	Vulnerable

6.2.7 Aquatic Ecosystems

The ecological attributes of the region surrounding the CTT project site and within the Inhassoro area (Northern Inhambane Province) have been comprehensively studied during baseline data gathering surveys to inform the assessment of potential impacts of their gas exploration and gas to power generation programmes.

Data from these studies span more than a decade and were used in conjunction with the findings of two targeted field surveys of the proposed CTT project conceptual layouts (conducted in 2015 and 2018) to inform the current assessment. These data were used to develop and update the baseline aquatic ecosystem characterisation for this impact assessment.

The scope of the aquatic ecosystem's assessment was focused around the Govuro River, which runs in a northerly direction parallel to the coast for approximately 185 km and is the only perennial river in the study area. The coastal plain catchment area is approximately 11,200 km^2 and has an average elevation of 80 masl (Mark Wood Consultants, 2001). The low-lying areas of the Govuro River valley are poorly drained and characterised by open woodlands with an herbaceous layer, comprising hygrophytic[3] grassland and grass and sedge marshes (Golder Report: 1302793-10712-12).

Baseline data gathered between 2015 and 2018 during the regional biodiversity sensitivity mapping and Regional ESIA conducted in June 2015 and December 2016 respectively, as well as the FSO Recon site visit conducted in September 2015, were consolidated into a full aquatic ecosystem dataset for the study area.

6.2.7.1 In-situ water quality

In situ water quality measurements (total dissolved solids [TDS], pH, dissolved oxygen and temperature) were determined on site as a component of the habitat and biotic surveys, and to determine if these were within range of historical values.

6.2.7.2 Habitat Assessment

Habitat availability and diversity are major attributes for the biota found in a specific ecosystem, and thus knowledge of the quality of habitats is important in an overall assessment of ecosystem health. Habitat assessment can be defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community. Both the quality and quantity of available habitat affect the structure and composition of resident biological communities. Habitat quality and availability play a critical role in the occurrence of aquatic biota. For this reason, habitat evaluation was conducted simultaneously with biological evaluations in order to facilitate the interpretation of results.

In addition to an index-based habitat (availability) characterisation, a general description of the habitat was conducted. This was aided by the use of underwater video, which has been used for both habitat descriptions and habitat preferences of fish. From the underwater video observations on the flow, substrate and linkages between these could be made.

6.2.7.3 Fish

The Study Area falls within the larger Zambezian Lowveld Freshwater Ecoregion. The Zambezian Lowveld exhibits a wide range of habitats and abundant aquatic diversity, with approximately 159 freshwater fish species present. The Govuro River system is considered to have high fish diversity (ERM, 2016), and is expected to have in excess of 60 species due to the interaction of the marine environment. Fifty-one (51) fish species have been identified in literature or have been sampled within the Govuro River system (Golder Report: 1302793-10712-12; ERM, 2016).

Ichthyofaunal samples were collected by means of electrofishing, netting and video. Electrofishing is the use of electricity to catch fish. The electricity is generated by a system whereby a high voltage potential is applied between two electrodes placed in the water. The responses of fish to electricity are determined largely by the type of electrical current and its wave form. These responses include avoidance,

[3] requiring an abundance of water

electrotaxis (forced swimming), electrotetanus (muscle contraction), electronarcosis (muscle relaxation or stunning) and death. Electrofishing is regarded as the most effective single method for sampling fish communities in wadeable streams.

During electrofishing variables such as conductivity, stream width, fish size, temperature, and operator experience have been shown to affect the capture efficiency in fish. The conductivity of the water affects the efficiency of sampling in two ways.

Firstly, under low conductivity (>100 µs/cm), the effective area of the electrical field is limited by the increased resistance of the water and the corresponding decrease in electrical current. As a result, the electrical field is confined to the area immediately surrounding the electrode. Secondly, water with a high conductivity has less resistance than that of the fish, and as a result the current tends to 'flow' around or have little to no effect on the fish. The Smith-Root LR24 is rated for a conductivity range of 10 – 1,500 µs/cm (www.smith-root.com). As a result of the conductivity and the depth of the Govuro River, electrofishing was not considered the best method of fish capture. Various netting techniques yielded higher diversity.

No endemic or restricted-range fish species were recorded during these surveys; however, four species of conservation concern were confirmed within the Project Area. The most noteworthy species was the Painted-fin Goby, *Oligolepis acutipennis* (Data Deficient, IUCN), located in close proximity to the Govuro Estuary (ERM, 2016). The Mozambique Tilapia (*Oreochromis mossambicus)* is under serious threat from hybridization with the rapidly spreading introduced species *O. niloticus* (Nile tilapia) (IUCN, 2017). Oxeye tarpon (*Megalops cyprinoides*), is currently listed as Data deficient (DD), and was confirmed in the PSA area in 2014 and 2018, where it is found in the Govuro River system. The Leopard Stingray (*Himantura uarnak*), which is listed as vulnerable by the IUCN was recorded in a fisherman's catch in the Govuro Estuary at a fishing camp in February 2016 (ERM, 2016).

Both the Near Threatened (NT) Bull Shark (*Carcharhinus leucas*), and the Critically Endangered (CR) Smalltooth Sawfin (*Pristis microdon*), may potentially occur within the Project Area. Both are marine species, and as such are not expected in the shallower waters of the Govuro River and its tributaries on a frequent basis. Neither have been recorded during surveys to date.

Included in the expected species list are several estuarine or marine species, such as the Oxeye Tarpon (*Megalops cyprinoides*), Round Moony *(Monodactylus argenteus)*, Butterfly Fish (*Chaetodon sp*.), Rock Flagtail (*Kuhlia rupestris*), Longspine Glassy *(Ambassis producta),* Riverbream *(Acanthopagrus berda),* Flathead Mullet *(Mugil cephalus)* and Largescale Mullet (*Liza macrolepis*). The presence of these species indicates the long reach of these species into the Govuro River as well as the salinity.

Further to this the African Lungfish (*Protopterus annecten*) and various killifish (*Nothobranchius sp*.) are known to be present within non-perennial waterbodies west of the Govuro River. Both of these species have been previously collected in the Study Area by Golder in 2016, and by Rob Palmer (ERM, 2016). Both the African Lungfish (*Protopterus annectens*) and Killifish species (*Nothobranchius sp.*) live in isolated temporary pan systems and have an inactive phase of several months.

Lungfish form a cocoon in the mud, whilst killifish eggs lie dormant but viable in the dry bed of the pan. As a result, disturbance of even dry depressions can have an impact on these species.

Of the 52 fish species expected to occur in the sample area:

- Fourteen (14) have not yet been evaluated against the IUCN criteria;
- Thirty-two (32) are currently listed as Least Concern (LC). Species in this category are widespread and abundant;

- Two (2) species, the Oxeye tarpon (*Megalops cyprinoides*) and Painted-fin Goby (*Oligolepis acutipennis)* are currently listed as Data deficient (DD);
- One (1) species, the Leopard Stingray *(Himantura uarnak)* is currently listed as Vulnerable (VU);
- Two (2) species are listed as Near Threatened (NT):
  - *Oreochromis mossambicus*- Mozambique tilapia is currently listed as Near Threatened (NT). A species in listed as NT when it does not currently qualify for Critically Endangered, Endangered or Vulnerable status, but is close to qualifying for or is likely to qualify for a threatened category in the near future; and
  - *Carcharhinus leucas* – Bull shark, is currently listed as Near Threatened (NT); and
- One species (*Pristis microdon*- Smalltooth sawfish) is currently listed as Critically Endangered (CR).

The most serious threat facing *O. mossambicus* is hybridization with the rapidly spreading introduced species *Oreochromis niloticus* (Nile tilapia). Hybridization has already been documented throughout the northern part of the species' range, with most of the evidence coming from the Limpopo River catchment. Given the rapid spread of *O. niloticus* it is anticipated that *O. mossambicus* will qualify as threatened under Criterion A due to rapid population decline through hybridization. Species in this category (Criterion A) have been highlighted as taxa that have undergone a significant decline in the near past or are projected to experience a significant decline in the near future. It should be noted that *O. niloticus* are freely available in Vilankulo and used in small scale aquaculture ventures.

Both *Carcharhinus leucas* (Bull Shark) and *Pristis microdon* (Smalltooth Sawfish) are marine species and as such are not expected to be resident in the shallower waters of the Govuro River and its tributaries within the Study Area. Leopard Stingray *(Himantura uarnak)* was observed at the Govuro River mouth during the 2016 field surveys.

6.2.7.4 Diatoms

Diatoms are a unicellular algal group widely used as indicators of river health as they provide a rapid response to specific physico-chemical conditions in the water and are often the first indication of environmental change. Benthic diatoms are present in all-natural watercourses and because of their microscopic nature, are generally not limited by available habitat. Research has provided a good record of diatom species and their water quality tolerances, making them useful for inferring integrated water quality conditions and river health classes. Diatoms are also useful for determining historical water quality conditions as their silica frustules (shells) remain behind once they die, leaving a record of past conditions.

6.2.7.5 Water Quality

In situ water quality measurements (total dissolved solids [TDS], pH, dissolved oxygen and temperature) collected in June 2018 were comparable to those collected in February 2015 with the exception of temperature and dissolved oxygen, which were marginally below the summer mean. This was expected as the survey was conducted in different seasons, and dissolved oxygen is related to water temperature.

As with the historical data collected, the concentration of TDS showed an increase in a downstream direction along the Govuro River and was considered ‘freshwater’. Even with the increased concentrations recorded in the Govuro River, TDS doesn’t appear to be limiting the presence of aquatic biota, but rather was a driver (function of salinity) of the diversity observed, which included a number of marine migrants.

Although dissolved oxygen concentrations showed fluctuations between sites, the scale of fluctuation was not of concern and was likely driven by water temperatures and the large amount of vegetation and detritus present within the channel.

The water quality was indicative of a *fairly natural state* with relatively low concentrations of most water quality parameters assessed. Most inorganic parameters were within guideline limits, the trace metals present were compliant with Mozambican effluent/discharge standards and the pH of the water was within the acceptable guidelines and can be described as slightly basic. The nutrient (nitrate and ortho-phosphate) concentrations in the river were low. However, salinity levels were elevated and increased along the river towards the lower reaches. The presence of naphthalene detected between 2014 and 2015 in the Govuro River was found to no longer be present in 2018 (Golder Report: 1405502-13410-9).

Habitat Assessment

The Govuro River system consists of the flowing river (aquatic) and the associated floodplain (riparian). The Govuro River channel is dominated by emergent vegetation comprising *Phragmites australis* (Common Reed) and *Nymphaea sp*. (Water Lily) (Figure 78). Figure 79 shows how the margins of the channel are dominated by detritus and submerged lilies. Organic debris not only provides a variety of structure, but also contributes to the transfer of nutrients within the system, being an allochthonous[4] source of food.

The centre of the channel is typically open water, with a sand and fine gravel substrate (Figure 78). Although a few rocks were observed, no rapid or riffle habitats were noted or sampled. These attributes resulted in two main hydraulic units being present, Slow Shallow (SS) and Slow Deep (SD). Backwaters along the edges of the floodplain are seasonally-inundated and with emergent vegetation create favourable habitat for smaller fish, fish fry, amphibians and other species. The riparian habitats consist mostly of inundated floodplain habitats. Riparian trees are scarce as the riverine zone rapidly merges into the terrestrial woodland system.

Figure 78: Govuro River Channel (GV-SW00)

Figure 79: Submerged Nymphaea sp. (Water Lily)

[4] denoting a deposit or formation that originated at a distance from its present position

During the June 2018 survey, large amounts of Kariba Weed *(Salvinia molesta)* were observed at site GV-SW00. This was the first time that large quantities of this invasive species were observed at this site (Figure 80).

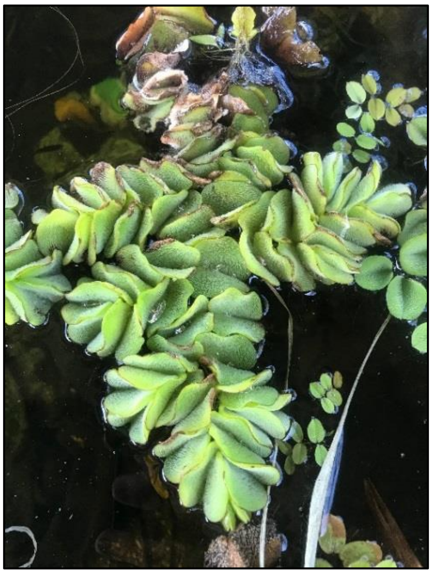


Figure 80: Kariba Weed (Salvinia molesta)

The riparian and aquatic habitats along the Govuro River are largely unmodified (falling within a habitat integrity class of Category A (natural) or B (near-natural)). Human use of the area for harvesting of reeds (*Phragmites sp.*) and saw grass (*Cladium mariscus*) has had limited impact and is currently considered to be at sustainable levels.

The intermediate habitat integrity results indicate that all the sites are largely unmodified and in a natural state, with the current anthropogenic impacts present being insignificant.

A general assessment of aquatic macroinvertebrates resulted in a rating of “fair” condition, due to the lower sensitivity scores of the abundant air-breathing taxa recorded at the sampled locations, which were dominated by vegetation in slow/shallow habitats and lack of rocky riffle type habitats. Furthermore, the tidal influence results in naturally high concentrations of salinity that are close to the upper tolerance limit for many freshwater species. The recorded freshwater macroinvertebrate fauna therefore comprises mainly hardy taxa that are generally unsuitable for monitoring environmental change.

Sampling of the floodplain and inland depressions during 2016 showed a high diversity and abundance of beetles and crustaceans respectively, with an overall moderately high diversity. The floodplain depressions were indicative of a stable system with high secondary productivity, while the inland depressions were considered unstable.

Zebra snail, *Neritina natalensis* was common in the vicinity of the proposed pipeline crossing. This species has a restricted distribution and is classified by the IUCN as Near Threatened. The species is easy to identify and collect and would be a good indicator species for purposes of long-term monitoring. *Septaria borbonica* (Neritidae), a small gastropod that was recorded on the stems of *Nymphaea nouchaii* within the Govuro River is listed as Endangered and should also be targeted for future monitoring programmes.

In addition to the standard sampling techniques utilised, underwater video was also used to observe fish in their natural habitat. The video footage was recorded to simply observe habitat preferences and gain insight into the underwater environment. Figure 81 to Figure 84 illustrate examples of fish recorded underwater. Figure 81 shows an *Oreochromis mossambicus* and a *Coptodon rendalli*. Figure 82 shows a large school of various *Enteromius* species (>100 individuals), while only 53 individuals were captured at all sites using different sampling techniques. Taking the sampling conditions into account, this video footage confirms that there is a larger fish population than what was sampled.

Figure 83 shows a school of *Kuhlia rupestris.* Figure 84 shows an *Enteromius trimaculatus* swimming through a school of *O. mossambicus*.

Figure 81: Oreochromis mossambicus and a Coptodon rendalli

Figure 82: Various Enteromius species

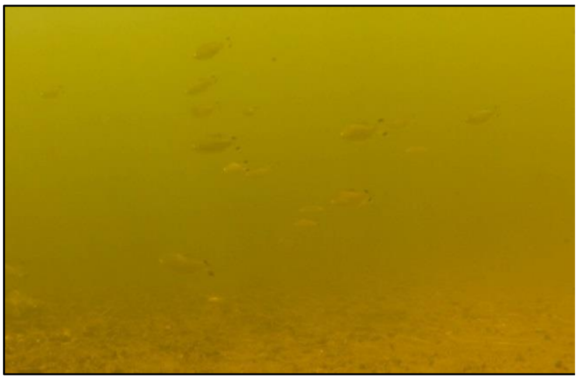


Figure 83: Rock Flagtails (Kuhlia rupestris)

Figure 84: Oreochromis mossambicus and Enteromius trimaculatus

Fish assemblages characterised by a continuous salinity gradient are very diverse and comprise of marine, estuarine, freshwater and migrating species; as one would expect in a system such as the Govuro River, the species recorded to date have had a bias towards marine species.

In general, all the fish sampled were considered healthy and free from parasites. Based on the observations made during the February 2015 and June 2018 surveys, the fish population appears healthy. Several diatom samples were collected during the November 2015 survey indicated a Specific Pollution Index (SPI) Score of 16.4, which was rated as Good (Category B). No indicators of anthropogenic impact were observed. No deformities in diatom valve structure were noted, reflecting metal toxicity was absent or below detection limits. The beach and near shore are utilised by local fishermen who pull seine nets commercially and collect sand worms as a source of bait. Depending on the season, fishermen can be observed pulling up large seine nets onto the beach, with a non-selective variety of fish.

6.2.8 Ecosystem Services

Ecosystem services are the benefits that people and/or a project (the beneficiaries) obtain from ecosystems. The term encompasses all the natural products and processes that contribute directly and indirectly to human well-being, as well as the personal and social enjoyment derived from nature (IFC 2012). The benefits gained can either be physical or psychological, and can be obtained actively or passively, directly or indirectly.

Ecosystem services include goods or products obtained from ecosystems (provisioning services) such as fresh water, wild foods and timber; control of natural processes (regulating services), such as flood control, erosion protection and climate regulation; and social, non-material benefits (cultural services) such as spiritual values, and recreational and aesthetic enjoyment. These services are underpinned by natural processes (supporting services), such as nutrient cycling, habitat provision and primary production.

The Inhassoro region has a relatively large human population. Several established urban centres are present, including the town of Inhassoro and various large villages (e.g. Jofane, Maimelane) that straddle the main EN1 arterial road. There are also numerous other smaller villages and homesteads scattered throughout the region.

Local people, particularly those living in more remote rural locations are expected to rely heavily on natural resources to meet their daily livelihood requirements.

6.2.8.1 Biomass Fuel - Fire Wood and Charcoal Production

The region has a limited electricity distribution network, and as a result woody biomass is used as a common form of energy. Numerous tree species are felled by locals and used as firewood or to produce charcoal. Tree feeling for biomass fuel occurs in all woodland habitat units in the region. Subsistence firewood collecting does not necessarily have a negative impact on vegetation, as dead wood is often gathered. However, the commercial sale charcoal and firewood relies on the harvesting of live trees, and this will lead to significant woodland habitat loss.

6.2.8.2 Raw Materials

The use of various plant materials for building huts, granaries, livestock pens and various other rural infrastructure is common throughout the region, and one of the main forms of ecosystem goods. The use of non-biological material was also noted during the field inspection. Common materials included rocks and sand that are sold for use as building material.

6.2.8.3 Livestock Husbandry

Despite the abundance of available rangeland for grazing, domestic livestock numbers in the study area do not appear to be large. The keeping of poultry seems to be more common in the study area, with numerous chickens observed.

6.2.8.4 Food

Various crops are grown on both a subsistence and commercial basis. Subsistence farming is by far the most common form of agriculture and features prominently throughout the area. Maize and cassava are common crop plants and are sometime grown together. Depending on productivity, each plot is cultivated for a few years (sometimes up to four) before being abandoned in favour of a new plot. Several forms of fresh produce were observed for sale at a road side stall including mangos, Marula[5] fruits, pumpkins, paw paws, chilli peppers and nuts which would be typically grown in homestead gardens. Fishing in the Govuro River and the barrier lakes is common in the study area and an important means of obtaining protein.

6.2.8.5 Fresh Water

The Govuro River is the major drainage feature in the region, and as such, it is of considerable importance as a source of water. The lower reaches of the river are significantly influenced by tidal fluctuations and are probably too saline for use as drinking water. It is anticipated that water further upstream is probably far less saline and can be used by local people for fresh drinking water.

[5] *Sclerocarya birrea* subsp. *caffra*

This notwithstanding, along much of its reach, the river is used for other purposes, such as bathing and clothes washing. The numerous barrier lakes in the study area are also frequently used for such purposes. Water hand pumps have been installed at strategic points throughout the study area Figure 86). Many villages and local people use these as the primary source of fresh water. They are thus critically important to the livelihoods of local people.

Figure 85: The Govuro River is a much used source of water for drinking, cooking, clothes washing and bathing

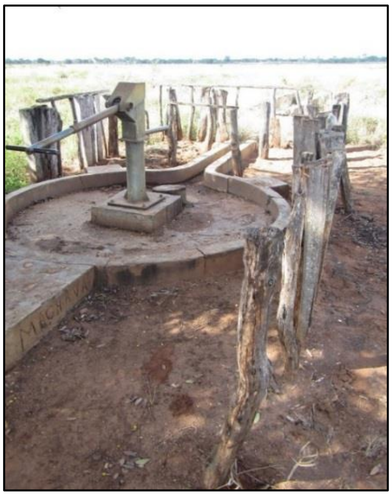


Figure 86: Hand pumps have been installed close to some villages to provide drinking water to local people

6.2.8.6 Regulating Services

The sandy soils of the woodland areas facilitate aquifer recharge while the vegetated riparian areas (*viz.* reed and sedge beds) contribute to reducing flooding frequencies and assist with partial water purification. Lastly, bees are important pollination agents and as such the subsistence agricultural practices strongly rely on the local bee population.

6.2.9 Marine and Coastal Environment

The Mozambican coastline is characterised by a wide diversity of habitats including sandy beaches, sand dunes, coral reefs, estuaries, bays, seagrass beds and mangrove forests, which in parts support pristine ecosystems, high biological diversity, high endemism, and endangered species (Pereira *et al.,* 2014). The following sections describe known ecosystems and fauna within the Study Area in terms of distribution, conservation status, and existing pressures/drivers of change.

Data on marine and coastal oceanography in the Study Area was provided by the proponent, consisting of text and figures extracted from relevant sections of the Sasol Offshore Block 16 & 19 Exploration ESIA conducted by ERM (2006) with additional studies commissioned in 2008. These data are reproduced without modification in the subsections that follow.

6.2.9.1 Bathymetry

Bazaruto Bay and the adjacent marine area to the north is a typical nearshore shallow water system with an average water depth of approximately 10 m. Two distinct basins can be identified in this bay, one located in the northern end, just north of Santa Carolina Island and another located in the middle section of the bay, in-between the Bazaruto and Benguerua Islands. The two basins are linked by a series of channels, which are regarded as flood- and ebb-tide deltas. These two basins and associated channels comprise the deeper areas of the bay with a maximum depth for southern basin of 24 m and 33 m for the northern basin. The remaining southern section of the bay is comprised of vast areas of tidal flats that often dry out during spring low tides.

The northern basin which is the deepest area of the bay is also the main connection to the open sea. Depth contours in this basin are irregular with numerous reefs occurring throughout the basin. The area north of the bay, exhibits a regular depth gradient up to depths of 50 m, despite the regular occurrence of reefs in the region. From the 50 m isobath, there is a sharp increase in water depth. The 1,000 m isobath is located very close to the coast, approximately 25 miles off the coast.

6.2.9.2 Spatial and temporal variability of physio-chemical regime of water masses

The physio-chemical characteristics of the water masses of Bazaruto Bay and the adjacent nearshore area north of the Bay, exhibit spatial and temporal variability. In the dry season (May to October), the bay is characterised by water of marine nature. Salinity in this period varies between 35 to 36 PSU and there is little spatial gradient. In the rainy season, the bay is more estuarine, exhibiting greater salinity gradient and lower overall average salinity when compared to the dry season. In the rainy season, salinities levels varies between 35 and 33 PSU (Figure 87).

In the early rainy season (November to December), water with a very high salinity (37 to 40 PSU) occur in the nearshore area north of the bay, in the vicinity of the Govuro River mouth. This phenomenon is only temporary. It is in the late rainy season that most spatial variability of salinity is observed. A stable salinity gradient is observed throughout the rainy season in the bay, with the lowest salinities being observed in the western side of the bay and the highest in the east (Figure 87). While the western side tends to be more estuarine showing larger temporal variability, the eastern side has more marine nature, varying little in its physic-chemical nature.

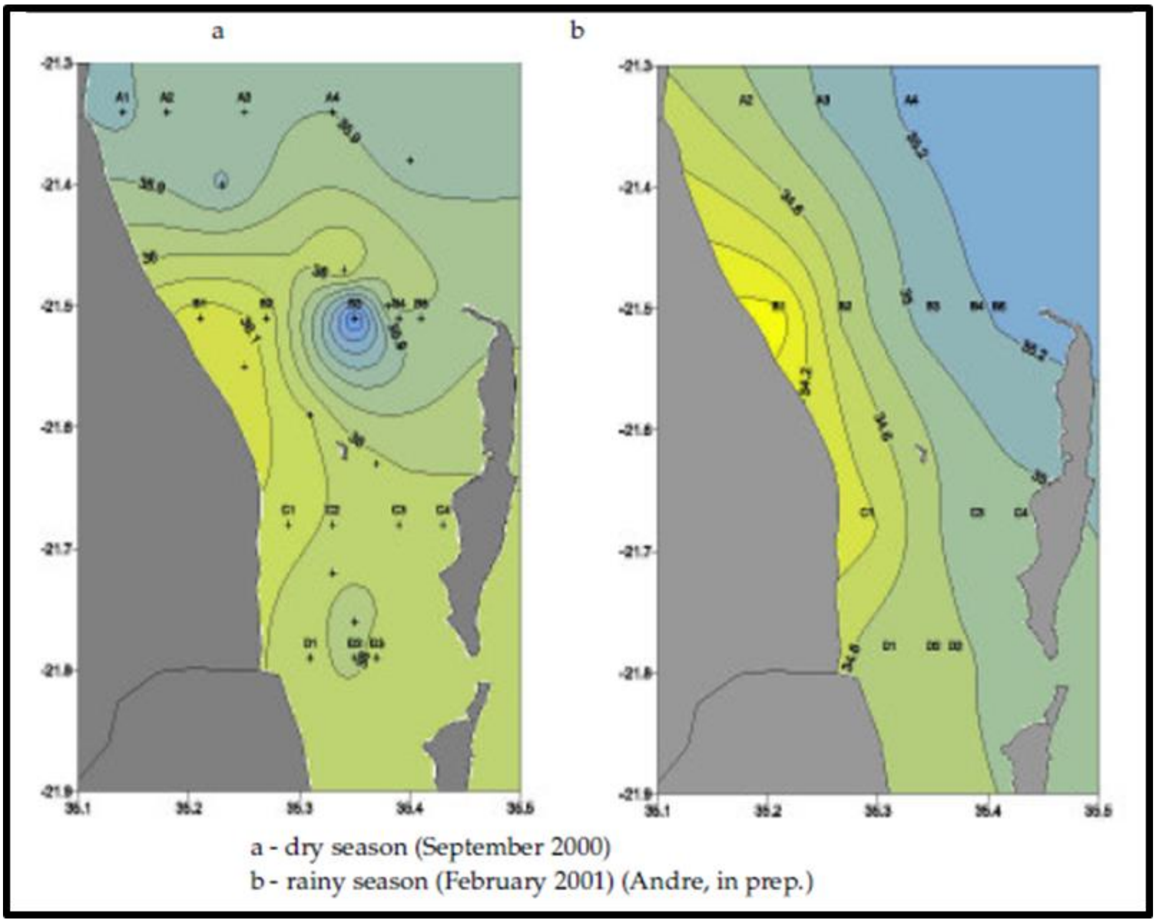


Figure 87: Spatial distribution of surface salinity in two distinct seasons (ERM, 2017)

6.2.9.3 Water Circulation

Distinct circulation patterns are recognised for the shelf, open ocean and Bazaruto Bay. The circulation of the open ocean adjacent to the Bazaruto Archipelago is governed by the Mozambique Channel circulation system which is comprised of a series of intermittent large-scale eddies drifting southward (see Figure 88). Surface currents associated with this circulation system are known to flow southward throughout the year, with flow speed varying with seasons. According to Admiralty (1995), this current is predominantly southwards and is strongest in summer (October to February), attaining speeds of up to 2 m during this period and 1.3 m at other times during the year.

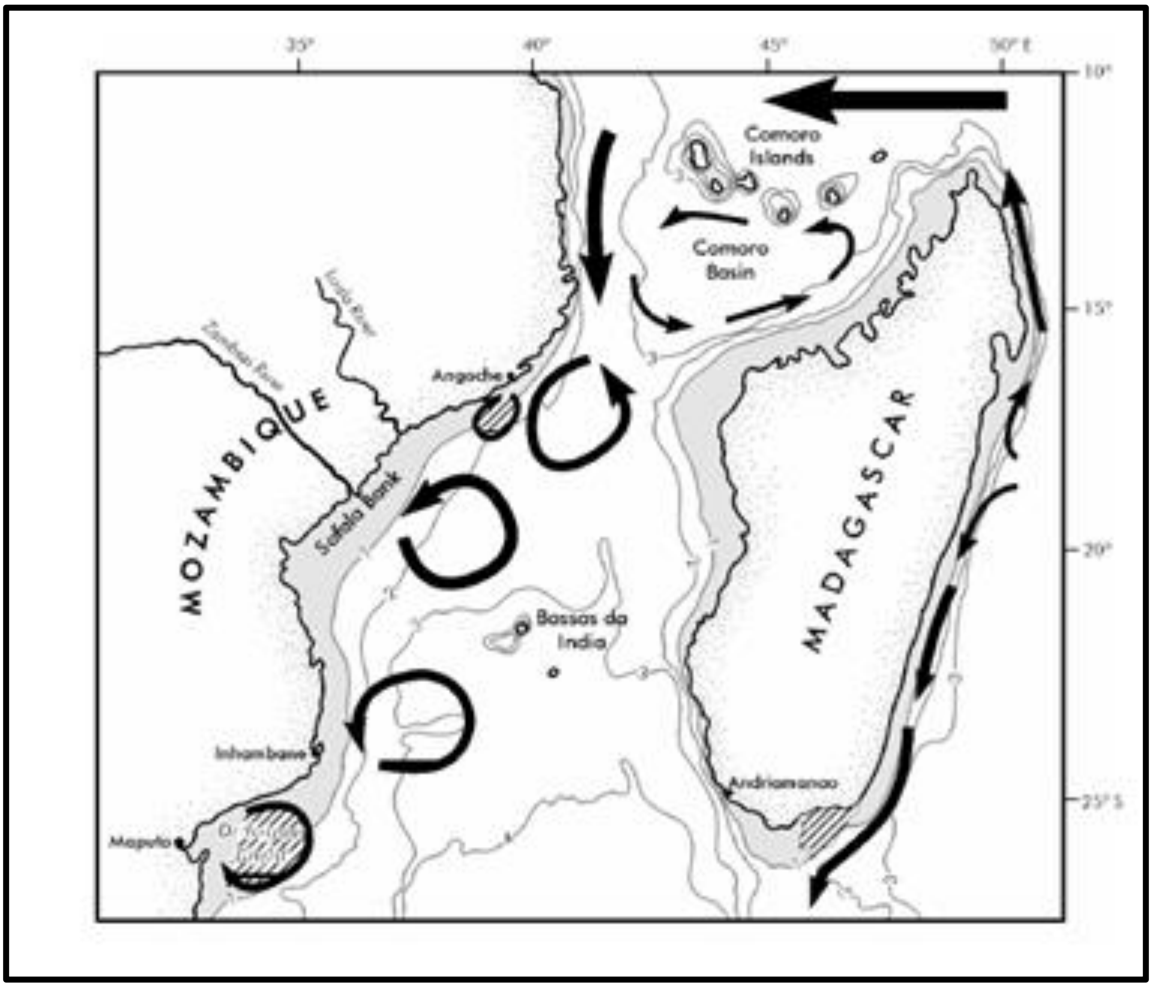


Figure 88: Bathymetry of the Mozambique Channel and the continental shelf off Madagascar in km (after Simpson 1974) with the major circulatory features indicated (Shaded areas are shallower than 1 km; hatched areas denote upwelling (after Lutjeharms, 2007))

The shelve circulation is considered to be a direct result of the Mozambique circulation (Lutjeharms, 2007). The average drift patterns at the sea surface, nevertheless, indicate a strong movement poleward along the eastern shelf of Mozambique (Saetre, 1985). This is also supported by recent salinity distribution map data for the region south of the Sofala bank, just north of Bazaruto, were salinity cells drifting southward are evident (Figure 87).

However, for the inshore region of Bazaruto Archipelago, currents are known to be highly variable in both speed and direction and are wave-driven and consistent with the wave patterns of this region. In the bay, the main feature of circulation is the occurrence of strong tidal currents that drive water into the bay during the flood phase of the dies and move water out the bay during the ebb tide (Figure 88).

The offshore region is dominated by the Mozambique current comprising a number of large-scale eddies (Saetre and Jorge da Silva, 1984). The surface currents in the offshore region flow southwards throughout the year (>50% occurrence at an average speed of approximately 0.6 m) with slightly stronger southwards flows occurring in the November to April period compared to the May to October period (Saetre, 1985). Notes on the Admiralty predominantly southwards and is strongest ins summer (October to February), attaining speeds of up to 2 m during this period and 1.3 m at other times during the year. Within the archipelago the water temperature ranges from 23°C in winter to 28°C in summer.

The tides are semi-diurnal. The open littoral of the Bazaruto Archipelago experiences low and high tides some 40 minutes ahead of Durban while the tides on the inner bay (north-eastern Bazaruto) are lagged and coincide more or less with those at Durban (Dutton and Zolho, 1990). The mean spring tidal range is approximately 3 m during normal spring tides, increasing to approximately 4.4 m during equinoctial spring tides (measured at 4.39 m during the equinox of 9 March 1989). The tidal range at spring high tide produces strong tidal currents in the channels between the islands that have transported vast quantities of sand to form extensive flood- and ebb tide deltas. These strong tidal flows also maintain the deep channels on the landward side of the islands and transport sand across the tidal flats.

The offshore wave patterns are dominated by waves from a south-easterly sector. These observations are based on Voluntary Observing Ship swell observations in a block 21°30’-22°30’S; 35° – 36°E) and for the period 1968 to 1998. The highest waves are observed to come from the south during summer. The local wind-driven waves, like the local winds, are from the southeast sector.

6.2.9.4 Water Quality

Physicochemical surveys of water quality in Bazaruto Bay were carried out in November-December 2015 for the EIA process for the Sasol Pipeline and offshore Floating, Storage and Offloading unit (FSO) Project (ERM, 2016). Results of these surveys relevant to the current Study Area are presented in the following sections.

Water Column Characteristics

Offshore water within the Study Area was found to be well mixed, as expected for an open coastal region. Water temperatures averaged 26.6°C and an average salinity of 35.2 PSU throughout the water column was recorded. Turbidity values of <0.6 NTU were recorded, which compare well to the turbidity values collected from the water samples at comparative depths (all <1 NTU). These values are very low and represent clear water, also indicated by the high photosynthetic active radiation (PAR) values with depth. The 1 percent level of the incident light at the surface, which is the lowest light level required for photosynthesis to occur, reached the bottom of the water column, indicating a well-mixed, clear water column. The mean pH of all sites at the three depths was 8.14 which agrees with the accepted average pH of the global surface ocean of 8.1.

Heavy Metal Content

Heavy metal analysis was conducted on the water samples collected at three depths (surface, mid and bottom). Measured concentrations were compared to environmental quality targets (EQTs) recommended for coastal waters in the region (UNEP/CSIR 2009). Heavy metals were generally present in the offshore water column in low concentrations, with most not exceeding the recommended EQTs. Cadmium, chromium and mercury were below the detection level of the analyses (<1 µg/l) at all sites, and majority of the remaining metals were present at natural levels, as is expected for a well-mixed offshore region, with relatively little anthropogenic impact. The concentration of copper and lead were the only exceptions, where the EQTs were exceeded at selected depths at several sites.

Dissolved Organic Carbon

Dissolved organic carbon (DOC, a direct estimate of labile organic matter in the water column and thus a proxy for estimating BOD and COD) concentrations were generally found to be low in the area surrounding the proposed FSO location, with concentrations being below detection limits at majority of the sites.

Oil and Grease

In the absence of natural seeps, the concentrations of oil and grease can be considered gross indicators of hydrocarbon pollution in the water body. Typical sources of offshore oil and grease include spills and pollution from ships/tankers and spills from offshore platforms and pipelines. Concentrations in the collected water samples showed that levels varied both spatially and with depth. The concentrations range from <3 mg/l (detection level of the analysis) to a maximum of 45 mg/l at the bottom depth of the FSO site. It was not possible to determine the source(s) of the observed elevated concentrations from the survey data.

Nutrients

Concentrations of total Kjeldahl nitrogen, nitrate, nitrite and phosphorus were found to be below the detection limit of the analyses used at all depths at all sites. The low values of these nutrients in the area could act as a limiting factor for the growth of phytoplankton.

Hydrocarbons and Aromatic Compounds

Both the total petroleum hydrocarbons and polyaromatic hydrocarbons were found to be below the detection levels of the analyses at all sites. This is expected for a well flushed area that is not close to any sources of anthropogenic contamination.

Low concentrations of naphthalene were detected in marine sediment samples. Concentrations at all measuring points were below the screening levels for significant human or ecological impact. Without a longer dataset the possible source is uncertain. Further research into activities in the upstream catchment would be necessary in order to establish a source.

6.2.9.5 Marine and Coastal Ecosystems

The Mozambican coastline can broadly be classified into three ecoregions from north to south, each supporting a variety of marine ecosystems; 1) the coral coast, 2) swamps and 3) parabolic coastal dunes (Spalding *et al.,* 2007). The Study Area is largely occupied by Bazaruto Bay, which is located within an area of overlap between the coral, swamp and parabolic coastal dune systems known as the Delagoa Bioregion (Figure 89) and includes aspects of each.

Bazaruto Bay is sheltered from high energy wave action by the Bazaruto Archipelago and Cabo São Sebastião, conditions which have supported the development of sandy tidal flats and associated seagrass meadows. The sea-ward side of the Bazaruto Archipelago is characterised by parabolic dune systems, consisting of steep and tall (up to 120 m) vegetated dunes, often backed by salt lakes and closed salt lagoons. Bazaruto Archipelago is a transitional ecosystem, where both tropical coral reef and submerged rocky reef occur offshore (Perreira *et al.,* 2014).

The specific ecosystems that are present within the Study Area are discussed in the sections that follow.

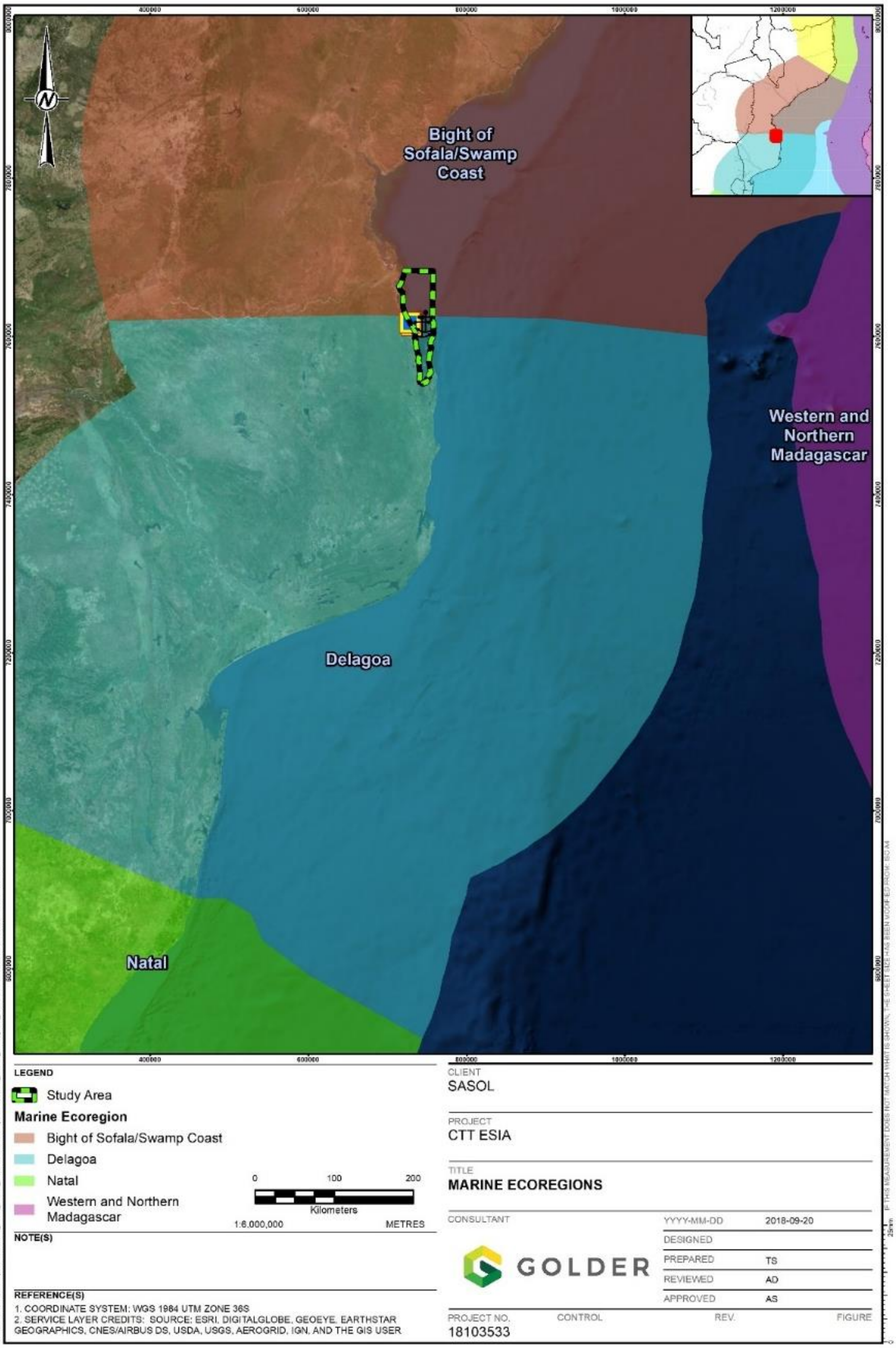


Figure 89: Marine ecoregions in the study area

Coral Reefs

Coral reef systems are distributed throughout the Study Area, the largest of which are located off the coast north of Inhassoro (Findlay *et al.,* 2006). The species diversity, extent and condition of the majority of these offshore and coastal reefs have not yet been studied; however Two-Mile reef off the south coast of Bazaruto Island has been monitored since 1999, as part of the CORDIO (Coral Reef Degradation in Indian Ocean) regional program to monitor coral condition and the impact of bleaching[6]. This reef is dominated by massive hard corals (mainly Porites and Faviids) followed by branching/tabular corals (Acropora) (Pereira *et al*., 2008). The most recent available monitoring results indicate that 16.7% of this reef was affected by bleaching which occurred during a widespread bleaching event in 2005 (Pereira *et al.,* 2008). No recent results to indicate whether the reef has recovered or further deteriorated since then were available at the time of writing. The condition of Two-Mile reef has been assessed as good (Findlay *et al*., 2006), despite pressures including increased populations of coral-feeding crown-of-thorns starfish (*Acanthaster planci*) and illegal fishing practises.

Seagrass Beds

In Bazaruto Bay, seagrass beds associated with the sand tidal flats typically occur in shallow and subsidiary waters of less than 5 m depth (Bandeira *et al.,* 2008). Within the Study Area, an extensive seagrass bed is located off the shoreline where beach landing sites Maritima and Seta are located (Guissamulo, 2006) Figure 90). Additional dense seagrass cover occurs 10 - 20 km north of Inhassoro, in an area approx. 10 km wide. Seagrass beds of much smaller extents are present in the near shore environment south from Inhassoro to Vilanculos, and along the western shore of Bazaruto Island. The most common seagrass species in the Study Area are *Halodule uninevis*, *Halophyla ovalis* and *Thalassondendron ciliatum* (Guissamulo, 2006).

The importance of seagrass beds in the Bazaruto Bay area is related to their importance as a food source for the populations of green turtle (*Chelonia mydas*) and dugong (*Dugong dugon*) that are resident in the area (Perreira *et al.,* 2014). The seagrass meadows of the tidal flats in Bazaruto Bay are known to support the largest remaining populations of dugong in the Western Indian Ocean (Findlay *et al.,* 2011; Perreira *et al*., 2014). In addition, seagrass meadows act as a shelter and nursing areas for several juvenile fish species and have importance as fishing grounds for the subsistence (artisanal) beach seine fisheries within the Study Area. Erosion of river systems that discharge into Bazaruto Bay as a result of damming and agricultural intensification are anticipated to increase sediment loading of waters, which could affect seagrass beds through smothering (Pereira *et al.* 2014).

[6] When corals are stressed by changes in conditions such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn completely white (National Oceanic and Atmospheric Administration, 2015).

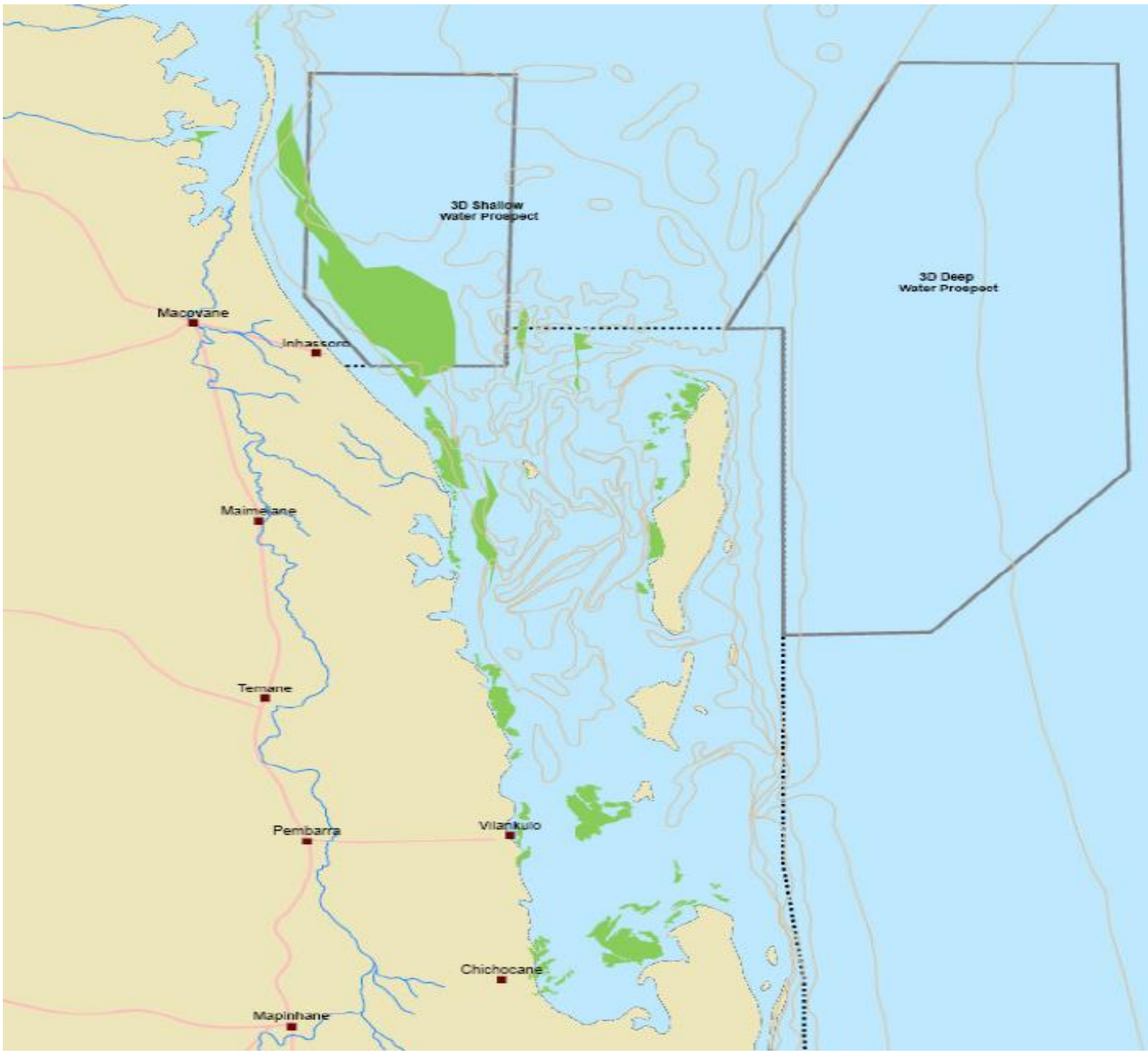


Figure 90: Seagrass beds (green areas) within Bazaruto Bay (Guissamulo, 2006)

Mangroves

Mozambique contains the second highest area of mangrove forest within the Western Indian Ocean (Spalding *et al*., 2007). Mangroves play an important role in the retention of marine sediment and stabilisation of coastlines (Perreira *et al.,* 2014). The sediments and sheltered waters of mangrove forests support a huge variety of invertebrates, phytoplankton, zooplankton, juvenile fish and shrimps (Perreira *et al.*, 2014) and therefore are crucial in support of higher-trophic level species such as birds and commercial fish species. They are particularly important during juvenile growth stages of commercial prawns that are harvested in open waters, as they provide a nutrient-rich environment and shelter from tides and predation for juvenile fish and marine invertebrates. Other ecosystem services provided by mangrove forests in Mozambique include supply of construction material and firewood.

Current pressures on Mozambican mangrove systems include clearance for agricultural purposes and salt extraction, harvest of accessible mangrove forests for firewood/charcoal production, accidental oil spills (Perreira *et al.,* 2014), and upstream dams (e.g. Cahora-Bassa dam) which reduce the flow of freshwater and associated nutrients to mangrove systems, resulting in their shrinkage (Bandeira *et al.,*2012).

Within the Study Area, mangroves are associated with river and stream mouths and concentrated in the Mangarelane area of the mainland, approximately 20 km south of the proposed beach landing sites (Findlay *et al.,* 2006). Five species are represented within the Study Area, including red mangrove (*Rhizophora mucronata*), see Figure 91 below, black mangrove (*Bruguiera gymnorrhiza*), Indian mangrove (*Ceriops tagal*), white mangrove (*Avicennia marina*), and *Sonneratia alba* (Findlay *et al.,* 2006).

Figure 91: Crab species in red mangrove, Mangarelane area (Golder Associates, 2015)

Primary Dunes and Sandy Beaches

Sandy beaches occur along most of the coast of the mainland between Cabo São Sebastião and Bartolomeu Dias Point and make up most of the east and west coasts of the islands of Bazaruto Archipelago (Findlay *et al.,* 2006). Sandy beaches are extensive within Bazaruto Bay, within which the Study Area lies. These beaches sometimes extend to form sand/mud banks and are backed by sparsely vegetated dunes. The dunes are subject to strong erosion pressure, both natural (wind/rain/sand accretion) and anthropogenic (unplanned development on dunes) in nature (Findlay *et al.,* 2006). Sandy beaches and dunes in this area have an important role as nesting habitat for marine turtles (Perreira *et al*., 2014).

6.2.9.6 Marine and Coastal Fauna

The Bazaruto Archipelago and its coastal waters is a marine protected area (MPA) and National Park, which supports the most viable dugong population in East Africa (UNEP, 2014) as well as turtles, dolphins and marlin. The proposed beach landing points are located north and south of Inhassoro town on the mainland coast, outside the National Park. The final selection of the anchorage point has not yet been made.

A description of the marine fauna expected to occur in the study area is provided in the following sections, using baseline studies previously completed for Sasol's seismic exploration area within which the Study Area lies, and available published and unpublished information.

Plankton

There are few data available for phytoplankton and zooplankton within the Study Area. In Mozambique the most phytoplankton-productive waters are found near the coast, due to the influence of river discharges and upwelling, while the warmer offshore waters support a lower plankton biomass (Perreira *et al*., 2014). The Inhassoro area experiences high nutrient loading due to outflows from the Save River where the sediment inputs cause elevated turbidity, thereby influencing primary production along the coast (Findlay *et al*., 2006). Therefore, the Study Area is likely to support productive planktonic communities due to the presence of river/estuarine systems.

The Delago marine ecoregion, within which the Study Area is located, is a transitional zone between the oligotrophic warm waters of the subtropics, and the more productive waters of the sub-Antarctic zone (Spalding *et al*., 2007). This mixing of waters results in an area of planktonic upwelling that is an important feeding ground for some migratory animals such as whales, whale shark (*Rhincodon typus*) and sea birds (Perreira *et al.,* 2014).

Invertebrates

There is limited available information on marine invertebrates of Mozambique, particularly species that are not harvested for commercial reasons. Most available information is focussed on molluscan fauna, many of which are harvested for food purposes or for their shells.

The invertebrate species discussed in the following sections have not yet been assessed by the IUCN Red List (IUCN, 2014); therefore, their conservation status is currently unknown.

Molluscs

Over 500 species of mollusc are known from the Bazaruto Archipelago alone (Everett *et al.,* 2008) six of which are endemic (Perreira *et al.,* 2014). Some species of marine mollusc on the Mozambique coast have important 'ecosystem engineer' roles. For example, giant triton (*Charonia tritonis*) is one of the few predators of crown-of-thorns starfish (*Acanthaster planci*). Giant triton is heavily exploited for sale as a souvenir; large-scale removal of giant triton can allow crown-of-thorns starfish to proliferate, which can result in coral reef collapse (Perreira *et al*., 2014). Other species such as sea slugs are thought to be very diverse but greatly understudied, with a recent study (Tibiriçá, 2013) contributing over 100 new records for Mozambique as well as a number of undescribed species.

Relevant coastal habitats within the Study Area that provide habitat for molluscan species include beaches, rocky intertidal areas and mangrove forests:

- Sandy beaches in the Bazaruto archipelago are inhabited by various gastropods capable of trapping water inside their shells to prevent dessication during low tide, such as the periwinkle species *Nodilittorina natalensis* and *Littoraria glabrata*, and the nerite (*Nerita plicata*) (Everett *et al.,* 2008);
- In rocky intertidal areas, species present include black rock oyster (*Crassostrea cuccullata*), grazing snail (*Planaxis sulcatus*), mussel (*Parviperna nucleus*), whelk (*Thais savignyi*), limpet (*Cellana capensis*) and the predatory black mulberry shell (*Morula granulata*) (Everett *et al*., 2008);
- Mangrove forest provides specialised habitat for several molluscan species, including mangrove creeper (*Cerithidea decollata*), mangrove periwinkle (*Littoraria scabra, Littoraria intermedia*), a creeping snail (*Terebralia palustris*), and oysters (*Crassostrea forskhalii*); and
- Six endemic species of gastropod (*Conus pennaceus, Epitonium pteroen, E. repandior, Fusiaphera eva, Thracia anchoralis, Limatula vermicola*) are known from the Bazaruto Archipelago (BirdLife International, 2018).

Crustaceans

Mangroves are particularly important as a nursery for juvenile stages of penaid prawn, including the Indian white prawn (*Fenneropenaeus indicus*) and brown prawn (*Metapenaeus monoceros*), prior to their migration to deep open waters. These species are crucial to the Mozambican prawn fishing industry, accounting for 90% of the total catch (Findlay *et al*., 2006). They have not yet been assessed by the IUCN Red List (IUCN, 2014) therefore their conservation status is unknown. Nursery habitat (mangroves) for these species is present within the Study Area.

Cephalopods

Although these are typically offshore species of deep waters, some cephalopod species may occur within the Study Area.

Deep channels near shore inside Bazaruto Archipelago provide habitat for some (normally deep-water dwelling) juvenile squid species including diamondback squid (*Thysanouteuthis rhombus*) and Indian squid (*Loligo duvauceli*), which are thought to be attracted to seagrass beds for feeding opportunities and shelter (Findlay *et al*., 2006). The cuttlefish *Sepia pharaonis* appears to be common in shallow waters, as it dominates the catches of the beach seine fishery in the coast of Vilankulo and Inhassoro district (Findlay *et al.,* 2006). The presence of these species in the Study Area was confirmed during the Golder site visit; squid and cuttlefish were brought ashore at Inhassoro from Bazaruto Bay by fishermen (Figure 92).

Figure 92: Squid and cuttlefish caught in Bazaruto Bay (Golder Associates Africa, February 2015)

6.2.9.7 Seahorses

There are at least 30 species of pipefish recorded in Mozambique, however it is likely that this number is underestimated (Perreira *et al*., 2014). Seahorses and pipefish are subject to overexploitation for souvenirs, traditional medicinal purposes, and the aquarium market (Perreira *et al*. 2014; Project Seahorse, 2003). CITES lists five species of seahorse in Mozambican waters as protected. These include Réunion seahorse (*Hippocampus borboniensis* – DD), giraffe seahorse (*Hippocampus camelopardalis* – DD), sea pony (*Hippocampus fuscus* – DD), spiny seahorse (*Hippocampus histrix* - VU), and spotted seahorse (*Hippocampus kuda* – VU). All of these species are associated with seagrass habitats (Aylesworth, 2014; Project Seahorse, 2003a, 2003b, 2003c; Wiswedel, 2012), therefore they could potentially occur within the Study Area. The entire seahorse genus *Hippocampus* spp. was listed in Appendix II of CITES in November 2002 (Project Seahorse, 2003).

6.2.9.8 Fish (excluding Sharks and Rays)

Fish diversity and population composition will vary according to habitat type within the Study Area. Fish species expected to be present within the Study Area largely consist of species associated with seagrass beds and shallow waters, as well as some juvenile stages of deep water and pelagic fishes.

Shallow-water coastal species expected to occur within the Study Area include *Strongylura leiura, Tylosurus crocodiles, Hemiramphus far, Cheilopogon cyanopterus, Fistularia commersonii, Aeoliscus punctulatus, Amblygaster sirm, Chyrocentrus dorab,* and *Carangoides ferdau* (Findlay *et al.,* 2006). Juvenile stages of deep water pelagic species that may occur include Indian scad (*Decapterus russelli*–LC*), Scomberoides tol, Selar crumenophthalmus, Carangoides dinema,* kawakawa *(Euthynnus affinis* – LC), *Rastreliger kanagurta* and *Herklotsichthys quadrimaculatus* (Findlay *et al*., 2006). Other species likely to be present include the mangrove and estuarine fish species flathead mullet (*Mugil cephalus - LC)*, yellowtail barracuda (*Sphyraena flavicauda)*, and bonefish (*Albula vulpes* - NT) (Findlay *et al*., 2006). The diversity of fish species taken by the local capture fishery is illustrated in Figure 93.

Figure 93: Capture fisheries observed during site visit (Golder Associates Africa, 2015)

6.2.9.9 Sharks and Rays

Sharks and rays recorded in Bazaruto National Park include black tip reef shark (*Carcharhinus melanopterus* – NA), white tip reef shark (*Triaenodon obesus* – NA), blackfin shark (*Carcharhinus limbatus* – NA), dusky shark (*Carcharhinus obscurus* - VU), Zambezi shark (*Carcharhinus leucas* - NA), Java shark (*Carcharhinus amboinensis* - DD), blue stingray (*Dasyatis chrysonota* - LC), and whale shark (*Rhincodon typus* - VU) (Everett *et al*., 2008). The conservation status of several of these is unknown (not assessed - NA) as they have not yet been assessed by the IUCN Red List of Threatened Species (IUCN, 2014). The oceanographic characteristics of the Inhambane area create favourable conditions for aggregations of resident and transient reef manta ray (*Manta alfredi* – VU), giant manta ray (*Manta birostris* - VU) and whale sharks (Perreira *et al.,* 2014).

Little information exists on the presence or distribution of sharks and rays within the Study Area.

Aerial surveys conducted in 2001 (Mackie, 2001) recorded no whale sharks between the Save River estuary and Bazaruto (within which the Study Area lies), possibly because the survey was conducted over shallow water of <10 m depth; by comparison, sightings of whale shark were made in the open sea between Pomene and Bazaruto Island (Findlay *et al*., 2006). The presence of whale shark within the Study Area therefore may be unlikely.

Dusky shark (*C. obscurus*) has a patchy distribution in tropical and warm temperate seas, being highly migratory (Musick *et al*., 2009). Population decline in several areas of its range are attributed to entanglement in shark-protection beach nets, fisheries bycatch, and targeted fishing - its fins are highly prized for the shark fin trade (Musick *et al*., 2009). Although recorded in Bazaruto National Park (Everett *et al.*, 2008), no information on frequency of occurrence or distribution is available.

Blue stingray (*D. chrysonota*) is often found in shallow bays and sheltered sandy beaches in summer, moving offshore to deeper waters of up to about 100 m depth in winter (Smale, 2009); it is likely to be present within the Study Area.

6.2.9.10 Avifauna

Bazaruto Archipelago is a designated Important Bird Area (IBA) (BirdLife International, 2015). A total of more than 180 bird species have been recorded for Bazaruto Archipelago, which is an important stopover for different species of migrating birds, particularly Palaearctic waders which are attracted by the extensive sand flats on the leeward shores of the islands (CSIR, 2001).

The number of waterbirds present during the austral summer regularly exceeds 20,000 (BirdLife International, 2015). The largest congregations in southern Africa of bar-tailed godwit (*Limosa lapponica)* and crab-plover (*Dromas ardeola)* have been observed within the IBA. Flocks of American flamingo (*Phoenicopterus ruber*), which arrive from breeding grounds in Botswana and disperse along the east coast of Africa, are present in the archipelago during mid-winter (BirdLife International, 2015). Rare birds observed in the marshes of San Sebastião include long-toed lapwing (*Vanellus crassirostris*) and rufous-bellied heron (*Butorides rufiventris*) (BirdLife International, 2015); however, these are not listed as threatened (i.e. Critically Endangered, Endangered, or Vulnerable) by the IUCN Red List of Threatened Species (IUCN, 2014).

6.2.9.11 Cetaceans

The combination of shallow, plankton-rich waters in Bazaruto Bay, and nearby oceanic conditions, provides highly suitable conditions for cetaceans (whales and dolphins) in the greater Bazaruto Archipelago area (Everett *et al.,* 2008). At least three species of whale and six species of dolphin occur in the area, and thus may occur in the Study Area.

Whale species include southern right whale (*Eubalaena australis*), humpback whale (*Megaptera novaeangliae*) and minke whale (*Balaenoptera acutorostrata*). These typically occur on the seaward side of Bazaruto Archipelago, the shallow waters of the leeward side not being deep enough for them. Minke whale and southern right whale are resident in the area, whilst humpback whales migrate along the coasts of Natal, southern Madagascar and Mozambique, passing Bazaruto Archipelago between September and November on their annual migration to Madagascar (CSIR, 2001).

Four species of dolphins are resident in coastal waters of the area; Indian Ocean Humpback Dolphin (*Sousa plumbea* - EN), Indo-Pacific bottlenose (*Tursiops aduncus* - DD), spinner dolphin (*Stenella longirostris* - DD) and spotted dolphin (*Stenella attenuata* - LC) (Perreira *et al*., 2014). Other species that are present in the Study Area (Findlay et al., 2006) include common dolphin (*Delphinus delphis* - LC), and bottlenose dolphin (*Tursiops truncatus* - LC). All of these species may occur within the Study Area.

6.2.9.12 Dugong

Dugong (*Dugong dugon*), is listed as Vulnerable on the IUCN Red List of Threatened Species (Marsh, 2008) because of population declines across its entire range. The declines have arisen from threats including gill netting (which entangles them as bycatch), overexploitation through subsistence hunting, and agricultural pollution resulting in sedimentation of seagrass beds and consequent habitat loss (IUCN, 2008). They are also listed on Appendix I of the Convention on International Trade in Endangered Species (CITES) which prohibits trade of this species or its parts. The dugong population of Bazaruto Bay is the largest population of dugongs in the Western Indian Ocean (IUCN, 2008).

Dugong presence and movements are closely linked to the presence and extent of seagrass beds, which form its primary food source (Guissamulo, 2006). Dugongs have been estimated to spend 72% of their time within 3 m from the sea surface (Chilvers *et al*., 2004). In Bazaruto Bay, seagrass beds associated with the sand tidal flats cover approximately 88 km^2 in shallow and subsidiary waters less than 5 m (Bandeira et al., 2008); it is thus assumed that dugong in Bazaruto Bay spend the majority of the time that they are present in waters of depths less than 5 m. Surveys offshore of Bazaruto Island have showed that dugongs move extensively to the offshore shallow areas during low tide to escape the risk of stranding; this information has prompted the proposal of an area north of Bazaruto National Park as an additional dugong protection area (WWF & UNEP 2004).

2006 Baseline Survey

An aerial field survey of dugong in Sasol's offshore exploration blocks 16 & 19, within which the Study Area lies, was previously undertaken in March/April 2006 (Guissamulo, 2006). The survey gathered primary data on dugong numbers/movements in the area to the north of Bazaruto National Park, and the extent of sea grass beds to the north of Bazaruto. Dugong presence within the Study Area based on the data gathered in Guissamulo's study is shown in Figure 94. Dugong was observed singly, in pairs and less frequently in aggregations, at distances varying from 500 m to 10 km from shore. Most sightings were concentrated between Bazaruto Bay and Vilanculos, with 54 of a total 79 dugong recorded in this area (Guissamulo, 2006).

Overall, during Guissamulo's survey, dugong were most common in the area north of the Santa Carolina Island and west of the northern tip of the Bazaruo Island, an area which lies between the proposed anchoring points and the beach landing site options (Figure 94). Dugong were observed to sometimes form large aggregations, for reasons speculated to be either for social behaviours, or due to presence of deeper water during low tide conditions when access to seagrass feeding areas was restricted. These aggregations were observed both within Bazaruto Bay, and up to 10 km offshore (Guissamulo, 2006).

2015 Supplementary Data

Additional shapefile data provided by the Endangered Wildlife Trust (EWT, 2015) who are currently studying dugong presence and patterns of distribution in the Bazaruto Bay area, shows the areas where sightings of dugong have been concentrated during their survey work Figure 95 and Figure 96). The figures illustrate the areas (isopleths) within which 100%, 95% and 90% of adult dugong sightings (Figure 95) and calf sightings (Figure 96) have been observed by EWT during 2012 - 2014; these areas may be considered as being of greater importance for dugong conservation within the Study Area.

2016 Baseline Survey

An aerial survey of dugong in Bazaruto Bay was carried out in April 2016 for the EIA process for the Sasol Pipeline and offshore Floating, Storage and Offloading unit (FSO) Project (Guissamulo, 2016), which updated the distribution and abundance estimates made previously (Guissamulo, 2006), and characterised the Study Area's importance for dugongs. Observed group sizes ranged from solitary individuals to groups of 11 individuals, 20% of which included calves (Guissamulo, 2016). Groups with calves were observed at four key locations, notably in the north eastern area of Bazaruto Bay between Bazaruto Bay and north of Santa Carolina Island, which lies within the Study Area.

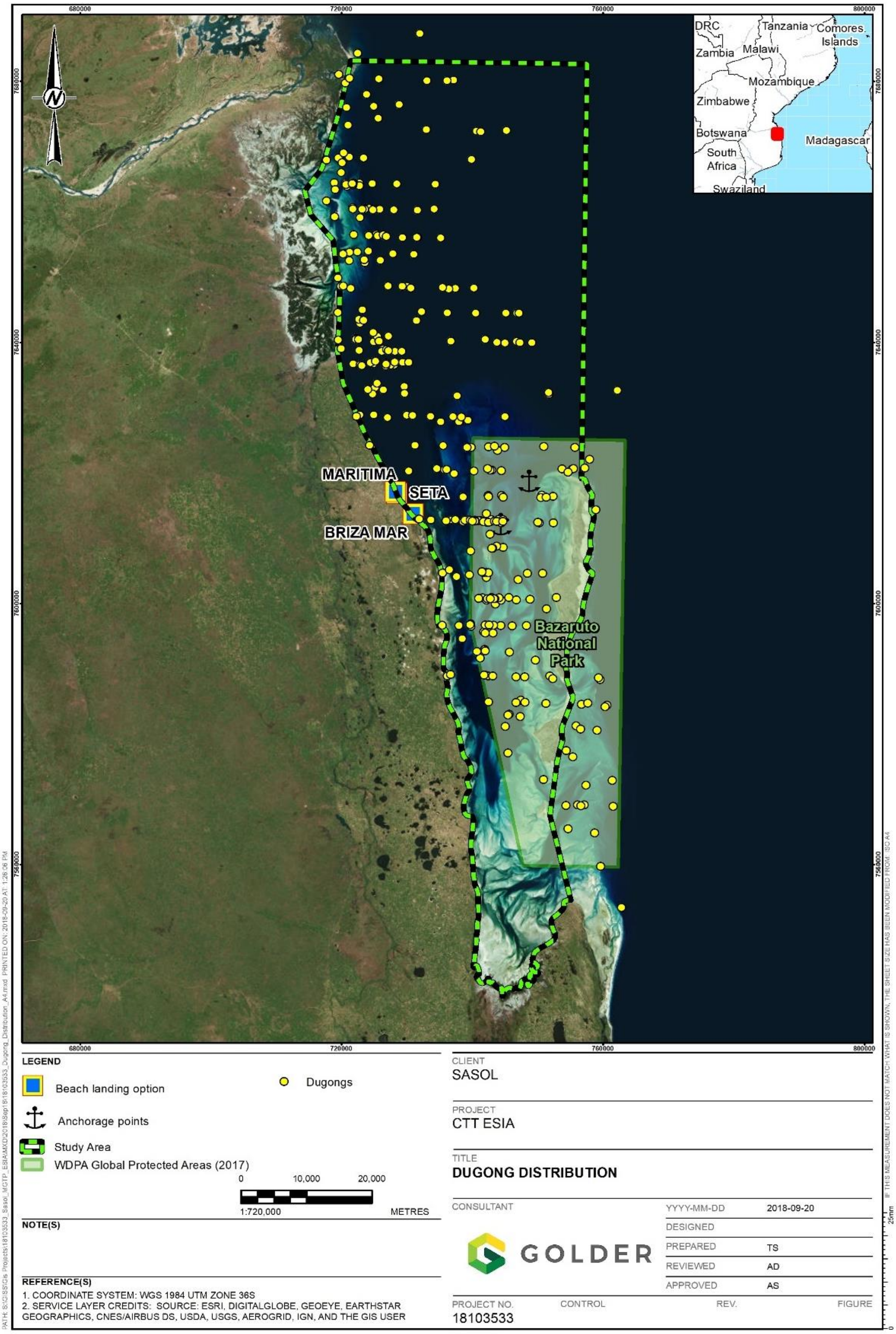


Figure 94: Dugong distribution in relation to the Study Area (Guissamulo, 2006)

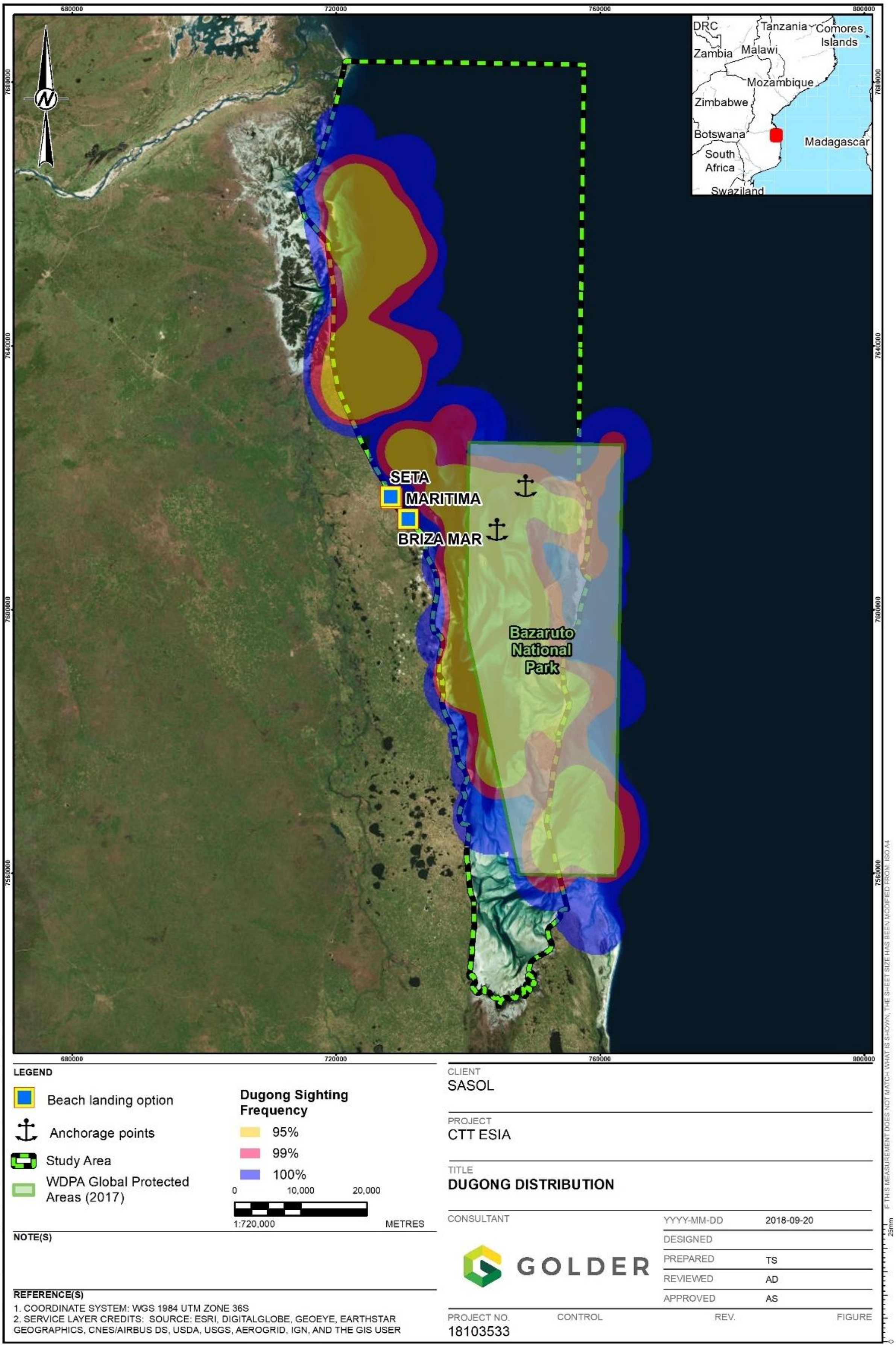


Figure 95: Adult dugong distribution 2012-2014 (EWT, 2015)

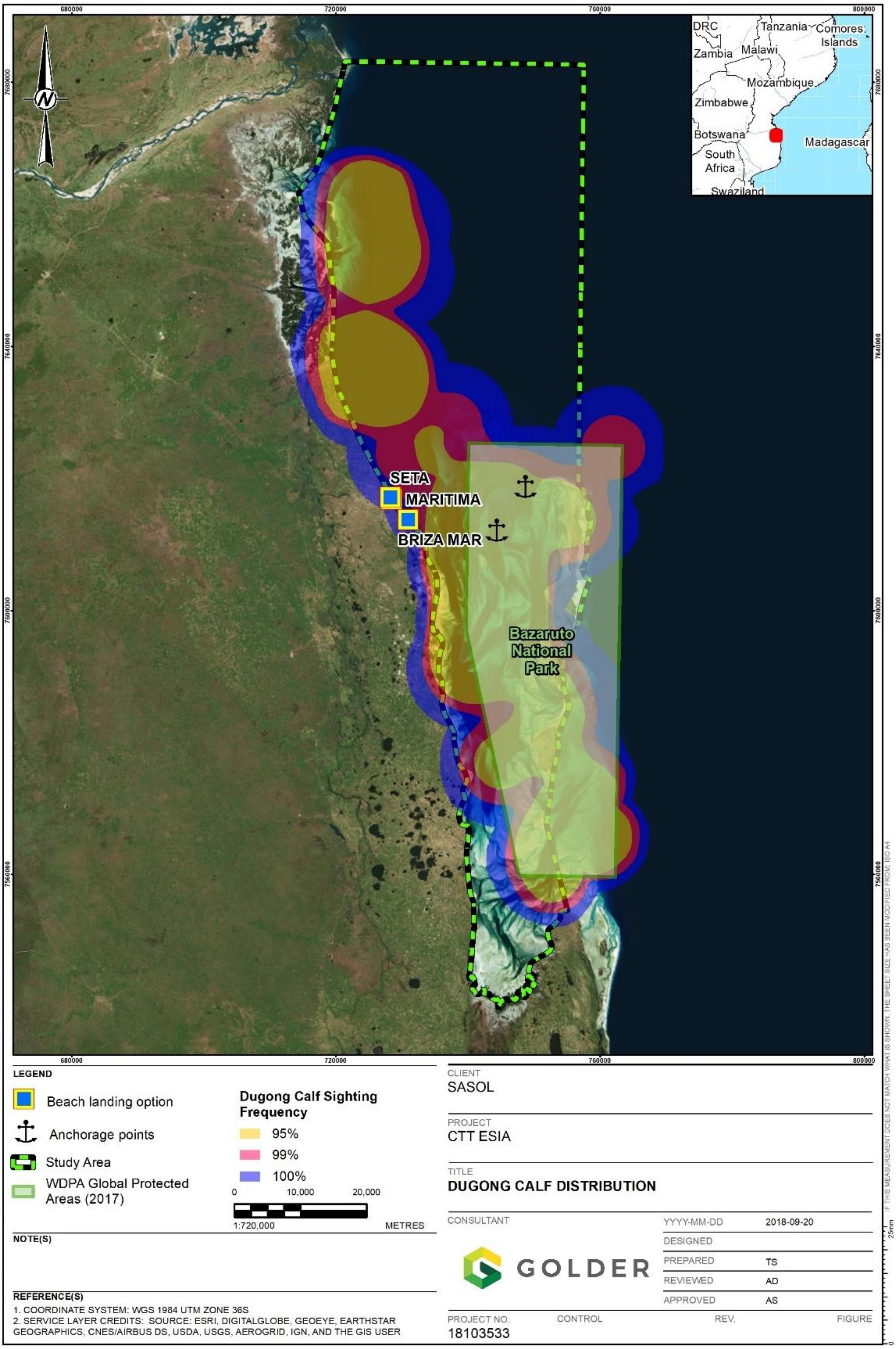


Figure 96: Breeding dugong distribution 2012-2014 (EWT, 2015)

6.2.9.13 Sea Turtles

Five species of marine turtles occur in Mozambique, the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochleys coriacea*), hawksbill (*Eretmochelys imbricata*), and olive ridley (*Lepidochelys olivacea*). Observations of the olive ridley turtle are largely confined to the northern region; the other four have been observed along the entire Mozambican coast (Perreira *et al.,* 2014).

Loggerhead and leatherback turtle nests have been recorded on the eastern coast of Bazaruto Island, and at the sandy beaches of the mainland coastline north of Inhassoro, especially in areas of small dunes and weak erosion (Findlay *et al*., 2006). The distribution and number of nests along the coastline within the Study Area is unknown; however suitable habitat may be present 10 - 15 km south of Inharasso where dune systems are evident. Loggerhead turtle is listed as Endangered (Marine Turtle Specialist Group 1996) and leatherback turtle is listed as Vulnerable (Wallace *et al.,* 2013) by the IUCN Red list of threatened species.

While the hunting of marine reptiles is prohibited by law, butchered adult green turtles were found on the foreshore at the mouth of the Nhangonzo coastal stream (Avis *et al*. 2015).

6.2.9.14 Seals

Two seal species (crab eater seal *Lobodon carcinophaga*, cape fur seal *Arctocephalus pusillus*) have been recorded in Mozambican waters; however, these are incidental records - Mozambican coastal waters are outside their normal distribution ranges (southern coast of South Africa and Antarctic respectively (Findlay *et al.*, 2006). Seals are therefore not expected to occur in significant numbers within the Study Area.

6.2.10 Protected Areas and Species

Several marine and coastal ecosystems and species are protected by Mozambican law, or as a result of obligations on the Mozambican government as signatories to various international conventions (ref. Section 4.0 of Marine specialist study). Protected areas and species that are present within the Study Area are summarised in the following paragraphs.

6.2.10.1 Nationally Designated Areas

Bazaruto Archipelago National Park

As mentioned throughout this report, Bazaruto Archipelago National Park lies within the Study Area. Designated in 1971, it was the first official National Park of Mozambique, and initially comprised the three southernmost islands Bangue, Magaruque and Benguerua, together with a contiguous sea area extending 5 km to the West and to the 100 m line of bathymetry to the East (WWF, 2010). The protected area was then extended in 2002, to include the remaining islands of the archipelago (i.e. Bazaruto and Santa Carolina), and was renamed as the Bazaruto Archipelago National Park, with a total area of 1,430 km^2 (WWF, 2010; Perreira *et al*., 2014).

The Nhamabue area at the Govuro River Estuary to the north of Inhassoro and Save River holds about 60 percent of the dugong population of the entire greater Bazaruto Archipelago and has been proposed as a sanctuary which could be managed as part of the Bazaruto Archipelago National Park (Guissamulo, 2016).

Bazaruto Archipelago Important Bird Area

Bazaruto Archipelago Important Bird Area (IBA) consists of the islands of Bazaruto, Santa Carolina, Benguerra and Margaruque, and also the San Sebastião peninsula on the mainland – overlapping in part with the National Park. The most important habitat for birds is the extensive intertidal flats which connect the islands, as the site is designated as an IBA due to its importance as wintering ground for large numbers of non-breeding migratory waders from the Palearctic (BirdLife International, 2015).

6.2.10.2 Protected Habitats

Primary dunes and sandy beaches are prominent habitats, especially from Bazaruto southwards, where these play an important role as nesting habitat for marine turtles. The Forestry and Wildlife Regulations offer total protection to all five species of marine turtles, which extends to their nesting sites. If nesting sites occur within the Study Area, these beach areas will be subject to the requirements of the Forestry and Wildlife Regulations.

In addition, the Regulation for the prevention of marine pollution further protects beach systems where turtles are present, describing beaches as “fundamental habitats for the normal development of marine turtles”. It requires that infrastructure development apply for special licenses, prohibits driving on the beach and makes provisions for heavy fines for violations.

6.2.10.3 Nationally Protected Species

Several nationally-protected faunal species occur within the Study Area, which will be closely considered during the assessment of potential project impacts:

- All turtle species are protected under national legislation so that the killing of marine turtles and possession of their eggs is an offence (Forest and Wildlife Regulations [Decree 12/2002 of 6 June 2002]). This regulation prescribes a fine of MT 25,000 (approximately US$ 1,000) for the illegal hunting of marine turtles;
- All cetacean species are protected under national legislation (Forest and Wildlife Regulations [Decree 12/2002 of 6 June 2002]); and
- Dugong is protected under national legislation (Forest and Wildlife Regulations [Decree 12/2002 of 6 June 2002]).

6.2.10.4 Marine Species of Conservation Concern

Three marine mammals are found in the coastal waters of the Study Area, the Dugong, Indian Ocean Bottlenose Dolphin and Indo Pacific Humpback Dolphin. The dugong population in the area (the Bazaruto Archipelago region), is considered the largest and last viable population in the Western Indian Ocean region, from Cabo de São Sebastião in the south to the Save River mouth in the north (Findlay et al. 2011; Allen 2013; Samoilys *et al*. 2015). Most recent population estimates, which should be considered cautiously as different methodologies were used at varying levels of detail, vary between 359, 463 and 852 dugongs for the Greater Bazaruto Area (Findlay et al, 2011; Provancha & Stolen, 2008; Guissamulo *et al*., 2016, respectively). Dugongs use the entire inshore waters depending on the availability of forage and disturbance. Their distribution is closely related to the location of the seagrass meadows between 1 and 5 m deep that they utilise for grazing (Guissamulo, 2006). Pressures from anthropogenic disturbances, causing reductions in available seagrass beds for foraging, is the main cause for classifying the East African dugong population as endangered on the IUCN Red List (Allen, 2013).

Both the bull shark (Carcharhinus leucas), which is classified as Near Threatened, and the smalltooth sawfin (Pristis microdon), which is Critically Endangered (CR), are expected to occur within the Study Area (Golder, 2017).

In addition, all five Western Indian Ocean (WIO) marine turtle species have been reported to occur in or near the Study Area (Costa *et al*., 2007). These species utilise the seagrass beds and coral reefs in the region for foraging, and the beaches, particularly on the east coast of Bazaruto Island, for nesting (Hughes 1971; Costa *et al*. 2007; Videira *et al*. 2008; Pereira and Videira 2009). Five species nest on the beaches of Bazaruto Archipelago and São Sebastião Peninsula (Olive Ridley awaits further confirmation) during the October-March period.

Some of these species may nest on the sandy beaches of the Study Area, with special reference to the Nhamábuè area (north of Inhassoro) where beaches are considered suitable for nesting. It is likely that loggerhead turtles nest in this beach (ERM & IMPACTO, 2016), but Marshall et al. (2015) consider the area a suitable nesting ground for green and leatherback turtles as well.

Marine turtles are the only threatened reptiles reported to occur in the estuarine and coastal habitats of the Study Area. All five species of marine turtles are protected from hunting by the Forest and Wildlife Law (Decree 12/2002 of 6 June) and its eggs and habitats by the Regulation on Pollution Prevention and Protection of the Marine and Coastal Environment (Decree 45/2006 of 30 November). Apart from these, one other threatened species (Zambezi Soft-shelled Terrapin - *Cycloderma frenatum*) may be present in the Study Area, confined to the Save River and the Govuro River estuaries (Golder, 2015a). This species is mostly found in northern Mozambique, with the Save River marking the southern extent of its range. Hence, these six species are the main reptile species of conservation concern for the estuarine and coastal area (Figure 49).

Table 27: Reptile species of conservation concern associated with estuarine and coastal habitats in Study Area

Species	Common name	Conservation status (IUCN, 2016)	Likelihood in Study Area	Notes
Chelonia mydas	Green turtle	Endangered	Confirmed	Recorded on the seagrasses north of Inhassoro, an important foraging ground (ERM & IMPACTO, 2016). May also nest in the Study Area.
Eretmochelys imbricata	Hawksbill turtle	Critically Endangered	High	Observed near the Study Area (ex. Santa Carolina Island). May also occur on shallow waters of Study Area.
Lepidochelys olivacea	Olive Ridley turtle	Vulnerable	Moderate	Observed in Bazaruto Archipelago and São Sebastião Peninsula). May occasionally visit the Study Area.
Caretta	Loggerhead turtle	Vulnerable *Near-threatened (South West Indian Ocean subpopulation)	Confirmed	Observed in Bazaruto Archipelago and São Sebastião Peninsula). May also nest in the Study Area.
Dermochelys coriacea	Leatherback turtle	Vulnerable *Critically Endangered (Southwest Indian Ocean subpopulation);	Moderate	Recorded near the Study Area ERM & IMPACTO (2016). May occasionally visit the Study Area and possibly nest here.

Species	Common name	Conservation status (IUCN, 2016)	Likelihood in Study Area	Notes
Cycloderma frenatum	Zambezi Soft-shelled Terrapin	Endangered	Low	Mainly found in northern Mozambique as far south as the Save River and may occur in the Save and Govuro River estuaries.

6.3 Socio-economic and Cultural Environment

The project area and SIA study area is situated in the District of Inhassoro in Inhambane Province in southern Mozambique Figure 97). The Inhassoro District is in the northern part of the Inhambane Province, between latitudes 10°33' north and 30°51' south and longitudes 40°35' east and 30°41' west. It is 6 329.5 km² in size, of which 6 299 km² is on the continent and 30.5 km² insular, subdivided into 28 km² of Bazaruto Island and 2.5 km² of Santa Carolina Island.

The Inhassoro District is bordered to the north by Govuro District, to the south by the Districts of Vilanculos and Funhalouro, to the East by the Indian Ocean and to the West by the Districts of Massinga and Mabote. The district is crossed by the Govuro River. In terms of geographical and administrative division, Inhassoro has two administrative posts Figure 50). The Administrative Post of Bazaruto and the Administrative Post of Inhassoro, the latter being the most populated. The Administrative Post of Bazaruto comprises of the Archipelago of Bazaruto as shown in Figure 97.

Table 28: Administrative Division of Inhassoro District

Administrative Post	Localities	Number of Villages
Administrative Post of Inhassoro Town	Inhassoro Town	12
	Maimelane	22
	Nhapele	03
	Cometela	05
Administrative Post of Bazaruto	Bazaruto	03
Total		**45**

Source: Strategic Plan for District Development – PEDD (2011/2015) (2010)

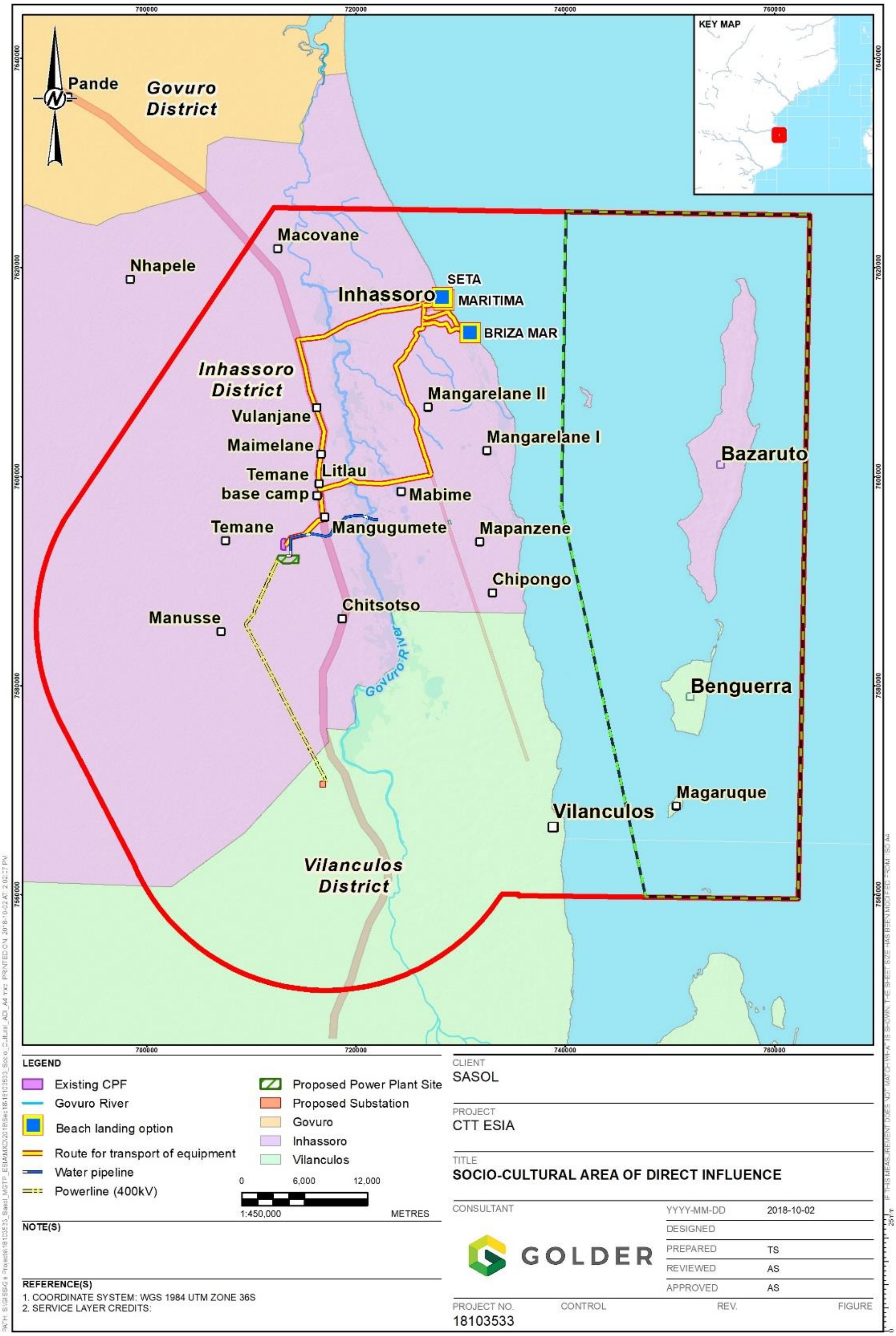


Figure 97: Project location

6.3.1 Socio-demographic Profile

6.3.1.1 Population

The Inhassoro district hosts a population of 15 318 inhabitants in 3 991 households, shown in Table 29. This information is based on data obtained through KULA's 2014 household survey and extrapolation of existing data sources. Information gathered through the 2015 FGD's in Pambara, estimate the population of this particular area to be 7 000 inhabitants who have developed into three settlement groups namely, Pambara 1, 2 and 3.

Table 29: Population Demographics of the villages within the Inhassoro district

Community and village	Number of households	Population numbers
Temane	285	710
Mangungumete	912	3 237
Manusse	341	1 238
Chitsotso	323	1 305
Mabime	400	1 686
Mapanzene	403	1 500
Chipongo	225	809
Maimelane	672	3 150
Mangarelane	137	548
Litlau	293	1 135
Total	**3 991**	**15 318**

Source: Sasol Petroleum Temane and community leaders

It is anticipated that this project would bring a further influx of employment seekers to the area. The areas of expected influx are within the larger towns of Mangungumete and Maimelane. Settlement expansion is indicated in Table 30 which shows the increase (in square kilometres) in the village footprints between 2005 and 2010 for Mangungumete and Maimelane, as documented during the Socio-economic study supporting the ESIA for the PSA & LPG project. The area increase was calculated based on the area where rooftops are visible on Google Earth imagery (there is no recent imagery available for analysis). During the previous study, villagers described the main reason for the increase in population size was due to the arrival of work and opportunity seekers.

The percentage increase is high, 72.46% for Mangungumete and 58.45% for Maimelane, when compared to the general population increase in the Inhassoro District of about 15% over the six years from 2007 to 2014. The percentage increase for the transformation of the area was a result of the inclusion of the expansion at the CPF (versus a previous status of having no/limited industrial construction).

Table 30: Increase in village size between 2005 and 2010 for Mangungumete and Maimelane in square kilometres

Villages	Year	Area (km^2)	Difference (km^2)	Percentage increase
Mangungumete	2005	2.22	1.61	72.46
	2010	3.84		
Maimelane	2005	3.16	1.85	58.45
	2010	5.00		

6.3.1.2 Ethnicity

The main ethno-linguistic groups in Inhassoro district comprise the Matsuda, the Ndau and Elomwe. The predominant local language in the region is Xitswa. The native population known as "Bazarutos" or "Mahoca", descendants of Ndau origin Tsonga group, migrated from the Save River to the islands of the Bazaruto Archipelago. This group speaks "Xihoca" which is a mixture of Cindau and Xitswa.

6.3.1.3 Gender and Age

The gender distribution in the project area is mainly female. Two thirds of Maimelane and Mangungumete which are the most populated villages are female. Communities with a relative balance between female and male population are those in Temane, Mabime, Mapanzene, Chitsotso and Manusse (Table 31). A majority of males have been reported to be the heads of their households and work as migrant labours outside the study area (Golder, 2014). As a result, the gender distribution in the study area is mainly female.

Table 31: Gender status of respondents by community and total

Community	Gender			
	Male		Female	
	Number	%	Number	%
Chipongo	12	35.3	22	64.7
Maimelane	9	26.5	25	73.5
Mangungumete	7	20.6	27	79.4
Litlau	12	37.5	20	62.5
Mabime	19	51.4	18	48.6
Mangarelane	15	39.5	23	60.5
Mapanzene	15	44.1	19	55.9
Manusse	14	43.8	18	56.3
Temane	17	53.1	15	46.9
Chitsotso	14	43.8	18	56.3

Community	Gender			
	Male		Female	
	Number	%	Number	%
Total	**134**	**39.5**	**205**	**60.5**

(Golder, 2015)

The percentage of women in the three Districts is slightly higher than that of men, which may be an indication of some men leaving the Districts to seek employment elsewhere (Table 31).

According to the Index Mundi (2018), the age structure of Mozambique's population was estimated in 2017 and categorised into different age groups as shown in Table 32.

Table 32: Mozambique age structure

Age groups (years)	No. of Males	No. of female	% per age group
0-14	5,975,407	5,908,511	44.7
15-24	2,824,012	2,907,033	21.6
25-54	3,409,425	3,875,837	27.4
55-64	435,203	468,939	3.4
65 years and over	352,546	416,793	2.9

6.3.1.4 Vulnerable groups

The following vulnerable groups have been identified during field work conducted by Golder (2018a):

- Women headed households with children and youth:

17 women headed households with children and youth were identified in the study area.

- Elderly headed households with children (and no other adults):

For this group, four households have been identified within the affected population (however, it should be noted that an additional two households could be classified as 'elderly headed households with children' but have been accounted for under the 'Woman headed households with children and youth'). In these cases, it is likely that the children have moved to live with their grandparents due to the death of their parents, their parents being unable to support them or, alternatively, due to the parents working away from home.

- Women and elderly people living alone:

These two groups have many similarities in terms of vulnerabilities. Women living alone are vulnerable to several social and economic threats, especially in a society where women and men do not enjoy the same benefits. In the same way, the elderly population does not have the same opportunities as younger members of the community, while they are more susceptible to health problems, disabilities and food insecurity. 26 women living alone have been identified in the affected area. Of this group, four are in a critical age group between 70 and 90 years old.

- Mentally handicapped persons:

A single, mentally handicapped person was recorded as living in the project area. While no medical assessment was undertaken of the individual, reports from neighbours and family members were considered, along with general observations, where after it was suspected that the potentially affected individual appeared to be mentally handicapped.

6.3.1.5 Marital status

The patterns of marital status vary across countries and even within countries among different cultural groups. Based on the survey results, just more than half of the population (58.2%) are married or staying together as married, with the highest numbers reported in Temane (69.7%), Chipongo (63.6%), and Mangarelane (62.2%) (Table 33).

Table 33: Marital status of respondents by community and total

Community	Marital status							
	Single		Married/marital relation		Separated/ divorced		Widow	
	N	%	N	%	N	%	N	%
Chipongo	9	27.3	21	63.6	0	0.0	3	9.1
Maimelane	12	37.5	15	46.9	0	0.0	5	15.6
Mangungumete	14	43.8	15	46.9	2	6.3	1	3.1
Litlau	9	28.1	17	53.1	1	3.1	5	15.6
Mabime	9	26.5	20	58.8	1	2.9	4	11.8
Mangarelane	10	27.0	23	62.2	2	5.4	2	5.4
Mapanzene	11	35.5	18	58.1	0	0.0	2	6.5
Manusse	8	25.8	19	61.3	1	3.2	3	9.7
Temane	3	9.1	23	69.7	2	6.1	5	15.2
Chitsotso	6	20.0	18	60.0	1	3.3	5	16.7
Total	**91**	**28.0**	**189**	**58.2**	**10**	**3.1**	**35**	**10.8**

6.3.1.6 Education

Almost half of the respondents (49.0%) had finished primary school, followed by one-third (34.9%) who had no type of formal education. Secondary school (8.2%) and adult literacy (7.3%) is low. None of the respondents had completed a university education, and only 0.6% had completed vocational education.

Maimelane had the highest proportion (28.6%) of people who had completed secondary education and one of the two interviewees who had completed vocational education. Litlau has 14.3% of secondary school graduates. In Temane, the illiterate constitutes about half (48.5%) of all the respondents, and in Maimelane it is 23.5%. Only 17.6% of people surveyed in Mapanzene have no education.

Almost two-thirds of respondents (64.7%) had completed primary education, and 8.8% had finished secondary school – this is a real anomaly when considering there is no school in this village. Temane, which has a primary school, had 60.6% of respondents with no education at all, or only adult literacy education. People with completed secondary school finished were only 3.0% of all the contacted persons in Temane in the survey.

There are primary schools in Mabime, Mangarelane, Mangungumete, Chitsotso, Maimelane and Temane, and a secondary school in Inhassoro main village, built and supported by Sasol.

The reasons for children dropping out of school in the project area are firstly the lack of available secondary education facilities in the area and secondly the pressure on children to assist in household livelihood activities. These factors also contribute to the low literacy and education levels in the project area.

The Primary School in Mabime

The Primary School in Mangaralane

The Mangungumete Complete Primary School

The Chipongo Primary School

The Mapanzene School

Figure 98: Schools in the villages in the study area

6.3.1.7 Religion

Religion represents an important entry point for understanding how a community organises its way of life materially and spiritually. Figure 99 shows church structures within the project area.

Figure 99: Three churches in the study area, in Maimelane, Mangugumete and Chipongo

Data from the district government (GDI, 2010) shows about 50 churches at the district level, distributed across all communities, with the majority (11) being Roman Catholic, followed by Evangelical Protestants and Old Apostles with nine churches (Table 34). The data reported by the household survey confirm the trend illustrated above, the majority of respondents (45%) responded as belonging to the Catholic Church, followed by Protestant Churches (27%). Among the communities covered by the project, the Catholic Church was reported proportionately more spread out in the communities of Mangarelane (84.2% of the respondents), Maimelane (76.5% of the respondents) and Manusse (60.2% of the respondents). Participation in the Protestant church was more reported in Mangugumete Community (60% of the respondents), Chitsotso (43.8%) and Chipongo (38.2).

Table 34: Religions represented in the Inhassoro District

Religious community	Number of establishments	Community
United Methodist Church of Mozambique	05	Maimelane, Inhassoro and Nhapele
Glorious United Universal Church of Mozambique	05	Maimelane, Inhassoro and Nhapele
Free Methodist Church of Mozambique	03	Maimelane and Inhassoro
Assemblies of God Christ Vision Church of Mozambique	07	Maimelane, Inhassoro and Nhapele
Assemblies of God International	01	Inhassoro Town
Seventh Day Adventist	08	Maimelane, Inhassoro and Nhapele
Old Apostles	09	Maimelane, Inhassoro, Nhapele, Cometela and Bazaruto
Roman Catholic Church	11	Maimelane, Inhassoro, Nhapele and Bazaruto
Islamic Community	01	Inhassoro Town

Source: PEDD 2011/2015 (GDI, 2010)

The religious profile of these communities indicates a predominance of Roman Catholic Church but also the rise in the number of Protestant congregations. That fact might hypothetically indicate a shift in the ethics and local cosmology.

While the “old” and conservative Catholicism supports the ideal of life after death and the eternal heavenly life as a reward for “good” behaviour, Protestant (and other new Pentecostal) preachers advocate for a struggle towards material good and prosperity during the present life. The number of new pastors and denominations with a huge mass of followers is rapidly increasing, and that might have consequences in the way these communities see life in general.

6.3.2 Access to Social Services and Infrastructure

6.3.2.1 Housing

Building materials used for building houses is a good sociological indicator for understanding social and economic dynamics of households. The socio-economic status and social recognition of people is reflected in the type of house in which they live, and the kind of materials they use to build their homes. In the project area, houses are predominantly of local and mixed materials with roofs made of tree cuttings, grass and iron sheets; those built of conventional material are located largely at the district headquarters. The floors of the houses for more than 60% of respondents are made from clay, 37% from cement (costly in rural communities). The use of wood in the construction of houses was only reported in the community of Mabime, one of the most remote villages where access to wood is easier compared to other materials.

Long-lasting materials (local and conventional) tend to be used in the construction of permanent homes in the communities of Mapanzene, Mangarelane and Chipongo. Apart from these houses, fishing families make use of temporary homes precariously constructed from less durable materials. These temporary homes form campsites along the coast among and on the dunes or intermediate areas. Fishing families typically spend part of their time throughout the day making preparations for fishing, using the temporary houses to keep their fishing equipment, prepare the fishing nets and repair their boats.

Pambara is a sprawling settlement which covers the base of the proposed transmission line for the project. It may seem like three settlements as it is referred to as Pambara 1, 2 and 3 but it is in effect one village. The settlement is rural with structures mainly consisting of straw and reeds which are sourced from the nearby Govuro River.

6.3.2.2 Roads

Roads in the area are dirt roads, and although narrow in some areas, some roads are in good condition, others are not.

Soil erosion and deep mud during the rainy season is a major issue, damages dirt roads and making access difficult. Community members indicated during the 2015 public participation process that lack of good roads prevents them from reaching health facilities.

Communities benefit from roads established by Sasol to existing well sites and along flow lines. These roads provide access to natural resources, to other communities either for social interaction or trade or to reach health centres or schools. During the recent consultation process, several requests were made for upgrading some roads for better access to health facilities. Table 35 shows the road network in the study area. The main mode of transport for the locals includes bicycles, motorbikes and taxis.

Table 35: Road classification in the study area

District	Type/ Classification	Surface	Number	Links	Length within Districts (Km)
Inhassoro District	Primary	Paved	EN-1	Vilankulo/Inhassoro limit to Inhassoro/Govuro limit	59

District	Type/ Classification	Surface	Number	Links	Length within Districts (Km)
	Secondary	Paved	N241	EN-1 – Inhassoro Town	14
	Vicinal	Unpaved	R921	R481 (Mabote) - Cometela - EN-1	83,8

6.3.2.3 Sources of energy

Only Temane, Mangungumete and Maimelane have electricity. Most cooking is done with local charcoal or wood. Locally made kerosene lamps are used for lighting. In some villages, fairly large solar panels are being used by some inhabitants and smaller panels in others. Solar panels are one of the main imports from migrant workers in South Africa to provide power for their households. A solar panel is one of the main social status defining factors for families in the area.

6.3.2.4 Water and Sanitation

The main source of water (Figure 100) in the affected communities was indicated being "a well with a hand pump", which accounts for almost half (47.2%) of all the respondents. "Unprotected well[7]" is the second most used water source covering 29.9% of the persons contacted. Piped water, be it inside or outside the household yard was only referred to as the main water source by 0.3% of the people who answered the questionnaire. Regarding communities, the highest use of protected wells occurs in Temane, where 84.4% of the contacted people enjoy the benefit of such sources, while no one stated the use of the unprotected well, piped water or water from a stream/lagoon. People using the latter source of water all came from Mapanzene and Mabime. Mabime is the only one with access to public fountain water as well.

The only community with piped water use was Mangungumete. Munavalate and Pambara source water from similar hand dug wells as well as the Govuro River when necessary.

Figure 100: Drinking water, Mabime

Respondents were asked about the methods used to eliminate human body waste. More than half of the people interviewed (58.4%) stated that they use a traditional pit latrine (with no slab). The percentage is particularly high in Mangungumete (97.1%), Litlau (84.4%) and Maimelane (82.4%) where more than

[7] *An 'unprotected well' is a well that is not covered and can allow the introduction of objects or rain water because of that feature*

three-quarters of all respondents confirmed the use of this method. The second most cited way of eliminating body waste was to bury human waste outside household premises. 35.5% of respondents stated use of this method. Burying waste inside household premises is a procedure followed by only 0.6%, and respondents with access to an improved latrine (with a slab) account for 12%.

Temane and Chitsotso were the only two communities where burying human waste inside the household yard takes place, and Mangungumete is the only community where there was no record of burying human waste. Improved latrines were not prevalent in the observed communities. While Chipongo, Mabime, Mangarelane and Mapanzene did not register a single case of improved latrines, the communities that confirmed its presence revealed very low percentages (Mangungumete – 2.9%, Manusse – 3.0%, Temane – 3.0% and Litlau – 3.1%). The distribution of improved latrines seems to be linked to the logistical capacity of distribution rather than to people's preference for one or other means of taking care of their sanitary well-being.

6.3.3 Baseline Health Conditions

A Health Impact Assessment (HIA) seeks to identify and estimate the lasting or significant changes of different actions on the health status of a defined population. The WHO defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. This is influenced by a complex interaction of social, economic, genetic, and environmental factors and follows a social model of health. A reductionist approach is used to consider all these factors.

6.3.3.1 National Health Profile

As of 2016, the annual population growth rate stood at 2.9%. Similar to other countries in sub-Saharan Africa (SSA), the fertility rate is high (5.9 children per woman) with a significant disparity between urban (4.5) and rural (6.6) settings. Life expectancy at birth is short (56 years in 2016) but has nevertheless shown some increase over the past decades. The health indicators for Mozambique describe a challenging situation with some health data worse than the average for SSA. In 2011, the national infant and under-five mortality rates were reported at 64 and 97 per 1,000 live births, a significant decline from the 1990 figures of 155 and 233, respectively. However, maternal mortality, a useful indicator for health sector performance, remains high, recorded at 408 per 100,000 live births in 2011.

The distribution of disease burden in Mozambique reflects a predominance of communicable diseases, maternal, neonatal and nutritional diseases. The 2015 WHO Burden of Disease estimates put the disease burden in Mozambique at 19.6 million Disability Adjusted Life Year (DALY)[8]. Communicable diseases account for 64% of the burden of disease while the remainder is shared between non-communicable diseases (27%) and injuries (9%). HIV/AIDS (13%), neonatal conditions (12%), acute respiratory infections (8%), malaria (8%) and diarrhoeal diseases (6%) are the leading causes.

6.3.3.2 Inhassoro District Health Profile

The annual health report (2017) shows that Inhassoro District has only 1 physician for every 31,980 inhabitants and 1 nurse for every 3,366 inhabitants (compared to the WHO recommended ratio of 1 per 10,000 and 1 per 1,000 respectively). The main reasons for health consultations are malaria, diarrhoea, HIV/AIDS, anaemia, tuberculosis and acute respiratory tract infection including pneumonia (Figure 101).

[8] The DALY is a measure of overall disease burden. It is designed to quantify the impact of premature death and disability on a population by combining them into a single, comparable measure. It extends the concept of potential years of life lost due to premature death to include equivalent years of 'healthy' life lost by virtue of being in state of poor health or disability, quantified as years lived with disability.

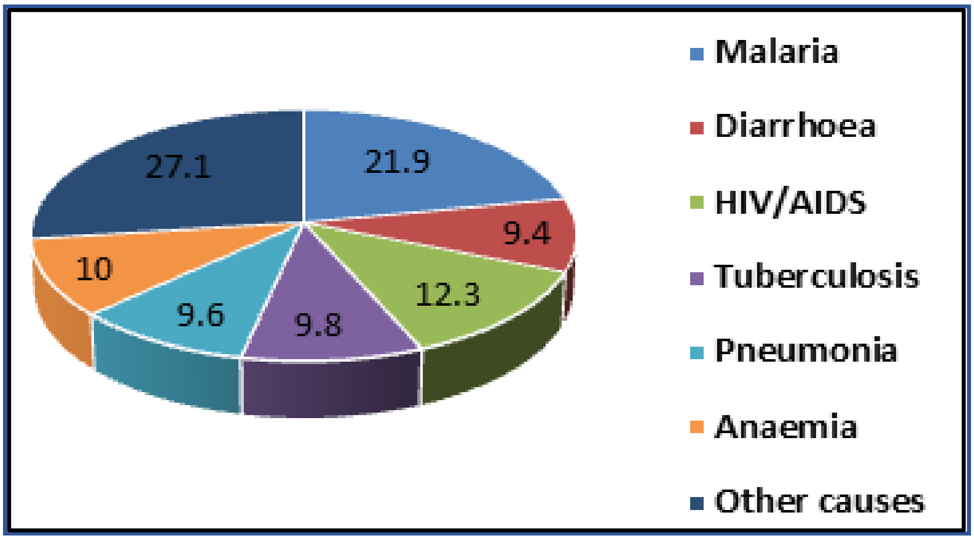


Figure 101: Main reasons for visiting health facilities (morbidities only) (Source: Inhassoro District Annual Health Report 2013)

Inhassoro is generally poorly served with no district hospital (as at 2018) and relies on the District hospital located in Vilanculos. The Sasol Corporate Social Investment programme funded the construction of Mangugumete Health Centre as well as the recently completed health centres in Temane and Pambara (Vilanculos District) to serve surrounding communities. About half of the population of the district is within favourable (0 - 5 km) distance from a health facility, 35% travel more than 10 km to the nearest health facility and the rest travels 15 km or more.

6.3.3.3 Mortality and Burden of Disease

The distribution of disease burden in Mozambique reflects a predominance of communicable diseases, maternal, neonatal and nutritional diseases. The 2015 WHO Burden of Disease (BOD) estimates put the disease burden in Mozambique at 19.6 million Disability Adjusted Life Year (DALY)[9]. Communicable diseases account for 64% of the BOD while the remainder is shared between non-communicable diseases (27%) and injuries (9%). HIV/AIDS (13%), neonatal conditions (12%), acute respiratory infections (8%), malaria (8%) and diarrhoeal diseases (6%) are the leading causes. Figure 102 ranks the top 10 causes of deaths in 2016 and compares this to that of 2005.

[9] The DALY is a measure of overall disease burden. It is designed to quantify the impact of premature death and disability on a population by combining them into a single, comparable measure. It extends the concept of potential years of life lost due to premature death to include equivalent years of 'healthy' life lost by virtue of being in state of poor health or disability, quantified as years lived with disability.

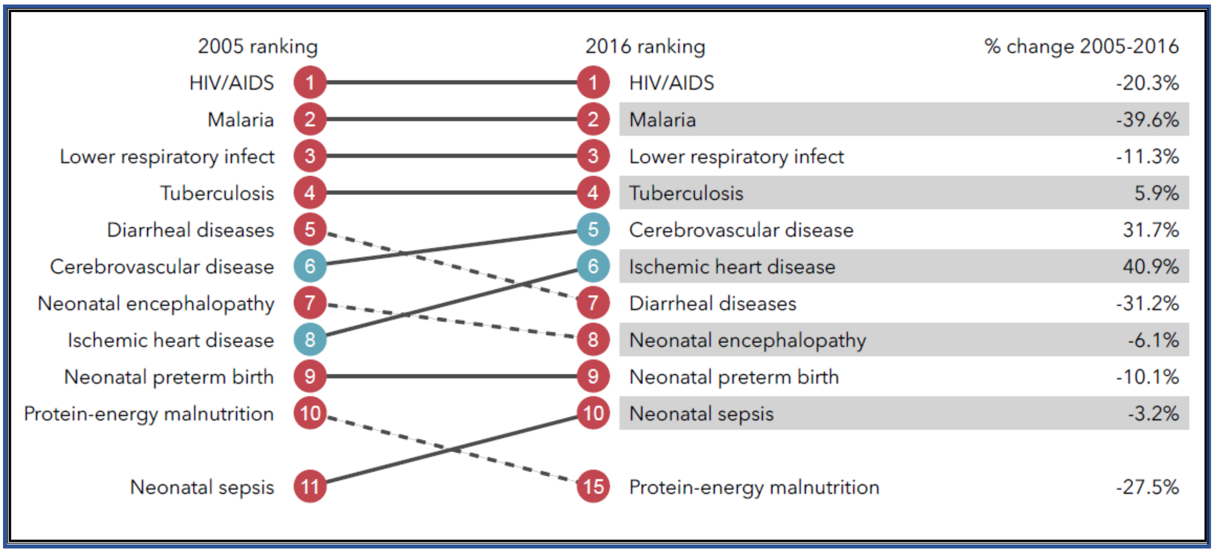


Figure 102: Ranking of leading causes of deaths in Mozambique, 2016 versus 2005 (Source: Institute for Health Metrics and Evaluation, 2016)

The figure shows the top 10 causes of deaths in 2016 and percentage change, 2005-2016. Solid lines indicate a cause has moved up in rank or stayed unchanged. Broken lines indicate a cause that has moved down in rank.

6.3.3.4 Communicable Diseases Linked to the Living Environment

Communicable diseases (e.g. acute respiratory infections, pneumonia, tuberculosis, meningitis, plague, leprosy, etc.) rely on fluid exchange, contaminated substances, or close contact to travel from an infected carrier to a healthy individual. Therefore, they are directly linked to housing design, overcrowding and housing inflation. Households in Inhassoro District are generally large at an average of 6 persons per household.

Acute respiratory infection (ARI) is responsible for 8% of disease burden in Mozambique. The disease is only second to malaria as the leading cause of morbidity among young children, nationally. It also emerged from the FGDs in the study area that cough-related illnesses were among the commonest ailments, especially affecting young children. Data from the 2017 district health report show that pneumonia (a severe form of ARI) was the second leading cause of hospitalisation in the district with 31 cases and 3 deaths in 2017, this increasing four-fold from 7 cases and 1 death in 2016.

Mozambique is ranked among the world's 22 high TB burden countries; the disease particularly affecting young adults and people living with HIV/AIDS. Around 12% of the TB cases in the country are children. While some progress has been made, the country continues to register high rates of transmission with around 154,000 new infections per year. Multi-drug resistant TB is an emerging threat, with 911 cases recorded in 2016, a prevalence of 3.7%, nationally. TB is a common cause of morbidity in Inhassoro, with the district registered 248 cases of TB, including 56 that were laboratory confirmed in 2017. Treatment success rate is generally high and has increased from 78% in 2014, to 95% in 2016. The district also recorded a significant decrease in TB deaths from a high of 22 in 2015, to 6 in 2016 and 2 in 2017.

Measles remains a challenge in the country despite the availability of a safe and effective vaccine. In 2015, measles vaccine coverage was recorded at 83% nationally, thus below the 90% minimum threshold required for herd immunity. Inhassoro District reported 32 suspected cases of measles in 2017 (an increase from 16 in 2016) but no cases were confirmed or deaths reported. The district records generally high coverage of measles vaccine, 94% in 2016 and 98% in 2017.

6.3.3.5 Vector Related Diseases

Malaria continues to be the principal public health challenge facing Mozambique, contributing 8% of the overall disease burden. The whole country is considered a high transmission area and entire population is at risk of infection. Transmission shows a seasonal pattern, with peak season between July and November, which coincides with the warm and wet summer season. Baseline data shows that malaria is the number one cause of morbidity in Inhassoro District. In 2017, the district recorded 27,094 cases of malaria, a four-fold increase from the number of cases recorded in 2016. The number of malaria deaths however, remained very low, with just 4 deaths recorded over the period 2014 - 2017.

The most important arboviral (arthropod borne viral) diseases that may occur in the Project study area are dengue and chikungunya fever. Rift valley fever is also a potential risk. These diseases are transmitted by several species of day-biting mosquitoes from the genus Aedes and Culex that are generally domestic and breed in dirty/polluted water or in human-made containers. Often these diseases are un-reported due to similarity in clinical presentation with other febrile illnesses (such as malaria) and diagnostic challenges. Available evidence shows that dengue is prevalent in Mozambique but remains poorly documented. In 2007, flooding caused by the Zambezi river increased the prevalence of dengue with 1,600 cases reported in January of that year.

6.3.3.6 Soil, Water and Waste-related Diseases

The prevalence of soil, water and waste-related diseases depend highly on sanitation coverage and access to safe drinking water, factors which often show high variations at national and regional levels. Access to safe drinking water and sanitation remains a huge challenge in Inhassoro District. In 2015, the district had 212 boreholes equipped with hand-pumps, of which 31 (15%) were faulty; as well as 17 small piped water systems, of which only 12 were operational. The local communities largely relied on groundwater sources, mainly boreholes fitted with hand pumps as well as shallow hand-dug wells. In most cases, there was only one functional hand-pump for the entire village. Mabime village entirely relied on shallow well and surface water for their drinking and domestic needs.

Focus Group Discussion (FGD) participants reported that most of their households lacked toilet facilities and this was partly linked to poverty and the “culture” of indiscriminate disposal of human waste (in the bush or open field). Waste disposal remained a challenge with no organised waste collections system. Domestic waste was generally buried in pits or disposed of in open fields.

Diarrhoeal diseases account for 6% of the disease burden in Mozambique. It is also a leading cause of morbidity in Inhassoro District owing to the underling challenges of poor access to safe drinking water and sanitation. Soil-transmitted helminthiasis (STH) commonly referred to as intestinal worms, are endemic in Mozambique. Inhassoro District shows a high coverage for preventive chemotherapy against soil transmitted helminths among children (100% in 2016 and 2017) and pregnant women.

Schistosomiasis, also known as bilharzia, is a disease caused by a parasitic trematode. Fresh water snails are the intermediate hosts and they become infected with schistosome eggs when the water is contaminated with infected urine or faeces. Baseline data on the occurrence of schistosomiasis in the local communities was not conclusive, with no documentation of the disease in the district annual reports and lack of awareness of the disease by key informants.

6.3.3.7 Sexually-transmitted Infections, including HIV/AIDS

The HIV epidemic in Mozambique is generalized, but with a higher burden of disease in the southern region, which has links to the higher prevalence rates in South Africa and the migrant labour system. HIV/AIDS is the leading cause of adult morbidity in Inhassoro District. Around 30% of hospitalisations in the district in 2016 were due to HIV, but this fell to 11% in 2017. It is also the single leading cause of deaths, claiming 8 lives in 2017, and 32 in 2016.

The number of patients on antiretroviral treatment (ART) has marginally increased from 947 in 2014, to 1,089 in 2017. HIV testing services were available in all the district facilities, including health posts. HIV treatment and care services were available in four health facilities, including the two Type 1 Health Centres (Inhassoro and Mangugumete).

Sexually transmitted infections (STIs) such as gonorrhoea, syphilis and chlamydia all cause significant morbidity but are an important consideration as certain STIs can increase the risk of acquiring and transmitting HIV and they can alter the course of HIV disease progression. The prevalence of STIs in Mozambique has been reported around 6% among adults and generally similar between men and women, and information for the district was not documented.

6.3.3.8 Food- and Nutrition-related Issues

Mozambique's chronic food insecurity sits at 24% (down from 61% in 1990s) but 80% of the population cannot afford the minimum requirements to meet the needs of an adequate diet. Findings from FGDs show that majority of the local communities do not have adequate food. Most households eat only one or two meals a day. The diet largely consists of carbohydrates (cassava, maize meal, or rice) and beans or local vegetables. Fish is available at times, while other animal proteins (chicken, meat, or milk) are a rarity. The majority of respondents reported that they buy food from the local market because they do not grow enough to feed their families. Food prices were reported to be increasing especially rice, maize flour, sugar, and cooking oil.

Malnutrition is considered the underlying cause of death in an estimated 30% of children under-five years in Mozambique. Inhassoro District shows only a few cases of malnutrition recorded in the health units. In 2017, the district recorded 9 cases of severe malnutrition, decreasing from 20 cases in 2016. The number of cases of mild and moderate malnutrition was not properly documented. Despite the reported challenges of access to food, FGD participants did not mention malnutrition among their health concerns.

6.3.3.9 Non-communicable Diseases

The burden of Non-Communicable Diseases (NCDs) is increasing worldwide. In SSA, it is predicted that NCDs and injuries may cause up to 60% of morbidity, and 65% of mortality by 2020; and that this increasing burden may overwhelm already over-stretched health services. The four major NCDs are cardiovascular disease, diabetes mellitus, cancers and chronic respiratory diseases. NCDs are an emerging challenge in Inhassoro District, particularly increasing cases of hypertension.

Ischaemic heart disease and cerebrovacular disease now rank among the top-ten causes of overall mortality, with hypertension as the key predisposing factor. Data on the burden of these diseases at district or community level were not available. Assessment of health facilities revealed that treatment and care for hypertension was available but was limited by lack of specialised care and poor awareness by patients.

The most common non-infectious chronic respiratory diseases are asthma and chronic obstructive pulmonary disease which includes emphysema, chronic bronchitis, asbestosis, silicosis etc. The predominant use of biomass fuels by households is an important risk factor consideration for chronic respiratory disease in this setting. Key informants reported the occurrence of asthma in the local communities but cases were not well documented. There was no data or information on these conditions at the district or local level.

6.3.3.10 Accidents and Injuries

Road traffic accidents are a leading cause of injuries in Mozambique, accounting for 5% of DALYs.

The main causes are careless driving, drunk driving, fatigue, speeding, poor condition of roads and jaywalking. road traffic accidents are relatively common in the study area especially along the main EN1 road. The EN1 road is in generally poor condition, narrow in most parts and relatively busy with heavy commercial vehicles making it quite dangerous.

6.3.3.11 Veterinary Medicine and Zoonotic Diseases

Zoonotic diseases are caused by infectious agents that can be transmitted between animals and humans. Mozambique remains a high-risk country for rabies. Transmission predominantly occurs from infected dog bites. Once symptoms of the disease develop, rabies is entirely fatal. The most cost-effective mode of prevention is vaccination of domestic dogs. Data indicates that animal bites (especially from dogs and snakes) were common in the Project study area.

6.3.3.12 Social Determinants of Health

The health status of a population is affected by factors known as health determinants. These are varied and include natural and biological factors (age, gender and ethnicity); behaviour and lifestyles, such as smoking, alcohol consumption, diet and physical exercise; the physical and social environment, including housing quality, the workplace and the wider urban and rural environment; and institutional factors such as access to medical care. A mental health programme is in place in Inhassoro District, and in 2015 the district recorded 855 consultations due to mental and behavioural illness of which 232 (27%) were new cases, increasing from 704 cases in 2014.

FGDs show that alcohol abuse is very common in the study area. Consumption ranges from traditional brews (e.g., “nipa” and “sabanga”) to conventional beers and spirits. Tobacco smoking was reported especially among men.

There are high levels of violence against women in Mozambique, and its acceptance as a socio-cultural and traditional norm by many remain a major constraint to the implementation of gender equality commitments. Available data (see Table 103) shows that gender-based violence is common in Inhassoro District. In 2017, the district recorded 146 cases of physical violence against women, increasing from 95 in 2016. Cases of sexual violence decreased from 25 in 2016, to 10 in 2017. FGDs revealed that domestic violence is common in the communities, but most victims suffer in silence and cases are not reported (therefore data is likely to be skewed due to under reporting). Alcohol abuse, economic frustrations and mistrust between partners were seen as contributing factors.

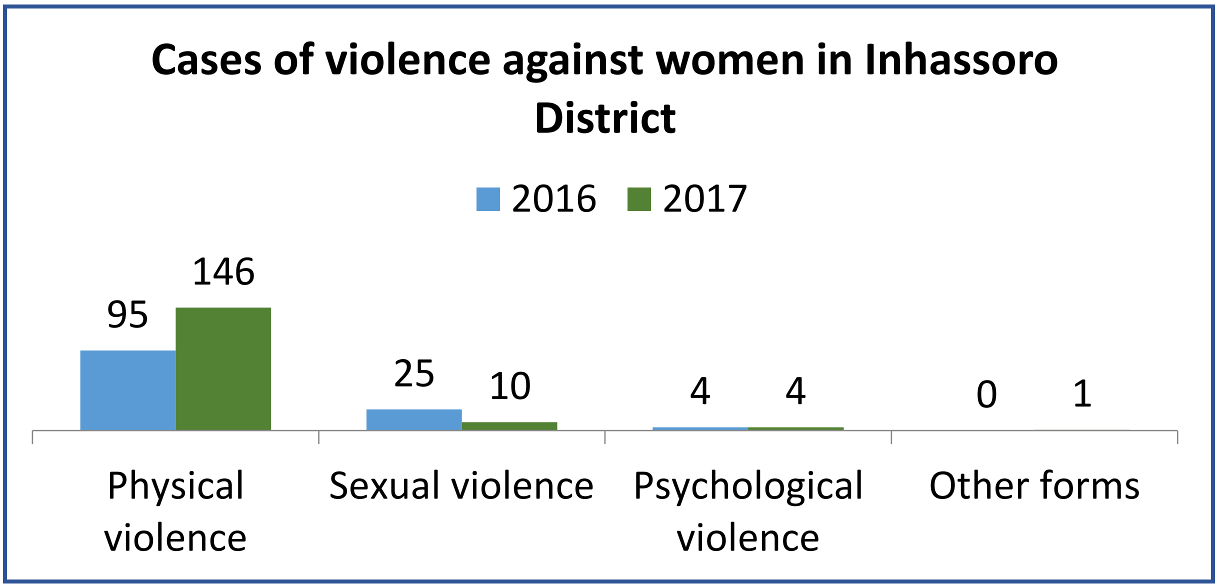


Figure 103: Cases of violence against women in Inhassoro District, 2016-2017

Source: Inhassoro District Annual Report, 2016 and 2017

6.3.3.13 Maternal and Child Health

Key indicators for maternal health include maternal mortality, access and quality of antenatal care, delivery care and postnatal care. Data for Inhassoro District show that the number of institutional deliveries increased by 40% between 2014 and 2017. The leading causes of maternal morbidity were pre-eclampsia/eclampsia, obstructed labour and haemorrhage. No cases of maternal deaths was recorded in the district between 2014 and 2017. Access to antenatal services in the district is nearly universal, with 96% of pregnant women in 2017 receiving the full component of skilled antenatal care.

Childhood immunisation against common ailments is an important factor that ensures proper child growth and development; with implications into adulthood. Mozambique childhood immunisation schedule is well aligned to the WHO recommendations. Inhassoro District has an adequate immunisation programme, with full immunisation coverage increasing from 84.5% in 2014 to 98.8% in 2017. Each of the individual vaccines (in 2017) reached the minimum 80% threshold required for herd immunity indicating that the local communities are generally well protected against outbreaks from the vaccine preventable diseases.

6.3.4 Economic Activities and Livelihoods

To determine how the respondents, make a living they were asked to name the three main economic activities performed by the household. Subsistence agriculture was indicated as the principal economic activity, followed by poultry and small-scale fishing which was the third most cited category of activities. Activities that are least practised include tourism, sea product collection and commercial agriculture. The survey team did not find communities that depend solely and entirely on fishing, only members of communities who combined fishing with other “inland” activities.

Subsistence agriculture was named as one of the three ways of making a living by every respondent of the Temane and Litlau communities. Mangarelane (78.9%), Chipongo (85.3%) and Mangungumete (88.2%) indicated subsistence agriculture fewer times in their responses. Rearing of poultry was mentioned in a range of 14.7% (Mangungumete) to 75.8% (Temane). Small-scale fishing follows a very specific geographic distribution: in the coastal communities of Mangarelane (68.4%), Chipongo (50.0%) and Mapanzene (47.1%) about half of the interviewees mentioned it as a way of survival. With the exception of Maimelane and Mabime (2.9% and 5.4% points respectively), no other communities referred to small-scale fishing. Munuvalate and Pambara are predominantly subsistence farmers and livestock breeders, but they have a large charcoal production operation which sells charcoal commercially. The charcoal production activity is the most lucrative income source for these households (responses from Golder FGDs, 2015). These livelihood options are discussed further in the next sections.

6.3.4.1 Employment

In 2009, ERM and Consultec (2009) reported that apart from the few school teachers, health workers and other government employees, the only available employment is either directly with Sasol or with the companies contracted to provide various services to the existing Sasol activities. These include security guards for gas well sites, workers in the gas processing facility, and ad hoc construction work. During the 2015 and 2018 fieldwork conducted by Golder, no new sectors of employment were identified. Nearly two-thirds of respondents (64.2%) run their own business as the main source of regular income, this includes the livelihood activities discussed in the next sections. Other employment was indicated as follows: in the private sector (17.7%), work at Sasol (8.0%), in the informal sector (6.0%) and lastly the public sector (4.0%). Relying on own businesses is particularly common in Chipongo (90.6%), Mapanzene (84.8%) and Temane (81.8%), with several other communities also reporting high numbers (Mabime – 69.4%, Litlau – 65.6%, Manusse – 64.7% and Maimelane – 60.0%).

Income from the public sector is completely absent in Mangarelane, Mapanzene, Manusse and Temane. Work at Sasol, albeit in small numbers, is relatively well distributed among the communities, with the exception of Manusse and Mabime where no one indicated being employed by Sasol at the time of the 2014 survey (this was not surveyed during the 2018 baseline update). Employment with Sasol is either for the company itself or for the companies contracted by Sasol to provide various services.

These include security guards for well sites, workers in the gas processing facility and ad hoc construction work. Ad hoc opportunities include those provided by past development phases of the gas field, during the rehabilitation or maintenance of the main highway, or construction of fuel stations and other social or commercial facilities. Some local people were employed in past gas field construction phases between 2004 and 2006 but for a short period only. Local communities consider that there were no long-term benefits from this employment and that recruitment favoured those living closer to the CPF west of the EN-1 highway.

The threat of political instability over recent years has caused a serious downturn in the tourism industry of the Inhassoro District. Tourism establishments in and around Inhassoro, and to an extent Vilanculos, have reported a drastic reduction in bookings, however it is believed to have stabilised in the past couple of years. This currently is believed to be significantly affecting the flow and spread of income to the district and employment opportunities in the tourism industry. Fishing from the sea provides income to a large proportion of economically active people in Mangarelane, Mapanzene and Chipongo, where most men are practising fishers and where fishing is the main source of family income either in cash or goods. When beach seine fishing is not practised in the closed season, most fishers pursue other forms of income generation and in good years cultivate and benefit from the winter agricultural harvest (ERM/Consultec, 2009).

Household income is directly correlated with the structure of their expenses. The questionnaire, therefore, obtained information on household expenses. “Food” was the main expense (86.9%). At least 80% of respondents in all communities stated that food was the main expense, except for Temane where 69.7% of interviewees listed food as their main expense. Education was listed as the second major expense (4.6%), followed by health (2.4%) and clothing (0.9%). In Maimelane and Temane, however, more than half (53.3%) of respondents reported education as their main expense.

6.3.4.2 Food security

Vegetable and fruit production

The three main crops produced are maize, groundnuts and cowpeas. Potatoes, millet, sweet potatoes and vegetables are the crops least mentioned as part of agricultural activities. Maize production is consistently undertaken among the different communities, and Chitsotso – the village with the lowest responses – registered maize as the most used crop. The same can be said about groundnut which had the lowest respondents’ in the other communities except for Manusse which recorded well above three-quarters of all crops. The existence of potatoes was only registered in Mabime, millet in Manusse and Chitsotso, and sweet potato in Temane.

Household food supply is supplemented with natural resources collected by the communities in the project area. Villagers collect wild fruits and berries in the resource areas around their communities. Other grown fruits and vegetables within the study area include mangos, marula, paw, chilli pepper, nuts, pumpkins and cassava. Figure 104 shows fruits and vegetables sold by a roadside vendor (Golder, 2018f).

Figure 104: Fruits and vegetables sold by a street vendor within the study area

6.3.4.3 Livestock

Chickens and goats are the main livestock species in the communities. Cattle and sheep are reared by very few of the interviewees. Chickens are reared by more than two-thirds of the respondents in every community with the exception of Maimelane where it was closer to 50%. Goat rearing is practised in all areas with the exception of Maimelane, goats are generally kept for household consumption, local sale and to perform traditional rituals. Unfortunately, goat farming lack appropriate goat farming and management techniques resulting in poor supply. Maimelane community is the only community which reported cattle farming. Sheep rearing was prevalent only in Chitsotso. Figures Figure 105 and Figure 106 illustrate grazing cattle and goats to the west of the Govuro River (Golder, 2018f).

Figure 105: Grazing cattle, photographed to the west of the Govuro River

Figure 106: Grazing Goats, photographed to the east of the Govuro River

6.3.4.4 Fishing

The inland villagers fish from nearby freshwater areas (streams, wetlands etc.). The coastal villages utilise the beach area for communal fishing. Fishing is an activity done by all members of the household utilising methods of line and hook or nets and sold at local markets (Figure 107).

Figure 107: Sale of fish at the local market, Inhassoro

6.3.4.5 Charcoal production

The growing demand for charcoal for use in towns and cities along the coast and in other Districts has made charcoal production more economically rewarding for local communities, putting pressure on the natural woodland resources of the district. This also applies to the sale of firewood. Stacks of cut and neatly piled firewood can be seen for sale along the EN1 and along the gravel road leading from Inhassoro to Vilanculos through the eastern parts of the study area. Community members interviewed separately by the ecology team during their February fieldwork indicated that the harvesting and selling of firewood for some low-income households is one of the most important sources of income. Responses from Golder FGDs in 2015 maintain the same statement that charcoal is the most lucrative cash income source for households in the project area.

6.3.4.6 Palm wine production

Local communities also harvest the palm locally known as Uchema to produce palm wine. Palm wine is sold and consumed by households. The sale of palm wine contributes minimally to household income. The palm appears to be sustainably harvested and is often left in agricultural land due to their economic value.

6.3.5 Tourism

The town of Inhassoro has developed into a popular tourist location for both holiday and fishing enthusiasts due to the scenic and tranquil environment, recreational and game fishing for amateurs, sport fishing competitions, snorkelling, scuba diving and windsurfing.

Inhassoro lies directly opposite the northern point of the Bazaruto Archipelago with Santa Carolina Island in clear view between Bazaruto and the mainland. Santa Carolina and Bazaruto Island lie approximately 15 km and 25 km offshore form Inhassoro respectively.

This small fishing village has a relaxed atmosphere, and many travellers now choose to base their holiday here, rather than in the bigger, busier town of Vilanculos, 80 km south. There are several restaurants, a lively beach bar serving ice cold beers, a few shops, banks, bakery, hardware store and fuel station. The town also hosts the Central African Deep-Sea Angling Society Mozambique fishing tournament and other fishing competitions. Transfers are available from the international airport at Vilanculos to Inhassoro and from Inhassoro to Bazaruto Island by boat. The Bazaruto Archipelago is considered one of East Africa's best and certainly Mozambique's premier fishing destination. Bazaruto Archipelago offers upmarket tourist accommodation and facilities such as fishing, scuba diving, snorkelling, saunas etc. while Inhassoro caters, to a large extent, for the middle-class holidaymaker and fishermen.

The Bazaruto Archipelago National Park lies within the study area. Designated in 1971, it was the first official National Park in Mozambique, and initially comprised the three southernmost islands Bangue, Magaruque and Benguerua, together with a contiguous sea area extending 5 km to the west and to the 100 m line of bathymetry to the East. The protected area was then extended in 2002, to include the remaining islands of the archipelago (i.e. Bazaruto and Santa Carolina), and was renamed as the Bazaruto Archipelago National Park, with a total area of 1,430 km^2.

6.3.5.1 Accommodation

Tourist accommodation on Bazaruto Island is "full board", while the majority of the facilities in Inhassoro are bed and breakfast and self-catering facilities. Official sources list 54 accommodation facilities located in Inhassoro, however, when analysing the actual location of these facilities it appears that only 32 facilities account for the majority of the tourists visiting Inhassoro town. The tourist accommodation on Bazaruto Island is located on the west coast of the island with Pestana Bazaruto Lodge Hotel on the northern end of the island and Anantara Bazaruto Island Resort and Spa approximately in the centre of the island, all facing west. The accommodation facilities on the island cater for upmarket tourists and both facilities overlook the sea channel between Inhassoro and the island.

Table 36: Physical data of the tourist focused facilities

Town or Island	Number of Facilities	Number of Beds	Average Annual Occupation Rate	Average Annual Bed Nights	Permanent Employees
Inhassoro	22	782	38%	103 492	213
Bazaruto Island	2	274	40%	50 005	628
Total	**24**	**1 056**	**39%**	**153 497**	**841**

Source: Conningarth Calculations and deduced from data gathered material

The average self-catering facility fee is estimated at US$56.80 per person sharing and the full-service catering at about US$314.30 per person sharing (Table 37). It also appears that a very large percentage of tourists using the self-catering units are from South Africa and Zimbabwe and tend to bring large quantities of food and other supplies with them.

The sea excursions are divided in to three categories:

- Pleasure excursions;
- Fishing charters, and
- Snorkelling/diving excursions.

There are approximately 69 boats based in Inhassoro which offer pleasure cruises or recreational fishing excursions, each boat has one operator per boat. The average number of trips per day varies considerably from the peak season to the off-season; it is not only the number of trips that varies, but also the number of boats involved.

Table 37: Estimated annual financial turnover on accommodation, food and extras and sea excursion spending

Town/Island	Accommodation		Food & Additional Spending		Boat Trips		
	Daily	*Annual*	*Daily*	*Annual*	*Fee/Day*	*Number/ Year*	*Annual Income*
Inhassoro	$56.80	$5 878 131	$12.00	$1 241 905	$66.58	855	$56 921
Bazaruto Island	$314.30	$12,573,114	$4.00	$160,016	$0.00	0	$0
Total		$18,451,245		$1,401,921		855	$56 921

Source: Conningarth Calculations and deduced from data gathered material

The table shows that the total estimated annual tourist spending on both the Inhassoro Beach and Bazaruto Island is $18 451 245.

6.3.5.2 Tourist Characteristics

According to the baseline survey conducted in June 2018, between 60% and 80% of the tourists using the Inhassoro facilities are from South Africa or Zimbabwe with another 10% to 20% from Mozambique itself. The structure of the fees indicate that they are mostly family groups, youth groups or fishing enthusiasts coming to enjoy the scenic beaches, diving and fishing experience, targeting mainly the bed and breakfast or self-catering facilities. It is also clear that high occupation numbers are experienced over the peak holiday season from November to January and during the Easter holiday period.

The fee structure of the Bazaruto Island accommodation facilities together with the accompanying services offered and the numbers of employees per facility indicate that the average guests are from the higher income group, with many International visitors. Though these facilities also experience a high occupancy during the summer months they experience a less dramatic drop in occupancy during the winter months.

6.3.6 Cultural Heritage Environment

The cultural heritage assessment has been undertaken in accordance with World Bank Group PS 8: Cultural Heritage (2012), which seeks to protect cultural heritage from the adverse impacts of project activities, support its preservation and promote the equitable sharing of benefits from the use of cultural heritage. With reference to the definitions of cultural heritage detailed in PS 8 and the Mozambican Law on the Protection of Cultural Heritage 10/88 (1998) the assets that were considered in collation of the baseline environment comprise:

- Archaeological sites and artefacts;

- Historic structures and districts;
- Palaeontological sites;
- Cultural landscapes;
- Cultural or religious sites; and
- Intangible heritage practice.

Baseline data gathering was undertaken in January 2015 and June 2018, encompassing the proposed power plant site, new transport routes, the beach landing options, the transmission line, the associated gas/water pipeline and villages within c 2.5 km of these footprints. The baseline was supplemented by baseline information gathered by Golder Associates and Rrequal Ltd & Ancient Ltd for Sasol's PSA Project during May 2014. The study of cultural heritage encompasses all elements as defined by Mozambican law including: archaeology, historic sites, graves and sacred places as well as related traditional practices and immaterial (intangible) heritage. Although there are no statutorily protected sites within the project area, project-related disturbance has the potential to permanently remove unique cultural heritage features protected by Mozambican law.

The cultural heritage community consultations for the CTT project were completed in conjunction with the archaeological field surveys in 2015 and 2018. Key Informants were identified in those nine villages within the study area. Key Informants were elder members of the community, often village leaders, selected for their knowledge of local traditions and sites, and their willingness to share with the survey team. One to one interviews were held (in the appropriate local dialect e.g. Xitswa) in order to ascertain the likelihood for places of religious and cultural importance to occur.

The CTT Site is situated in an important area in relation to Iron Age social formation and settlement along the Indian Ocean coast of southern Africa. Sites located within the study area have been dated to the Iron Age. These include one Early Iron Age site (AR-111) and six Late Iron Age sites (AR-103 – 105, AR-110, AR-112 and AR-114 – 115). AR-111 is a pottery scatter site possibly indicative of a small farming community. The site is situated south east of Manusse, approximately 5 km west of the powerline route. The Late Iron Age sites are also evidenced by pottery scatter without exception. Iron slag was also observed at site AR-105 (adjacent to the transportation route at Temane) and a shell midden deposit was recorded at site AR-114 (coastal, east of Mapanzene). Site AR-114 is situated north of Seta, on the coast. Archaeological evidence was found to be limited at this location however, a shallow shell midden was observed (Figure 108).

Figure 108: Shell midden deposit at AR-114 (Adamowicz, 2015)

Figure 109: Cultural Heritage study area

Dispersed pottery scatter was evident throughout the area surveyed with concentrations observed in areas of predicted historic (primarily Iron Age) agricultural and/or settlement activity. The number of archaeological sites inspected were found to have been damaged as a result of human (agricultural) or climate induced erosion. A small amount of lithic scatter was also recovered, indicative of typologies common across Prehistoric southern Africa.

The artefacts identified during the 2015 fieldwalking phase, namely pottery, shell and lithics, are considered to be typical of those well-known sites along the southern coast of Mozambique. The identification and analysis of tangible archaeological material (artefacts) was, however, limited to that recovered during surface inspection. The relationships (if any) between the surface scatters observed (lithics, pottery, shells) and any sub-surface remains (e.g. settlement and/or industrial activity) cannot be verified at this stage.

Further investigation will be required to determine whether these remains are indicative of past activity in the immediate project locality or purely representative of ephemeral, possibly migratory, landscape exploitation. There remains a potential for previously unidentified archaeological sites and artefacts to exist within the study area.

At present, the artefacts identified within the study area are categorised as ‘Moveable’ cultural heritage as defined by Mozambican Law (10/1988) and no features were found which could be classed as ‘Critical’ or ‘Non-Replicable’ cultural heritage, as defined by IFC (PS 8, 2012).

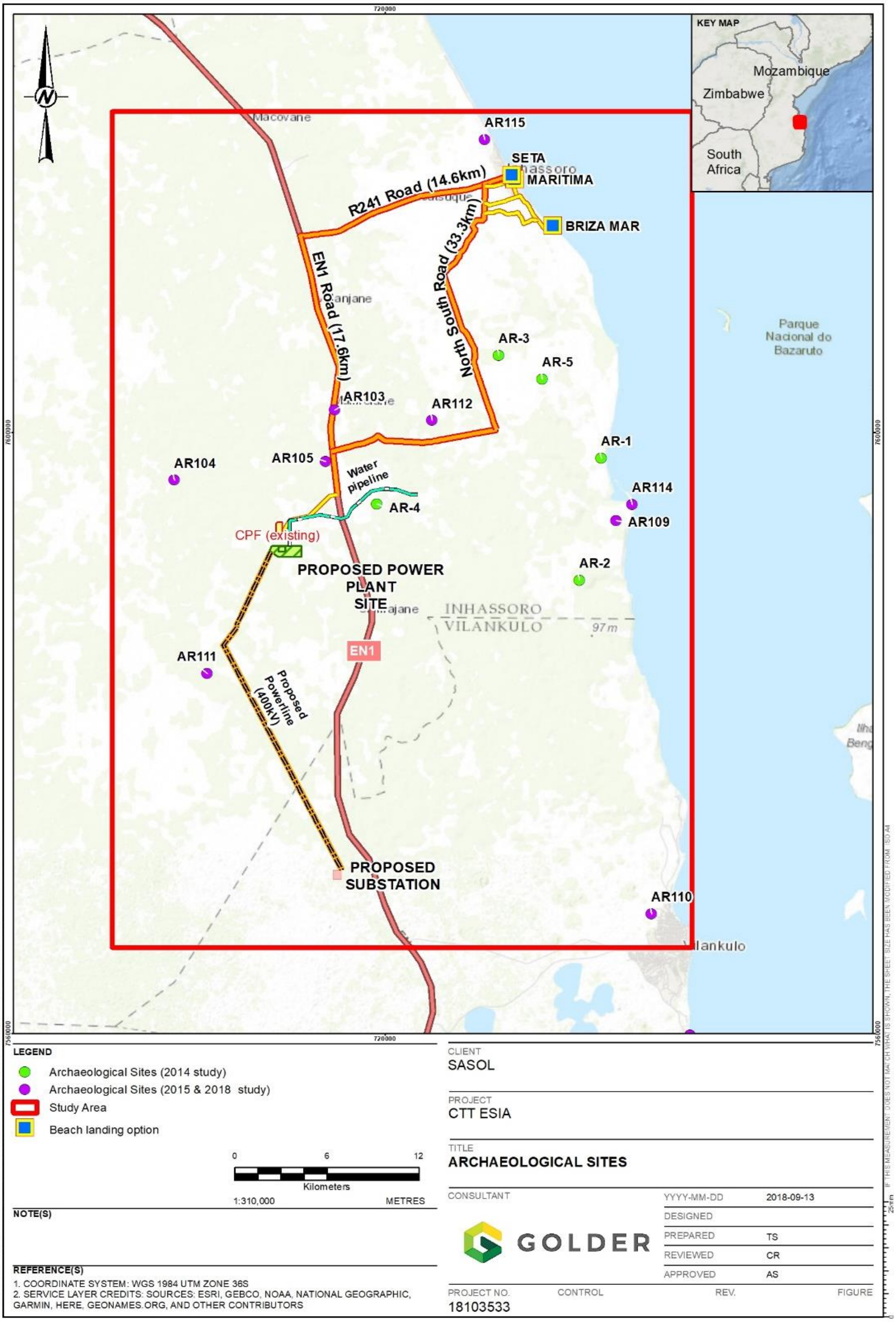


Figure 110: Archaeological sites within study area

6.3.6.1 Community Consultation and Cultural Survey

The oral tradition was found to be a strong feature among the Xitswa-speaking communities within the study area. The natural landscape and fishing customs are associated with stories, legends, songs and pottery, passed from one generation to the next. These elements of intangible heritage are highly valued by the local communities, enhancing their sense of identity, it has however meant that written settlement histories are scarce and village-founding dates and associated information many vary from person to person.

6.3.6.2 Cemeteries and Burials

Communities were primarily recorded to bury their dead within settlement areas, near houses, rather than in demarcated burial grounds. Nine burials for community leaders were recorded in the study area (BU-101 – 09) in 2015, as well as four cemetery sites (e.g. associated with religious buildings), CE-102–105. It should be noted that the 19 burial and cemetery sites identified in 2015 and 2018 are in addition to 26 sites recorded in 2014 for the PSA and LPG project survey.

Furthermore, during both the 2014 and 2015 fieldwork, a high potential for unmarked burial sites along the roads between the villages in the study area was identified, particularly near Mabime; Mapanzene and Mangugumete, possibly where unknown individuals were laid to rest during the civil war. These locations are well known to the community. The presence of Baobab trees are also considered as indicators of an important burial site by the local communities (particularly if the tree is very mature).

Seven sites of cultural importance ‘sacred places’ were identified in 2015, these include six sites within the cultural heritage study area (SP-102 – 107). No additional sacred places were recorded in 2018. The known sites comprise sacred trees, sacred forest and a sacred pool. It is considered that all identified sacred sites fall into IFC’s ‘Non-Replicable’ category (PS 8, 2012) and are defined ‘Immoveable’ by Mozambican Law (10/1988).

6.3.6.3 Archaeological Site Valuation

As a result of the literature review and survey phase the archaeological potential of the Inhassoro area is considered to be relatively high. This potential relates to its favourable geographic location, making it an attractive place for prehistoric settlement. However, those archaeological sites presently recovered within the study area ultimately amount to artefactual surface scatter; none of these are unique to the region’s archaeological record. In summary the archaeological sites within the study area, AR-102 – 105, AR-109 – 112 and AR-114 - 115 are valued as low – medium to account for their potential research value. Sites beyond the study area AR-101, AR-106 – 108 and AR-113 are valued as high to account for their protected status and proven research value.

6.3.6.4 Cultural Site

The significance of the cultural sites identified in the study area has been calculated in terms of the potential negative impact on the community in the event that they (the community) or the sites themselves are relocated. Burial sites and sacred sites which provide tangible ancestral links to the past (e.g. a sacred tree) are considered particularly sensitive and ‘immovable’. Those features associated with unique, intangible, cultural practice (medicinal plants, sacred sites) are also highly sensitive. In summary, all sacred places (SP-101 – 107) are valued as high.

Baseline data gathering undertaken in 2015 identified 36 potentially significant cultural heritage sites within the study area (plus 10 outside) (Figure 111), primarily comprising archaeological surface scatters of Iron Age date, suggestive of seasonal hunting/fishing activity, and cultural sites, including graves and religious or locally sacred places An additional seven cultural sites (burials, cemeteries and churches) were identified within the study area in 2018. A total of 44 sites from the 2014 survey were recorded in the study area of the CTT project.

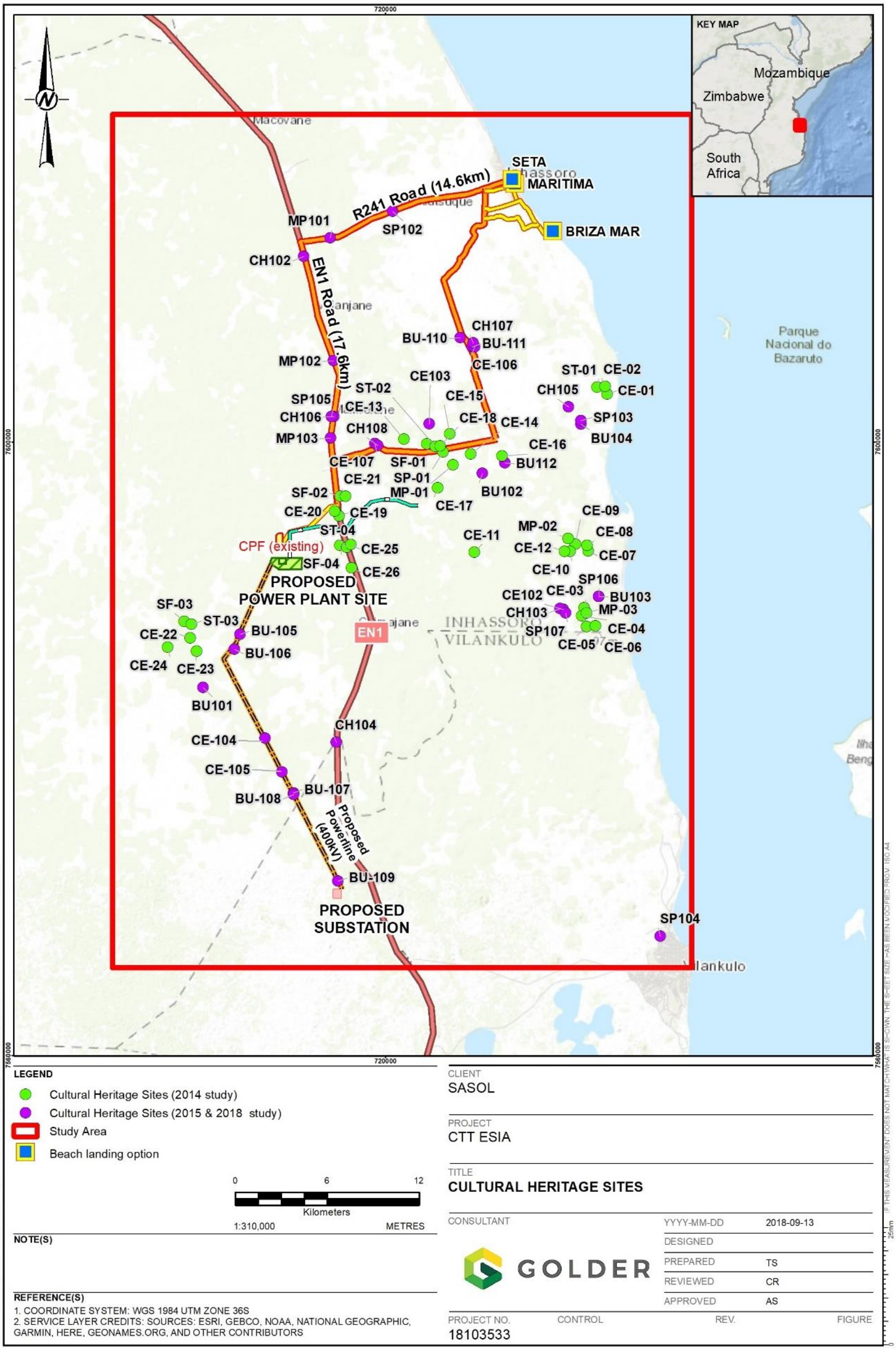


Figure 111: Cultural sites within study area

6.3.7 Traffic Assessment

A Traffic Impact Assessment was undertaken to understand the impacts associated with the increase in heavy vehicles caused by the proposed project. The key aspects of the study revolved around the beach landing sites and the transportation route alternatives.

The following road sections were surveyed as shown in Figure 112:

- Section A: Seta - R241 Inhassoro beach landing to EN1 (14.4 km);
- Section B: EN1 - From R241 Intersection to CTT Turnoff (17.6 km);
- Section C: Brisa Mar - From Intersection X to Brisa Mar Beach Landing (3.21 km);
- Section D: Shortcut Road - From Point E (2,8km north of CPF turnoff) to North South Road (11 km);
- Section E: Local Road – From Intersection X in Inhassoro to North South Road (2.3 km);
- Section F: North South Road (18.3);
- Section G: From Brisa Mar Access to North South Road (4.15);
- Section H: CTT Access – From EN1 to CTT (4.7 km);
- Section I: Maritima to North South Road (1.77 km); and
- Section J: Inhassoro Monument (R241) to Intersection X.

Access routes from the beach landing areas were first evaluated, then other local internal sections and major sections and, finally, sections were combined into routes and analysed further.

A Health and Safety Plan and a Traffic Management Plan shall be prepared by the Contractor and reviewed, approved and monitored by the Construction Supervision Consultant. The RAP will also need to address any temporary economic displacement of businesses and PAPs along the beach landing site and the access roads going to the power plant.

6.3.7.1 Seta Beach Landing Access

The road reserve is approximately 18m wide and can easily accommodate the abnormal vehicles. Should a reverse movement be required for the trailers on return from the delivery then this could be easily achieved within the current road reserve due to the T-Junction configuration. Direct access to the R241 is quite easy from this beach landing location

6.3.7.2 Maritima Beach Landing Access & Road Section J

Adequate road reserve is available to accommodate abnormal vehicles along Road Section J. However, there are various businesses located along Road Section J, for instance a business named Handling distributes retail products from a warehouse and retail outlet. Heavy vehicles were seen collecting and delivering goods throughout the day. Abnormal vehicles would have to make a left turn from the local road into the access road on their return trip and a right turn from the access road going towards the R241 as shown in Figure 113. Low hanging power cables will also need to be extended to accommodate abnormal load vehicles. Fishermen are very active along the coastline between the Seta and Maritima Beach Landing locations

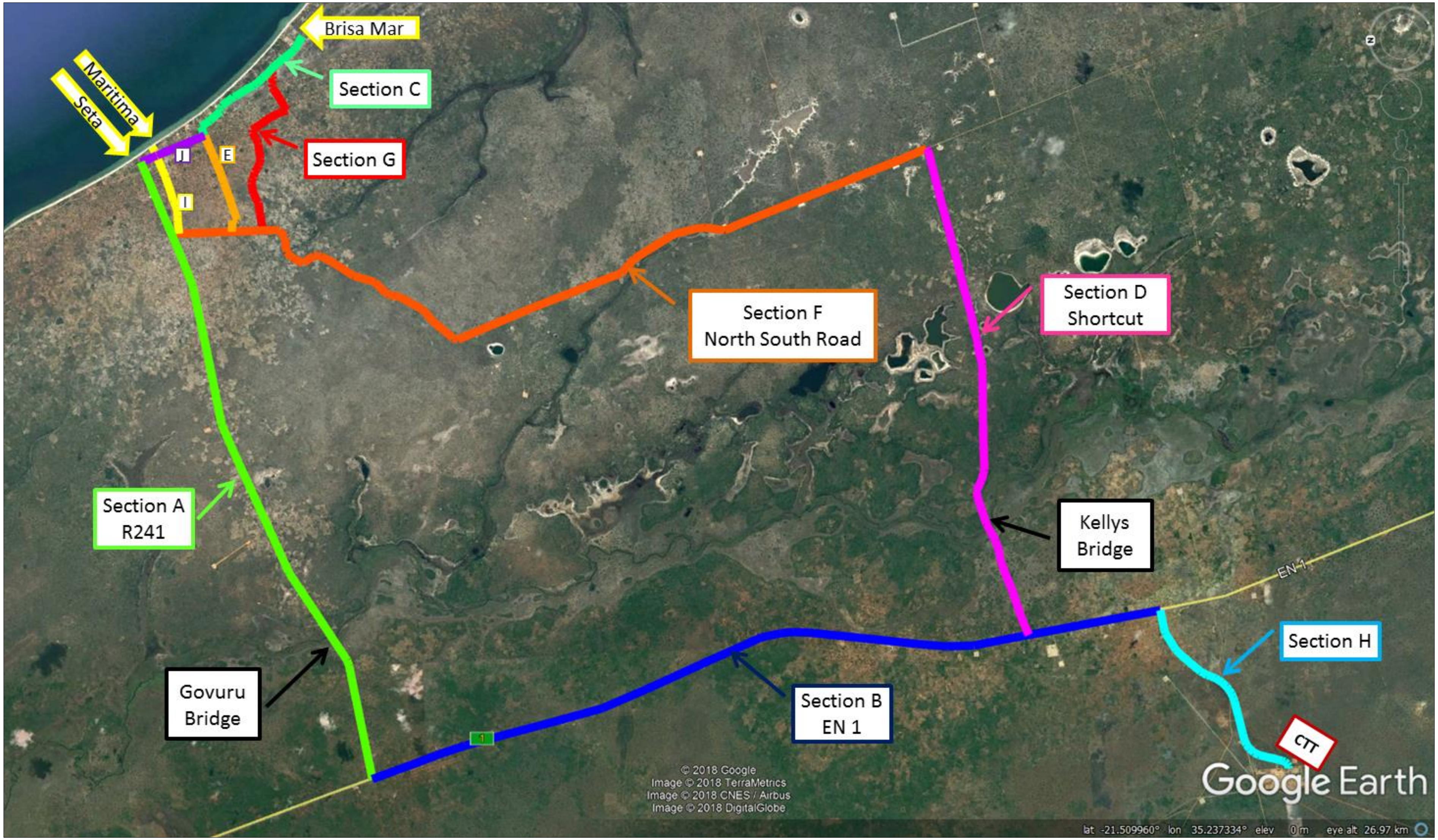


Figure 112: Sections Surveyed (Source: Google Earth)

Figure 113: Maritima Access Road to the left past the tree

6.3.7.3 Brisa Mar Beach Landing Access & Road Section C

Figure 114 shows the 4th four-way intersection leading to Brisa Mar 1.49 km south of the R241. At this point the road is no longer tarred and becomes a winding track towards Brisa Mar. The beach landing site does not have a steep slope toward the sea and is similar to Maritima in this respect. Low hanging power cables will have to be extended to accommodate abnormal load vehicles.

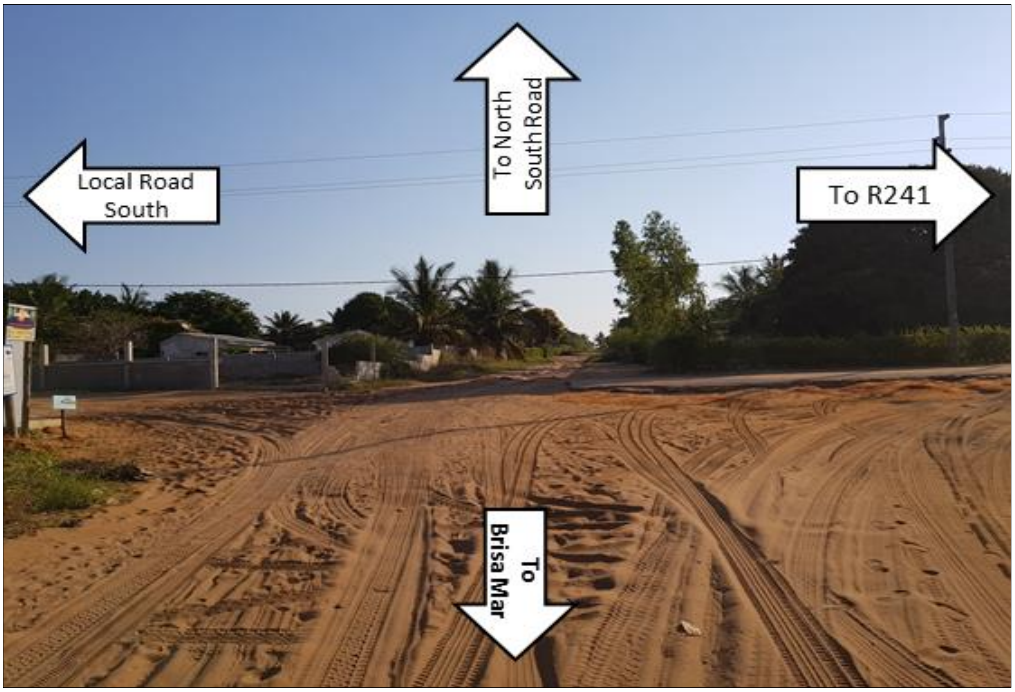


Figure 114: Intersection X before Road to Brisa Mar

6.3.7.4 Local Roads assessed

Over and above Road Sections C & J that was mentioned in the previous sections the following four local road sections were also evaluated, as shown in Figure 115:

- Section E: From Intersection X to North South Road (2.3 km);
- Section G: From Brisa Mar Access to North South Road (4.15 km);
- Section I: Maritima to North South Road (1.77 km); and
- Section J: Inhassoro Monument (R241) to Intersection X (1.49 km).

Section C: Brisa Mar - From Intersection X to Brisa Mar Beach Landing (3.21 km)

Section C is 3.21km long and consists of a sandy track that starts at the intersection from Road C to Brisa Mar and ends at the Brisa Mar Beach landing access point, 350 m from the Brisa Mar turnoff. The track winds through the area that is sparsely populated. Low hanging power cables will have to be extended.

Section E: Local Road – From local road in Inhassoro to North South Road

Section E is 2.3 km long and consists mainly of a sandy track that starts at the intersection with Road J and ends at the North South Road to the east. The area surrounding the road is residential and the main mode of transport was seen to be walking along this road. Safety for pedestrians would be a major concern as the road reserve is in some areas less than 10 m wide.

Section G: From Brisa Mar Access to North South Road

Section G is mainly bush with some sections a sandy track that goes through a tribal type of residential area as at nears the North South Road. Pedestrian safety would also be a concern in the residential area should abnormal loads be transported through this rural area.

Figure 115: Local Road Sections (Intersection X marked)

Section I: Maritima Beach Landing to North South Road

Section I is an existing sand road that runs parallel to the R241 and connects the Maritima Beach Landing site with the North South Road. It travels through a residential area where the road reserve varies from 15 m to 20 m and direct property access is allowed to the sandy road. Pedestrian safety would also be a concern in the residential area should abnormal loads be transported through this area.

Section J: Inhassoro Monument (R241) to Intersection X

Section J is the main collector road linking the lodges facing the sea. Various businesses are located along this road. It consists of a black top road without any kerbs. Low hanging power cables, pedestrians and delivery vehicles will be points of conflict with abnormal loads along this road.

6.3.7.5 Major Linking Sections

Major linking sections are defined as the R241, EN1, North South Road, the Shortcut Road between EN1 & the North South Road as well as the link to the CTT site.

Section A: R241 – Inhassoro area

The road consists mostly of a 6m wide black top road. Damage to the edge of tar (edge cracking) can be seen in various areas, however the road is without any major potholes. Maintenance will be required in the near future. Low hanging power cables will have to be extended to accommodate abnormal loads on the road. The approach from Inhassoro to the EN1 intersection is shown in Figure 116 and Figure 117 The turning radius is gradual and the long trailers will be able to traverse this movement easily.

Figure 116: R241/EN1 Intersection: Eastern Approach

However, the turning movement (yellow turning arrow) from the EN1 onto the R241 would require some improvement to accommodate the abnormal vehicles.

Figure 117: R241/EN1 Intersection (Source Google Earth)

Section B: EN1 - From R241 Intersection to CTT Turnoff

This section is 17.6 km long and starts at the EN1/R241 intersection ending at the turnoff to the Sasol CTT plant access road. The EN1 is in good condition for approximately 1.6 km from the EN1/R241 intersection in the southern direction. However, after this point the quality of the road does deteriorate, and potholes are seen from time to time. Evidence of edge cracking can also be found along this road.

Severe deterioration of the black top can be found 2.8 km from the EN1/R241 intersection. Fortunately, road maintenance is done on this road and evidence can be found where the washed-out shoulder material is replaced with sand and potholes are filled and compacted. The turnoff to CTT from the EN1 does have a short right turn lane and bypass lanes for through traffic on the northern approach. Traffic on the southern is accommodated by means of a left turn lane into the CPF access road and one through lane. This is a busy intersection in terms of pedestrian traffic as many businesses have developed over time at this intersection. Both the wester approach and the northern approach have low hanging cables that will need to be extended.

CPF Existing Access Road for the CTT

As shown in Figure 118 the road surface to the existing CPF, which will be used for the CTT is well maintained, without potholes, and is 7 m wide. The speed is 50 km/h along the road, pedestrian and bicycle, activity was observed.

Figure 118: CTT Access Road

Fuel Tanker trucks were observed queueing outside the facility waiting to be hailed to the Gantry. Special care must be taken so as to minimise the conflict between abnormal vehicles queueing/holding outside the facility and abnormal vehicles delivering heavy equipment.

EN1/North South Road Shortcut

The start of the access road is located 2.89 km north of the CTT access from on the EN1 as shown in Figure 119. It is a dirt track and only one vehicle wide. It crosses the Govuro River over a pipe bridge as shown in Figure 120 This track passes through a tribal area with scattered villages along the way and joins the North South Road. Overhead power cables can be found along the route that will have to be accommodated should a more formal road be constructed through this area.

Figure 119: Shortcut road starting point on EN1

Figure 120: Shortcut road pipe bridge

North South Road

The North South Road starts in Inhassoro and continues south until it reaches Vilanculos. It is a well pad road and in most places between 6.5 m and 6.7 m wide as shown Figure 121**.** As it the road nears the town of Inhassoro the road changes from a well pad road to a black top road as shown in Figure 122. The black top road is 2 km long and 5 m wide.

Figure 121: North South Road 970 m from shortcut road

Figure 122: North South Road near Inhassoro

6.3.8 Visual Attributes of the Study Area

6.3.8.1 CTT power plant and transmission line visual resource value

The visual character and resource value of the power plant and transmission line study area is considered representative of that of the larger region, as illustrated by Figure 123 and discussed below:

- **Topography**: The topography of the inland study area is mostly flattish to gently rolling or undulating, with no prominent landforms occurring in the vicinity of the power plant and transmission line site. A low ridge is located several kilometres east of the site, between and roughly paralleling the EN1 national road and coastline. Although this feature is expected to screen the proposed power plant from view to some extent, it is not visually prominent. The visual resource value of the study area topography is therefore rates as being low (1);

- **Water bodies**: The majority of the eastern half of the study area located between the coastline and the EN1 national road contains numerous pans of varying sizes and extensive wetland areas, while the Govuro River roughly parallels the road from north to south. Conversely, the more inland western half of the study area is noticeably dryer with almost no pans present, although a number of less obvious and possibly ephemeral wetlands are still in evidence. The degree to which water bodies contribute to the visual resource value of the overall study area therefore varies from east to west, however the majority of the more visible water features are located more than five kilometres from the site itself. For this reason, their visual resource value in terms of the study area as a whole is estimated to be moderate (2);

- **Vegetation cover**: The vegetation cover varies somewhat throughout the study area, ranging from cleared grazing and open grassland sparsely dotted by shrubs and small trees, to relatively dense bushveld. In addition, the settlement areas also contain a variety of exotic ornamental garden and fruiting plant species, which noticeably contrast with the more indigenous vegetation. However, from a *visual perspective* the visual character of the majority of the study area vegetation cover appears to represent the native vegetation communities. Coupled with the mostly low levels of development, the visual resource value of the vegetation within the study area is therefore considered moderate (2);

- **Visual absorption capacity**: The VAC of the power plant and transmission lines study area varies somewhat in accordance with the changes in vegetation cover and levels of development. However, as a whole the study area VAC is considered to be moderate (2), due to the mostly low vegetation height and varied density, as well as low levels of development; and

- **Sense of place**: The power plant and transmission line study area are visually similar to much of the area immediately inland of Mozambique's coastline, and possesses few to no discernible distinguishing features. However, the rural and largely undeveloped nature of the entire area could be perceived as evoking a sense of peaceful solitude with at least some visual appeal and is therefore rated as moderate (2).

Figure 123: Landscape visual character of the proposed power plant site

Figure 124: Visual character of the power plant and transmission lines study area

The visual resource value of the power plant and transmission lines study area was subsequently determined using the score ranges provided in Figure 124, based on their individual visual baseline characteristic scores, as summarised in Table 38.

Table 38: Visual resource value - CTT plant and power line study area

Visual baseline attribute	Topography	Water bodies	Vegetation	VAC	Sense of place
Visual resource value score	1	2	2	2	2
Total visual resource value score					**9 (moderate)**

6.3.8.2 Beach landing sites visual resource value

The visual resource value of the potential beach landing sites is considered to be more or less equal for all three sites, due to their largely similar visual character, as illustrated by Figure 125 to Figure 127 and discussed below.

- **Topography**: The topography of all three beach landing sites is typical to the Mozambique coastline, characterised mostly by low rises and rolling sand dunes. In this respect, the landscape is therefore dominated by the strongly linear horizon line formed by ocean, which in itself has a particular and unique appeal. However, as there are very few prominent landforms at any of the landing sites the resource value of this aspect is rated as low (1);

- **Water bodies**: The visual character of all three beach landing sites is largely defined by the ocean and associated strip of beach. This specific attribute is considered one of the major attractions of the country as a whole and responsible for much of its tourism, and is therefore rated as having a high visual resource value (3);

- **Vegetation cover**: The vegetation along the populated sections of Mozambique's coast is usually a mixture of native indigenous and exotic garden species, as is evident at all three beach landing sites. In some instances, the exotic species are visually incongruous, and could therefore be argued to detract from the overall resource value of the study area. However, some of the larger trees are appealing in their own right, and strips of vegetation representative of the indigenous coastal plant communities are still in evidence along sections of beach. For this reason, the visual resource value of the vegetation cover at all three landing sites is rated as moderate (2);

- **Visual absorption capacity**: The VAC of a landscape is determined by the relationship between a number of factors, including the levels and nature of existing development and landscape transformation, overall vegetation density and to a lesser extent the topographical character of the area. The landing sites are generally characterised by low density to sparse development, vegetation cover of varying height, and landscape topography that is not highly varied. The VAC of all three beach landing sites is therefore considered to be moderate (2); and

- **Sense of place**: Sense of place is arguably the most subjective and intangible aspect of the landscape visual resource value, as it is a function of the relationship between all the other attributes, as well as how people perceive these. Furthermore, sense of place also considers how "unique" a visual landscape is within its greater contextual setting, i.e. to what extent it can be distinguished from other sites or areas in the greater vicinity. Essentially, the three beach landing sites are characterised by the same "types" of visual components, although each site differs somewhat in appearance due to the types of development present. The SETA site is located at the terminus of an existing road, which passes through the built-up area of Inhassoro. Similarly, the Maritima site is located just south of the SETA site, and both are therefore characterised by a fair degree of development and landscape transformation. The Briza Mar site by contrast is located some distance to the south on the outskirts of the development area, with noticeably lower levels of transformation and a more identifiable rustic character. For this reason, the sense of place of the SETA and Maritima sites is rated as being moderate (2), whereas that of the Briza Mar site is considered high (3).

Figure 125: Landscape visual character of SETA beach landing site

Figure 126: Landscape visual character of Maritima beach landing site

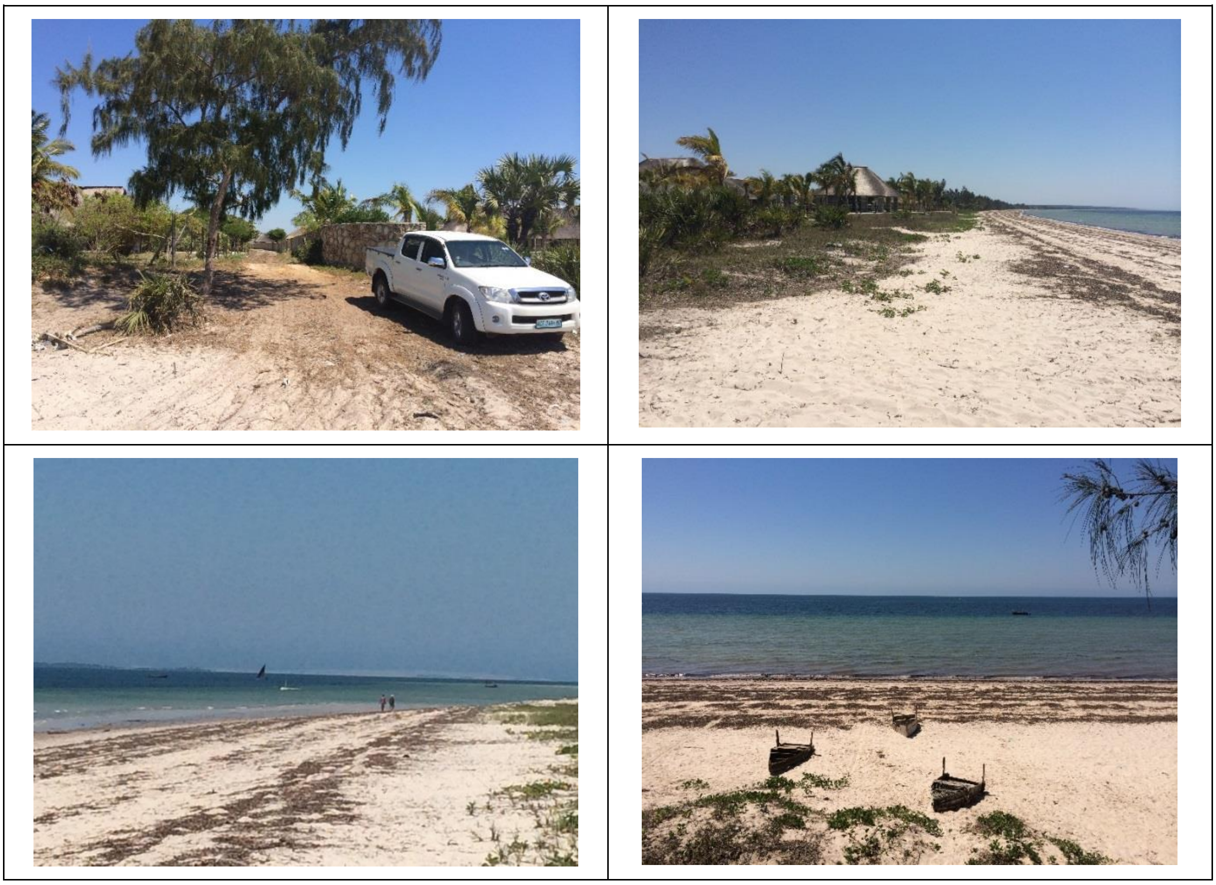


Figure 127: Landscape visual character of Briza Mar beach landing site

The visual resource value of the three beach landing sites was then determined using the score ranges provided in Table 39, based on their individual visual baseline characteristic scores. In addition, the visual resource value of the offshore visual environment within which the transhipment vessel will be anchored and through which barges will ferry equipment and material was also assessed, as summarised in Table 39.

Table 39: Visual resource value assessment – beach landing sites and off-shore environment

Beach landing site	Visual baseline attribute				
	Topography	Water bodies	Vegetation	VAC	Sense of place
SETA and Maritima sites	1	3	2	2	2
Total visual resource value score for SETA and Maritima sites					**10 (moderate)**
Briza Mar site	1	3	2	2	3
Total visual resource value score for off-shore areas					**11 (moderate)**
Off-shore/transhipment vessel anchorage areas	1	3	N/A (3)	3	3
Total visual resource value score for off-shore/transhipment vessel anchorage areas					**13 (high)**

From the above, it was concluded that the visual resource value of all three beach landing sites as well as the power plant and transmission line study areas is moderate, although certain elements or specific areas thereof may be of a higher visual resource value. By contrast, the visual resource value score for off-shore/transhipment vessel anchorage areas is considered to be high.

7.0 IMPACT ASSESSMENT

7.1 Impact Assessment Methodology

An impact is essentially any change (positive or negative) to a resource or receptor brought about by the presence of the project component or by the execution of a project related activity.

The purpose of impact assessment is to identify and evaluate the likely significance of the potential impacts on identified receptors and natural resources according to defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise, reduce or compensate for any potential adverse environmental effects and to report the significance of the residual impacts that remain following mitigation.

This chapter provides an integrated assessment of the proposed CTT project. The assessment has been derived from the characterization of the baseline environment and how it is likely to change as a result of the project and associated activities. The assessment is based on the specialist studies outlined in Volume 2 of this ESIA. Each specialist study details the process followed in identifying and describing key impacts. The process of assessing the significance of these impacts is then outlined.

In this chapter, an overall assessment of two proposed Project technologies is undertaken for the Construction, Operational and Decommissioning Phases of the CTT project. Technologies assessed include open cycle gas engine and steam turbines for combined cycle gas turbines.

The chapters are structured to present decision-makers with a clear statement of assessed residual risks should the project be approved. It is hoped that this approach will assist decision-makers by clarifying what they will *de facto* be approving in terms of potential environmental consequences should an approval is granted. The chapter has also been structured to present the potential impacts in a sequence that is reflective of the systems nature of the environment.

7.1.1 Environmental Costs versus Benefits

This chapter further provides an assessment of the environmental benefits that are likely to accrue as a result of the proposed project weigh against the likely environmental cost. It must however be noted that costs cannot always be traded off by benefits. Certain costs may be deemed untenable, regardless of the associated benefits. This assessment is intended to inform decision-makers as to the nature and scale of the benefits and the costs associated with the proposed CTT project.

In assessing impacts, the approach has been to interrogate the specialist studies and identify and describe the collective implications of identified impacts. A distinction can then be made between collective implication of impacts and their causes. Implications are presented as either potential environmental costs (where the implications are negative) or as potential environmental benefits (where the implications are positive).

7.1.2 Environmental Costs versus Benefits

This chapter further provides an assessment of the environmental benefits that are likely to accrue as a result of the proposed project weigh against the likely environmental cost. It must however be noted that costs cannot always be traded off by benefits.

Certain costs may be deemed untenable, regardless of the associated benefits. This assessment is intended to inform decision-makers as to the nature and scale of the benefits and the costs associated with the proposed CTT project.

In assessing impacts, the approach has been to interrogate the specialist studies and identify and describe the collective implications of identified impacts. A distinction can then be made between collective implication of impacts and their causes. Implications are presented as either potential environmental costs (where the implications are negative) or as potential environmental benefits (where the implications are positive).

7.1.3 Impact Assessment Methodology

An impact is essentially any change (positive or negative) to a resource or receptor brought about by the presence of the project component or by the execution of a project related activity.

The purpose of impact assessment is to identify and evaluate the likely significance of the potential impacts on identified receptors and natural resources according to defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise, reduce or compensate for any potential adverse environmental effects and to report the significance of the residual impacts that remain following mitigation.

This chapter provides an integrated assessment of the proposed CTT project. The assessment has been derived from the characterization of the baseline environment and how it is likely to change as a result of the project and associated activities. The assessment is based on the specialist studies outlined in Volume 3 of this ESIA. Each specialist study details the process followed in identifying and describing key impacts. The process of assessing the significance of these impacts is then outlined.

In this chapter, an overall assessment of two proposed Project technologies is undertaken for the Construction, Operational and Decommissioning Phases of the CTT project. Technologies assessed include open cycle gas engine (OCGE) and combined cycle gas turbines (CCGT).

7.1.4 Impact Prediction

There are a number of ways that impacts may be described and evaluated. Generally, the assessment of impacts proceeds through an iterative process considering four key elements:

- Prediction of the magnitude of impacts (the consequences of the project on the natural and social environment);
- Evaluation of the importance (or significance) of impacts taking the sensitivity of the environmental resources of human receptors into account;
- Development of mitigation measures to avoid, reduce or manage the impacts; and
- Assessment of residual significant impacts after the application of mitigation measures.

Where significant residual impacts remain, further options for mitigation may be considered and impacts re-assessed until they are as low as reasonably practicable (ALARP) for the project and would be deemed to be within acceptable levels.

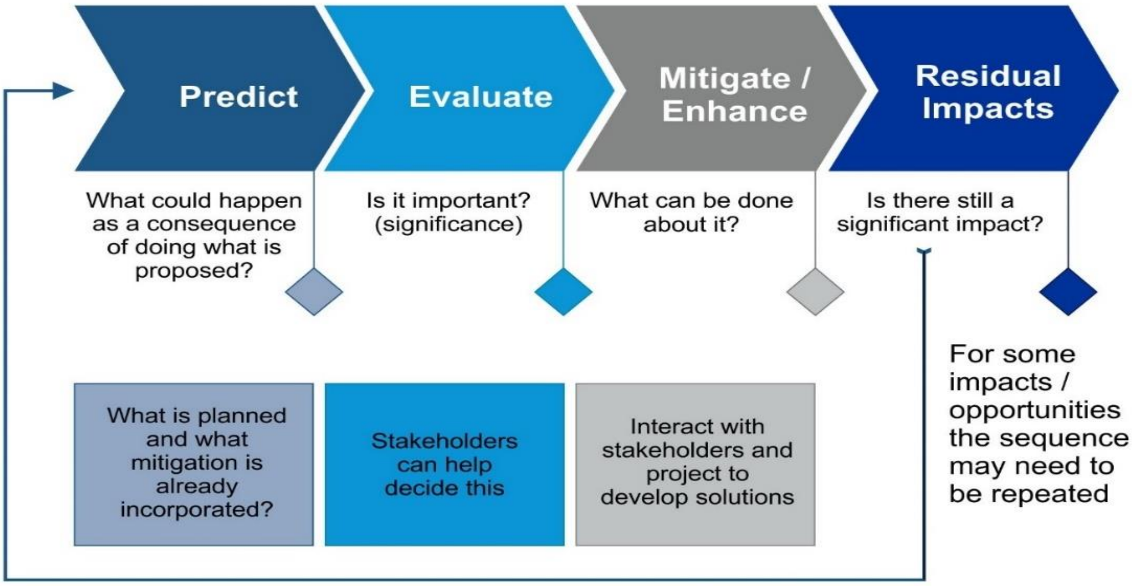


Figure 128: Prediction, evaluation and mitigation of impacts

The evaluation of baseline data gathered during desktop and field studies provides information for the process of evaluating and describing how the project could affect the biophysical and socio-economic environment. A clearly defined methodology is used in order to accurately determine the significance of the predicted impact on, or benefit to, the surrounding natural and/or social environment. For this, the project must be considered in the context of the area and the people that will be affected.

7.1.5 Assessing Significance

There is no single accepted definition of 'significance'. The approach used in this report defines significance as the combination of magnitude and resource sensitivity/vulnerability/importance. Magnitude is defined as being a function of the extent, duration and intensity of the impact. Nonetheless, an impact assessment is based on the professional judgment and experience of various specialists and EIA practitioners. The evaluation of significance is thus also contingent upon subject matter expertise, professional judgement and dependent upon the environmental and community context. Existing industry or national standards (e.g. water quality standards) and the risk assessment will inform this judgement.

Potential impacts are assessed according to the direction, intensity, duration, extent and probability of occurrence of the impacts. These criteria are discussed below in more detail.

Direction of an impact may be positive, neutral or negative with respect to the particular impact. A positive impact is one which is considered to represent an improvement on the baseline or introduces a positive change. A negative impact is an impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.

Magnitude/Severity is a measure of the degree of change in a measurement or analysis (e.g. the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none, negligible, low, medium or high. The categorisation of the impact intensity may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment). The specialist study must attempt to quantify the intensity and outline the rationale used. Appropriate, widely-recognised standards are used as a measure of the level of impact.

The categories are slightly differently defined depending on whether they refer to biophysical or social impacts:

Biophysical Environment

Negligible:	The impact on the environment is not detectable.
Low:	The impact affects the environment in such a way that natural functions and processes are not materially affected.
Medium:	Where the affected environment is altered but natural functions and processes continue, albeit in a modified way.
High:	Where natural functions or processes are altered to the extent that it will temporarily or permanently cease.

Socio-Economic Environment

Negligible:	There is no perceptible change to people's health, wellbeing or livelihood.
Low:	People/communities are able to adapt to the impact with relative ease and maintain pre-impact livelihoods.
Medium:	People/communities are able to adapt with some difficulty and maintain pre-impact health, wellbeing and livelihood status but only with a degree of support.
High:	Those affected people/communities will not be able to adapt to changes while continuing to maintain-pre impact health, wellbeing or livelihood.

Duration refers to the length of time over which an environmental impact may occur: i.e. transient (less than 1 year), short-term (1 to 5 years), medium term (6 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent.

Scale/Geographic extent refers to the physical area that could be affected by the impact and is classified as indicated below into site, local, regional, national, or international. Note that the reference is only to physical extent and does not include extent in a more abstract sense, such as an impact with regional policy implications which occurs at local level. The latter definition is a part of the term 'Sensitivity/vulnerability/importance, which is separately characterised.

Site:	Impacts that are limited to the direct area of disturbance and immediate surrounds.
Local:	Impacts that affect an area in a radius of up to 10 km around the site.
Regional:	Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ ecosystem impacts that are experienced at a regional scale e.g.: provincial level.
National:	Impacts that affect nationally important environmental resources or affect an area that is nationally important/or have macro-economic consequences.
International:	Impacts that affect internationally important resources such as areas protected by international conventions.

Receptor or Resource Sensitivity/Vulnerability/Importance: There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource/receptor is biological or cultural (for example, canopy forest or a sacred site), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered. Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value.

Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

Impact significance will be rated using the scoring system shown in Table 40 below. The significance of impacts is assessed for the three main phases of the project: i) construction ii) operations iii) decommissioning. While a somewhat subjective term, it is generally accepted that significance is a function of the magnitude of the impact and the likelihood (probability) of the impact occurring. Impact magnitude is a function of the extent, duration and severity of the impact, as shown in Table 40.

Table 40: Scoring system for evaluating impacts

Severity	Duration	Extent	Probability
10 (Very high/don't know)	5 (Permanent)	5 (International)	5 (Definite/don't know)
8 (High)	4 (Long-term – longer than 15 years and impact ceases after closure of activity)	4 (National)	4 (Highly probable)
6 (Moderate)	3 (Medium-term- 6 to 15 years)	3 (Regional)	3 (Medium probability)
4 (Low)	2 (Short-term - 1 to 5 years)	2 (Local)	2 (Low probability)
2 (Minor)	1 (Transient – less than 1 year)	1 (Site)	1 (Improbable)
1 (None)			0 (None)

After ranking these criteria for each impact, a significance rating was calculated using the following formula:

- **SP (significance points) = (severity + duration + extent) x probability.**

The maximum value is 100 significance points (SP). The potential environmental impacts were then rated as of High (SP >75), Moderate (SP 46 – 75), Low (SP ≤15 - 45) or Negligible (SP < 15) significance, both with and without mitigation measures in accordance with Table 41.

Table 41: Impact significance rating

Value	Significance	Comment
SP >75	Indicates **high** environmental significance	Where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. Impacts of high significance would typically influence the decision to proceed with the project.
SP 46 - 75	Indicates **moderate** environmental significance	Where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value. Such an impact is unlikely to have an influence on the decision. Impacts may justify significant modification of the project design or alternative mitigation.
SP 15 - 45	Indicates **low** environmental significance	Where an effect will be experienced, but the impact magnitude is small and is within accepted standards, and/or the receptor is of low sensitivity/value or the probability of impact is extremely low. Such an impact is unlikely to have an influence on the decision although impact should still be reduced as low as possible, particularly when approaching moderate significance.
SP < 15	Indicates **negligible** environmental significance	Where a resource or receptor will not be affected in any material way by a particular activity or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background levels. No mitigation is required.
+	**Positive impact**	Where positive consequences/effects are likely.

7.1.6 Mitigation Measures

Mitigation measures for adverse environmental and social impacts were developed concentrating on feasible, realistic and enforceable alternatives in the context of the existing uses. The full range of possible mitigation measures were considered for both types of power plants (gas engine and gas turbines) for construction, operations and decommissioning phases of the project.

Mitigation measures were discussed with the Proponent and binding commitments for implementation were identified and agreed. Agreed mitigation and management measures contain practical steps to be implemented during project operation which are based on the ESMPs contained in Volume 2.

Where a significant impact is identified, a hierarchy of options for mitigation is typically explored as outlined in Box 6.

Box 6: The 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 (e.g. a waste stream is eliminated) or altered (e.g. reduced waste volume). Often called minimisation.

Abate on Site: This involves adding something to the basic design to abate the impact - pollution controls fall within this category. Often called 'end-of-pipe'.

Abate at Receptor: If an impact cannot be abated on-site then measures can be implemented off-site - an example of this would be to use the stand-by vessel to help control the level of interference with fishing activity.

Repair or Remedy: Some impacts involve unavoidable damage to a resource, e.g. land disturbance. Repair essentially involves restoration and reinstatement type measures, such as base camp closure.

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.

7.1.7 Assessing Residual Impacts

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

The project ESMPs contained in Volume 2 address mitigation and management of residual impacts.

Residual major impacts, whether positive or negative, carry substantial weight (when compared with other environmental, social or economic costs and benefits) for authority decision making about the project. Conditions are likely to be imposed to ensure residual negative impacts are strictly controlled and monitored and residual positive impacts are fully delivered.

Residual moderate impacts are considered to be of lesser importance in decision making, but still warrant conditions regarding mitigation and monitoring, so as to ensure that best available techniques are used to minimise adverse impacts to be acceptable levels and to ensure beneficial impacts are delivered.

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

7.1.8 Impact Type

In addition to the above rating criteria, the terminology used in this assessment to describe impacts arising from the current project are outlined in Table 42 below. In order to fully examine the potential changes that the project might produce, the project area can be divided into Areas of Direct Influence (ADI) and Areas of Indirect Influence (AII).

- Direct impacts are defined as changes that are caused by activities related to the project and they occur at the same time and place where the activities are carried out i.e. within the ADI; and
- Indirect impacts are those changes that are caused by project-related activities but are felt later in time and outside the ADI. The secondary indirect impacts are those which are as a result of activities outside of the ADI.

Table 42: Types of impact

Term for Impact Nature	Definition
Direct impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (i.e. between an effluent discharge and receiving water quality).
Indirect impact	Impacts that result from other activities that are encouraged to happen as a consequence of the project (i.e., pollution of water placing a demand on additional water resources).
Cumulative impact	Impacts that act together with other impacts (including those from concurrent or planned activities) to affect the same resources and/or receptors as the project.

7.1.8.1 Area of Direct Influence

Bio-physical

From a biophysical point of view, the Area of Direct Influence is likely to be closely related to site clearance of the CTT plant, any further bush clearing along linear infrastructure such as transmission lines, pipeline or access roads, roads as well as possible bush clearing for the transport route (relates predominantly with the southern route option requiring widening of the existing track) and related construction and transport activities undertaken. A review of existing development of infrastructure in the area shows that there is little observable impact a short distance away from the perimeter of the cleared areas.

In the operational phase, there is little activity along linear infrastructure such as transmission lines, access roads and pipelines. The direct impacts during operational phase are mainly confined to the CTT site itself and its immediate surrounds (Air Quality, Greenhouse gases, and water abstraction, waste disposal etc). The Bio-physical Area of Direct Influence (ADI) is shown below in Figure 129.

Socio-cultural

The Area of Direct Influence (ADI) of the project comprises the area where the most significant direct positive and negative socioeconomic and sociocultural impacts will be felt, including jobs and training for local people and suppliers, improved social infrastructure and better access to land (positive impacts), and the impact of the footprint of project activities on social infrastructure, subsistence agriculture and cultural heritage (negative impacts). For purposes of this study, and in the absence of a traditional license area, the same ADI was used as for the Bio-physical impacts which is shown in Figure 130.

In certain instances, direct socioeconomic benefits will extend outside of the license areas due to employment of semi-skilled and skilled people who are not from local districts and due to the appointment of local and international contractors. Much of the equipment and materials necessary for construction of the CTT and ancillary infrastructure will be imported from other countries, and benefits will therefore extend internationally. Direct benefits to central Government in the form of taxes and royalties will also be paid, and Government expenditure, in turn, benefits all Mozambicans although these impacts will be short term, lasting during the period in which construction employment is available.

The addition of up to 450 MW of stable electricity supply to the National Grid will also have wide reaching impacts (positive) that extend well beyond the ADI and will be felt Nationally as it will have a direct positive effect on the Mozambican economy and will lead to further economic development. In the long term, CTT employment will be limited to relatively few jobs, mainly related to operational and maintenance staff.

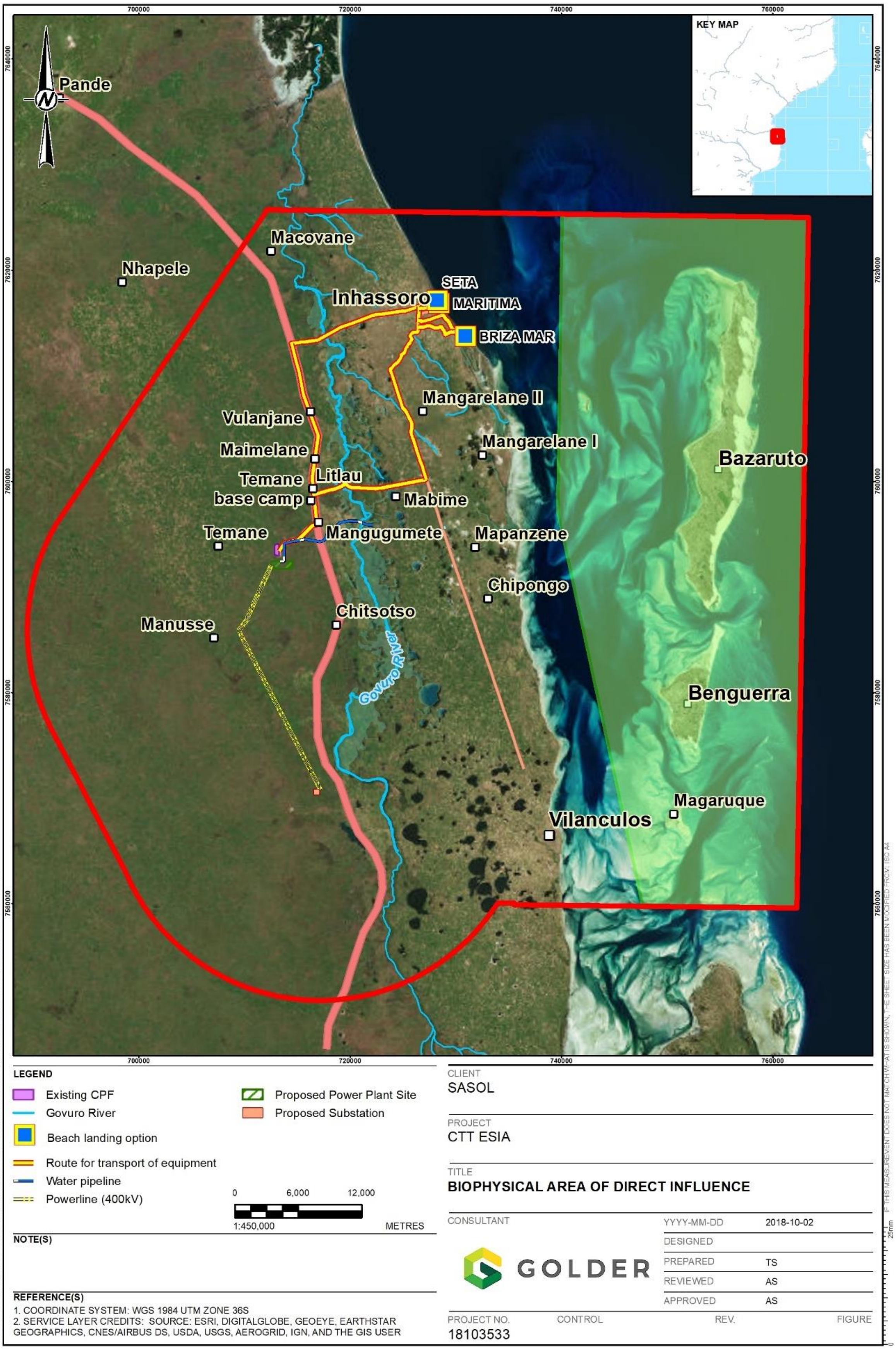


Figure 129: Biophysical Area of Direct Influence

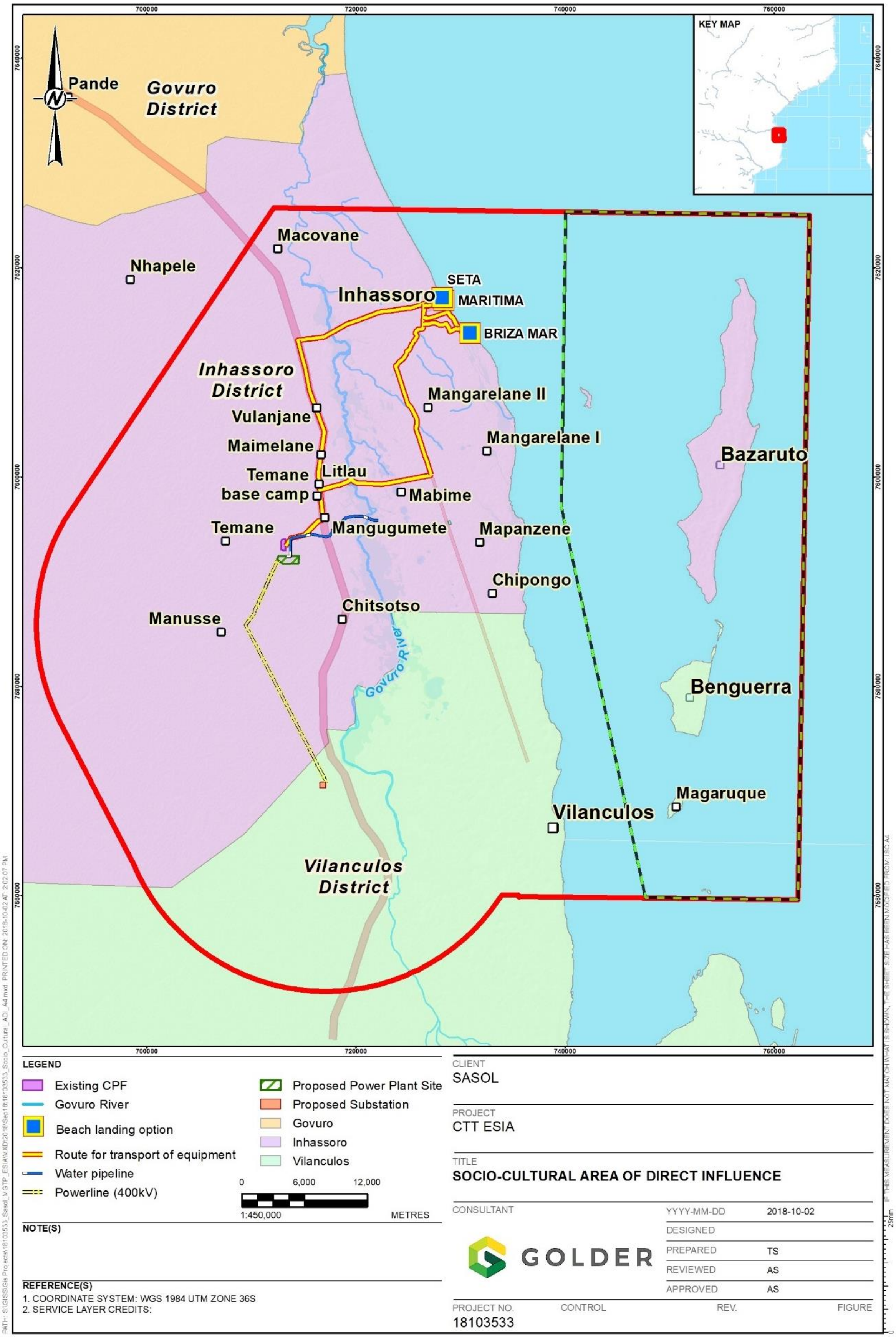


Figure 130: Socio-Cultural Area of Direct Influence

7.1.8.2 Area of Indirect Influence

A wide range of positive and negative indirect social and economic impacts are likely to result from the project. On the positive side, upstream and downstream multipliers resulting from employment and increased disposable income will benefit people within and outside of the physical boundaries of the ADI and at a local, district and regional level. Negative indirect impacts will include the effects of in-migration, which will be mainly felt at local level, particularly within the district of Inhassoro, where migrants perceive the opportunities for employment to be centred. These impacts will be cumulative, since migrants' decisions to move into the area are based upon perceptions about the overall chances of finding work and other benefits. As a result, the present CTT project, together with the existing Sasol CPF, and other Sasol projects in the area will all contribute to any migrant's decision to look for opportunities in the area. Cumulative impacts are presented and discussed further in Chapter 9.0.

7.2 Bio-Physical Environment

This chapter presents bio-physical impact assessment for predicted construction, operation and decommissioning impacts arising from the CTT project activities. It is important to note that certain technology options, beach landing site options and associated transport route options may have a different suite of impacts and mitigation measures. In such cases, these are presented in that particular section below under separate sub-headings for ease of comparison. Where there is no material difference in impact between options, this is stated, and impacts and mitigation measures apply to all options.

This chapter summarises the impacts and mitigation measures proposed, with more detailed information presented in the specialist reports contained in Volume 3.

7.2.1 Construction Phase

7.2.1.1 Decrease in Ambient Air Quality

Air quality impacts during this phase are associated with the construction of the key project components, ancillary infrastructure and preparation of the temporary beach landing sites and various route alternative. Specific activities that would generate impacts include earthworks, terracing, refurbishing of old, and erection of new surface infrastructure, vehicle and machinery usage and backup power generation as required for the construction of the CTT plant and infrastructure (Table 43). There is no difference between the power generation technologies and as such impacts are the same during CTT construction activities, which include limited road upgrades/construction, transmission line servitude clearance, construction and pipeline construction activities.

Table 43: Construction phase - Air Quality impact matrix

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Impact of PM_{10}	4	2	2	5	**Low 40**	2	2	2	5	**Low 30**
Impact of NO_2	4	2	2	5	**Low 40**	2	2	2	5	**Low 30**

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Impact of SO_2	4	2	2	5	**Low 40**	2	2	2	5	**Low 20**

Mitigation measures

Construction phase impacts are anticipated to be of low significance and mitigation measures may be implemented to further reduce impacts, such measures include:

- Particulates (PM_{10}):
  - Wet suppression (wet misting during material handling and construction activities such as linear infrastructure);
  - Covering or keeping stockpile heights as low as practicable to reduce their exposure to wind erosion and thus dust generation;
  - Progressive rehabilitation and re-vegetation of areas when operationally available;
  - Reduction in unnecessary traffic volumes;
  - Routine inspections to identify areas of unpaved roads that are increasingly dusty and that may cause nuisance;
  - Maintenance work to be undertaken on these areas including watering, application of dust suppressants, compaction, dust removal and/or utilisation of soil aggregate;
  - Vehicles and machinery to be serviced regularly to reduce the generation of black tailpipe smoke;
  - Speed control and the institution of traffic calming measures; and
  - No burning of waste onsite.
- Trace Gasses (NO_2/SO_2):
  - Maintain and service all vehicles, backup power generation and other equipment regularly to ensure that emissions are kept to a minimum;
  - Where possible, use low sulphur fuels to reduce SO_2 emissions;
  - Vehicles and machinery should be turned off when not in use to avoid unnecessary idling (i.e. idling should be limited to a maximum of three minutes on site); and
  - No burning of waste onsite.

7.2.1.2 Green House Gas emissions

In an ESIA, the potential impact of a project is typically assessed in terms of direction, intensity (or severity), duration, extent and probability of occurrence of the impact. However, given that the contribution of the CTT project to global GHG emissions is relatively insignificant, and the extended period between the emission of GHGs and potential climate change impacts, the conventional approach to impact assessment may not be appropriate.

As a result, GHG emissions assessments typically use an alternative approach to impact assessment based on benchmarks. In the context of this assessment, three benchmarks are considered:

- Contribution of the CTT project to Mozambique's national GHG emissions;
- Product unit intensity (operational phase only); and
- Pre-defined thresholds (operational phase only).

Contribution of the CTT project to Mozambique's national GHG emissions

The GHG emissions from the site preparation and construction and decommissioning phases have been excluded as they are insignificant in comparison to the GHG emissions from the operational phase (<1%). However, in line with best practice the following mitigation measures should still be applied to further reduce any emissions.

Mitigation measures

The mitigation that can be applied to reduce the amount of GHG emissions during the construction phase are outlined below in Table 44.

Table 44: GHG emissions mitigation action plan for Gas Turbines and Gas Engines: construction phase

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
Site Preparation and Construction Phase				
Fleet vehicles	Contribution to GHG emissions	Driver behaviour	■ Monitor diesel consumption and investigate incidents of excessive consumption; and ■ Alternatively, install telemetry in all fleet vehicles and monitor driver behaviour in terms of speeding and excessive braking, idling and so on.	Fleet manager
Barges and tugs	Contribution to GHG emissions	Number of trips and loading	Within the carrying capacity of the barges, maximise the load transported in each trip in order to reduce the number of trips.	Operations manager
Heavy goods vehicles	Contribution to GHG emissions	Number of trips and loading	Within the carrying capacity of the vehicles, maximise the load transported in each trip in order to reduce the number of trips.	Operations manager
Diesel generators	Contribution to GHG emissions	Sizing of diesel generators	■ When more detailed information becomes available, recalculate the maximum electricity demand of the	Electrical engineer and procurement

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
			construction camp and size diesel generators accordingly, taking into account the operational efficiencies of the generator sets; and ■ Generator sets could be configured so that those providing the baseload run are set to run at their optimum load (based on manufacturers specifications), while those providing power during peak periods could be fitted with variable speed drives (VSDs).	
Water pump	Contribution to GHG emissions	Sizing of diesel generator and water pump	■ When more detailed information becomes available, recalculate the maximum water demand of the construction camp and size diesel generator and pump sets accordingly, taking into account the operational efficiency of the water pump; and ■ Generator and pump set could be fitted with a VSD to ensure that the loading of the generator and pump set is more responsive to changes in demand.	Electrical engineer and procurement

7.2.1.3 Groundwater Quality Deterioration

The construction phase activities that could potentially impact on the quality of the groundwater resource include the bulk materials handling, and waste generation associated with the construction of the gas pipeline, the electrical transmission line, access and maintenance roads and the power plant. This potential for groundwater contamination can result from irresponsible practices during construction such as:

- Poor sanitation practices at construction sites (temporary facilities need to be provided at all construction sites);
- French drains (and sceptic tank combo system) for human waste/washing water etc. at construction camp;
- Accidental spillages and storage of hazardous chemicals at the construction site, laydown areas and construction camp;
- Hazardous waste materials will be generated during the construction phase ranging from used solvents, used oil and grease, etc.;
- Indiscriminate disposal of waste materials and chemicals (i.e. oils, greases, etc.); and

- Servicing of construction equipment and vehicles in non- designated areas.

All of the above impacts are rated negligible due to the fact that the duration and extent will be of very short term and the impacts are not expected to extend beyond the sites themselves. Waste water management measures need to be in place to ensure that impacts are minimised.

Domestic waste water will be generated at the construction camp kitchen, bathrooms, residential block, and administration areas. These waste streams will be discharged in subsurface drains, until the permanent waste water treatment plant is completed. There is no currently no detailed information on the expected volumes of domestic waste water that will be generated and the design of the systems.

Mitigation measures

The protocols that should be applied during the construction phase to mitigate the above impacts will be developed and documented in the ESMP. The protocols should address the following:

- Storage of new and used oils in bunded areas;
- No co-handling of reactive liquids or solids;
- Creation and monitoring of an inventory of chemicals held on site;
- Storage of hazardous or toxic substances securely and controlled use thereof; and
- Availability and accessibility of HAZOP sheets of all chemicals.

If the construction phase mitigation measures are followed, then impact during construction will be reduced to low significance (Table 45). The below impacts apply for both CTT plant technologies.

Table 45: Groundwater impacts: Construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Ground water deterioration- Poor sanitation	2	1	1	2	**Negligible 8**	1	1	1	2	**Negligible 6**
Ground water deterioration- Accidental spillages and Hazardous materials	4	1	1	2	**Negligible 12**	2	1	1	2	**Negligible 8**
Ground water deterioration– Waste water disposal	6	1	2	3	**Low 27**	4	1	1	2	**Negligible 12**
Groundwater level decline- additional water abstraction	2	2	2	4	**Low 24**	2	2	1	4	**Low 20**

7.2.1.4 Decline in groundwater levels

Abstraction of groundwater for potable use for construction crews, could add to the pressure on the local groundwater resources, and decline in groundwater levels. Raw water for the Project will be supplied from aquifers in the area and treated accordingly. Two boreholes of differing water quality and abstraction rates are currently being considered as the source of raw water to the CTT site, T9 and W5A. Alternatively, new boreholes may be installed at the Power Plant site, however investigations as part of the Engineering studies are ongoing at present. Not only will there be supply to crews working at various sites, but a construction camp (including accommodation for construction workers) will be set up for the duration of the construction phase.

Gas Turbine technology option

Daily water allowance of 150 l/person/day is made during construction. This implies that for the Gas Turbines Option there will be an expected 850 person construction workforce on site which will require a water supply of 5.31 m^3/hour. This will add additional pressure on the supply boreholes from which the Sasol already abstracts 8.3 m^3/h for the CPF water requirements.

The scenarios of various abstraction rates and water requirements were simulated and the results show that the additional water requirements during the construction period has a very low impact and occurs at local scale only. However, with mitigation and management of abstraction boreholes, the impact of water level decline can be reduced further to being limited (low significance) to close proximity of the abstraction's wells only (see Table 45).

Gas Engine technology option

Daily water allowance of 150 l/person/day is made during construction. This implies that for the OCGE Option there will be an expected 690-person construction workforce on site which will require a water supply of 4.3 m^3/hour. This will add additional pressure on the supply boreholes from which the Sasol already abstracts 8.3 m^3/h for the CPF water requirements.

The scenarios of various abstraction rates and water requirements were simulated and the results show that the additional water requirements during the construction period has a very low impact and occurs at local scale only. However, with mitigation and management of abstraction boreholes, the impact of water level decline can be reduced further to being limited (low significance) to close proximity of the abstraction's wells only (see Table 45).

Mitigation measures

Mitigation and management of abstraction boreholes need to include continuous level and abstraction volume monitoring. All abstraction boreholes should be set up and managed so that the sustainable yield is not exceeded during a 24-hour period, and to always allow for boreholes to recover sufficiently between abstraction cycles.

7.2.1.5 Increase in Ambient Noise Levels during construction

During the construction phase various activities will be undertaken that will generate noise in addition to the existing ambient (baseline) levels. This noise impact may have an effect on surrounding receptors. The increase in ambient noise levels were simulated and the following was deduced:

- The results from the noise modelling clearly show that the extent of the 55 dBA contour is limited to the immediate vicinity of the CTT construction site and that no households will be affected;
- The results show that the contours of significant increases in ambient noise level, i.e. in excess of 3 dB, are limited to the immediate vicinity of the CTT construction site. No households will be affected;

- The noise contours for transportation were not calculated due to their low frequency of occurrence and short event durations. The extent of their impacts will be limited to the immediate proximity of roads; and
- According to SANS 10103 there will be no community response to the increase in ambient noise levels during construction.

The noise impacts during the construction phase are the same for both power generation technology options as the same construction activities are envisaged for both. Due to the fact that no households will be affected during construction and based on the assumption that activities will be restricted to the hours of daylight, no specific mitigation measures are specified.

Table 46: Increase in ambient noise: Construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Resulting total ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**
Increase in ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**
Sleep disturbance	1	1	1	0	**Negligible 0**	1	1	1	0	**Negligible 0**
Transportation noise events	1	2	1	4	**Low 16**	1	2	1	4	**Low 16**

7.2.1.6 Change of Land use

The land uses observed during the field surveys indicate limited industrial use in the study area (wit exception of CPF and well pads). With the onset of the project construction activities, limited areas of the cultivated fields, savannah areas, urban areas (with portions of cultivated lands) and the peri-urban areas land use will permanently change to industrial use. It is understood that the entire project footprint will be impacted during the construction phase of the project. Therefore, the significance of the impact on land use is considered to be moderate (Table 47). These impacts apply to both technology options.

Mitigation

The potential negative impacts relating to land disturbance and change of land use can be mitigated as follows:

- Minimise the project footprint and therefore disturbance to a minimal area as possible;
- Identify and investigate sustainable land use options within the project footprint and adjacent communities; and
- Promote sustainable land use and agricultural practices in the project area and adjacent areas.

7.2.1.7 Soil quality degradation

Land disturbance is expected to occur due to initial clearing and ground levelling and excavation activities. The consequences of those activities during construction phase are:

- Loss of the original spatial distribution of soil types and natural soil horizon sequences;
- Loss of some original soil fertility;
- Loss of original topography and drainage pattern;
- Loss of original soil depth and soil volume; and
- Loss of the natural functioning of the soil (habitat for fauna and flora).

In essence, land disturbance during the construction phase, has a direct negative impact on the overall soil quality. Disturbed degraded soils, have lost their capacity to function within natural or managed ecosystem boundaries. The following activities will impact negatively on soil quality: Soil clearing and ground levelling, stripping topsoil and sub-soils, removal of organic horizon by heavy earth moving machinery during the construction of project infrastructure. The significance of the impact is moderate and with the appropriated mitigation measures, the significance of the impact can be low ((Table 47).

Mitigation

- Minimise the project footprint;
- Minimize surface footprints to the smallest extent possible and restrict heavy machinery and heavy truck access to sensitive soil areas (utilize machinery with the least amount potential to damage soils in sensitive soils areas i.e. smaller graders in sensitive areas);
- Implementing soil conservation measures (e.g. segregation, proper placement and stockpiling of clean soils and overburden material for existing site remediation and maintaining soils fertility on topsoils stored for future rehabilitation);
- Ensuring that the overall thickness of the soils utilised for rehabilitation is consistent with surrounding undisturbed areas and future land use;
- Designing slopes to an appropriate gradient for rehabilitation; and
- Basing the soil fertilizing programs on the soil chemical, biological and physical status after topsoil replacement.

7.2.1.8 Soil contamination

During the construction phase an increased presence and use of machinery and earthmoving vehicles is expected on site. Potential leakages of oil and diesel from the machinery could cause contamination of soils and shallow groundwater. The significance of the impact is moderate. To reduce the probability of the leakages of oil and diesel from the machinery and earthmoving vehicles, it is required that dedicated laydown areas for equipment are established and mitigation measures described below are applied. With the appropriated mitigation measures, the significance of the impact can be low (Table 47).

Mitigation

- Ensure proper handling and storage of hazardous chemicals and materials (e.g. fuel, gasoil, cement, concrete, reagents, etc.) as per their corresponding Materials Safety Data Sheets (MSDS);

- Maintenance of vehicles and equipment should be carried out in designated appropriate facilities fitted with spills containment, floors and sumps to capture any fugitive oils and greases;
- Ban the use of fire as a site clearance activity and establish fire breaks to minimise potential soil contamination and protect site areas;
- Implementing regular site inspections for materials handling and storage as well as pipeline monitoring; and
- Development of detailed procedures for spills containment and soils clean up.

7.2.1.9 Increase in Soil erosion

The sandy loam soils found within the study area are predominantly erodible in nature and once vegetation has been removed are susceptible to excessive soil loss. Soil instability is increased when soils are wet, which will intensify the process of erosion if mitigation measures are not implemented. Soil erosion is expected to have a negative effect with a moderate significance rating, however with the implementation of mitigation measures, the significance can be reduced to Low ((Table 47).

Mitigation

- Contractors (in particular heavy machinery contractors) need to be restricted to designated areas as defined by the Environmental Department;
- The procedures on land clearance and soils handling needs to be followed;
- Implement, monitor and control soil erosion minimisation procedures within project footprint;
- Implement measures to protect soil stockpiles from erosion. Minimise stockpile height to <1.5 m (if soil is stockpiled on construction site); and
- Investigate the use of binding agents for roads as an alternative to water dust suppression.

7.2.1.10 Soil compaction

This occurs when the soil particles and porous network within, are rearranged because of pressure applied on the surface. Pressure will be applied by the movement of heavy vehicles and machinery during the construction phase. The soil is expected to be more prone to compaction if the stripping process takes place when the soil is in a moist state. The impact of the construction phase will therefore have a moderate significance due to duration and high probability of this impact occurring ((Table 47).

Mitigation

- Remove and place soils in dry state when possible;
- Loosen soil through ripping and disking prior to revegetation; and
- Limit unnecessary trafficking and movement over areas targeted for soil removal.

7.2.1.11 Loss of agricultural potential

In the project area, there will be a definite and permanent loss of the soils with high agricultural potential. Since the land will not be rehabilitated back to agricultural land during the construction phase, the significance of the impact remains moderate ((Table 47).

Table 47: Impact on Soils and Land Use – Construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Change of land use	8	5	1	5	**Moderate 70**	8	5	1	5	**Moderate 70**
Soil quality degradation	8	5	2	5	**Moderate 75**	6	2	1	3	**Low 27**
Soil contamination	4	5	1	3	**Low 30**	4	2	1	2	**Low 14**
Soil erosion	8	5	1	4	**Moderate 56**	4	4	1	3	**Low 27**
Soil compaction	8	5	1	5	**Moderate 70**	8	3	1	5	**Moderate 60**
Loss of soil agricultural potential	8	5	1	5	**Moderate 70**	8	5	1	5	**Moderate 70**

7.2.1.12 Impacts on Surface Water Quality

Water quality at or below the watercourse crossing sites may be impacted on as a result of in-stream and bank disturbances during the construction phase, as well as the potential contamination as a result of poorly maintained heavy machinery. Fluctuations in the *in-situ* water quality parameters (pH, Electrical Conductivity (EC), TDS, DO, and temperature) as well as water chemistry (e.g. hydrocarbons) will in turn have impacts on the biotic communities. Due to the localised extent of the development, the impact significance of water quality impairment was rated as low along the Govuro River, whilst the non-perennial waterbodies and floodplain depressions were rated as moderate prior to the implementation of mitigation measures. By implementing the mitigation hierarchy, the post mitigation impact significance of water quality impairment was rated as low (Table 48).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Impacts on water quality are likely to result from the following activities:

- Riparian vegetation removal, leading to increase erosion and runoff. This will result in sedimentation and siltation of habitats downstream of the construction. Within the Govuro River, this will be transported downstream, while in the waterbodies with no flow, this silt with settle out and smother habitats;

- Flow impediment. During the construction, earthworks may impede the free movement of water, or water may need to be purposefully diverted in order allow construction with a permanently saturated area;
- Construction materials being utilised on site such as concrete, as well as oils from generators and vehicles, may come into contact with surface water, resulting in contamination; and
- Building of access roads to the site and servitudes along the pipeline and transmission route, resulting in large areas of vegetation being cleared and large quantities of topsoil being removal. This could lead to possible increased erosion potential and dust. Both of these would result in the sedimentation and siltation of habitats.

Mitigation measures

Mitigation measures to minimise the impacts on water quality, include reducing contamination, flow and sedimentation. This can be accomplished by the following means:

- Where possible, place construction activities as close to the existing road servitudes as possible to limit unnecessary clearing:
  - Avoid non-perennial bodies of water such as flooded borrow pits/drainage canals and floodplain depressions where possible.
- Construct the Govuro River crossings during the dry season so as to limit the amount of impact on the sites, particularly in terms of flow diversion and surface water runoff following rainfall;
- Implement low-impact construction techniques to minimise the impact on the river system, especially during the diversion of any water during construction (if required):
  - *E.g. low-impact construction techniques are those that make use on-site construction waste (i.e. rock substrate, topsoil) for use as non-structural fills or landscaping materials*.
- Where possible, keep construction activities out of the riparian areas, floodplain and inland depressions, and clearly demarcate no-go areas:
  - Limit movement of construction vehicles and activities (e.g. spoil heaps) to the demarcated zone only; and
  - Restrict vehicles to service roads.
- Monitor the water quality downstream of the river crossing sites during construction on an at least bi-annual basis. Information from this monitoring can be used to quickly implement management actions should a significant decrease in water quality downstream of the crossings be observed. More frequent surface water quality monitoring may be required during construction; this should be implemented in agreement with the mitigation measures set out in of the surface water impact assessment chapter (Golder, 2018);
- To ensure that any adverse impacts are reduced, the project team must ensure that any accidental spillages or impacts to the aquatic and riparian ecosystems are cleaned up and rehabilitate immediately; and
- In line with the terrestrial ecological impact assessment report, vegetation clearing and rehabilitation mitigation measures should be implemented.

Table 48: Impact on Surface Water Quality – Construction phase

Indicator of potential impact		Pre-mitigation					Post-mitigation				
		Intensity	Duration	Geographic	Probability	Significance	Intensity	Duration	Geographic	Probability	Significance
Impacts on Water Quality	Temporary bridge structures across Govuro River and tributaries	6	2	2	3	30 Low	6	2	2	2	**20 Low**
	Govuro River pipeline	6	2	2	3	30 Low	6	2	2	2	**20 Low**
	Inland, floodplain depressions/ Non-perennial waterbodies	8	5	3	3	48 Mod	8	2	2	2	**24 Low**

7.2.1.13 Impacts on Habitat changes

Macro-channel habitat and riparian vegetation loss or alteration (incl. backwaters and depressions)

The most significant impact on the macro-channel and riparian vegetation is expected to occur during the construction phase as this is when earth moving machinery will be active. The backwaters and margins of the waterbodies are rich with emergent vegetation, which provide favourable habitat for smaller fish, fish fry, amphibians and other species such as waterfowl. Construction activities may result in possible bank destabilisation, increased erosion potential and exotic vegetation encroachment. Due to the important role these habitats play, the impact of losing or altering them was rated as moderate prior to implementing any mitigation measures. Due to the expected small footprint and nature of the development, it is believed that with the correct management, the significance of the impact can be reduced to low (Table 49). These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades across similar habitats.

The following proposed activities will impact on the macro-channel and riparian vegetation during this phase:

- Riparian vegetation removal (see also the Terrestrial Ecology study);
- Building of access roads to the site and servitudes along the pipeline and transmission route, resulting in large areas of vegetation being cleared and large quantities of topsoil being removed. This could lead to increased erosion potential and dust. Both of these would result in the sedimentation and siltation of habitats, as the vegetated nature of the riparian systems is associated with decreased flow velocity, facilitating settling of particulates. Furthermore, the vegetation provides a larger surface area for the build-up of silt, resulting in the habitat being smothered; and
- Bank disturbances from heavy machinery gaining access to the river.

In-stream channel habitat loss or alteration

The road upgrade and pipeline crossings are expected to result in minimal bed damage and degradation downstream of the crossing points. In contrast to vegetated areas, sediments that make their way into the in-stream channel are likely to be carried downstream and flushed under periods of high flow.

The main in-stream disturbances are expected to occur as a result of earthworks within the channel. The application of the required mitigation measures is predicted to reduce the significance of predicted impacts to negligible, as a result of the reduced intensity and probability of this impact (Table 49).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Mitigation measures

In order to minimise the impacts on the in-stream habitats during construction of the proposed CTT Project, the following mitigation measures are required:

- The construction of the Govuro River crossings should take place during the dry season so as to limit the intensity of impact, particularly in terms of flow diversion and runoff of sediments;
- Implement low impact construction techniques to minimise the impact on the river system, especially during the diversion of any water during construction. Such techniques may include;
  - Pre-fabrication of components off-site in order to limit construction and assembly on site;
  - Careful planning and management of piling activities on river banks, so as to avoid any sedimentation of the Govuro River;
  - Use of smaller, more agile construction plant and machinery in order to reduce footprint and disturbance on site;
  - Contractor to have wet-spill kits available in case of any contamination in Govuro River;
  - Balancing the site’s earthwork cut and fill to avoid haul-off or imported soil will achieve both reduced costs and minimal site disturbance;
  - Use onsite material for backfill and other construction needs as opposed to importing bulk material; and
  - Confine laydown and shakeout areas for project deliveries to minimum practicable areas;
- Where possible, keep construction activities out of the riparian areas, floodplain, inland depressions and macro channel:
  - Vegetation clearing should be restricted to the proposed development footprints only, with no clearing permitted outside of these areas; and
  - Areas to be cleared should be clearly demarcated to prevent unnecessary clearing outside of these sites.
- The alignment of the road should be routed to avoid impacting the adjacent floodplain and inland depressions and any non-perennial bodies of water; and

- A suitable rehabilitation programme should be developed and implemented in all disturbed areas. The programme should include active re-vegetation, using locally-occurring indigenous grass and tree species.

Table 49: Impact on Habitat Changes – construction phase

Indicator of potential impact		Pre-mitigation					Post-mitigation				
		Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Habitat Changes	Macro-channel habitat and riparian vegetation loss or alteration	6	2	1	5	45 Mod	4	2	1	4	**28 Low**
	In-stream channel habitat loss or alteration	4	2	2	3	24	4	2	1	2	**14 Negligible**

7.2.1.14 Loss of aquatic biota of conservation concern

During the construction phase, disturbance of the habitats within the localised area will impact on the aquatic biota. It is likely that fish species that occur at or near the sites will move away if disturbed. This will, however, be localised and temporary, and thus the aquatic biota should recover quickly as the habitats are rehabilitated and re-colonisation takes place. It should be noted that the Vulnerable (VU) Leopard Stingray (*Himantura uarnak*) has been observed in the lower reaches of the Govuro River. The Leopard Stingray is often found off sandy beaches, in sandy areas of coral reefs, in shallow estuaries and lagoons, and may even enter freshwater. The Mozambique tilapia (*Oreochromis mossambicus*), listed as Near Threatened (NT) occurs in all but fast-flowing waters. This species thrives in standing waters and can tolerant fresh, brackish or marine waters.

The Zebra snail, *Neritina natalensis,* classified as Near Threatened (NT), was commonly encountered during the 2016 survey (ERM, 2016). The gastropod *Septaria borbonica* (Neritidae), was recorded on the stems of *Nymphaea nouchaii* within the Govuro River is listed as Endangered (EN).

The impact significance of losing any species of conservation concern was reduced to low (Table 50), provided that the required mitigation measures are successfully implemented as outlined below.

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro river with temporary bridge construction and road upgrades.

Mitigation measures

Monitoring the water quality and habitat downstream of the river crossing sites during construction on an at least bi-annual basis and implement an early warning system that would trigger a survey of the biological responses, should water quality or habitat alterations warrant this.

Table 50: Loss of Aquatic Biota Impact assessment – construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Loss of aquatic biota of conservation concern	8	5	4	3	51 Mod	8	5	4	2	**34 Low**

7.2.1.15 Vegetation clearing and earth works causing a loss or disturbance of natural habitat

Habitat loss refers to the direct removal of natural habitat. In terrestrial ecosystems, this occurs primarily through the clearing of indigenous vegetation and earth works. The immediate impact is the destruction of individual plants and some faunal species within development footprints. If remaining habitat is insufficient in size and heterogeneity to sustain ecological processes, a breakdown or impairment of ecosystem integrity and functioning at broader ecological scales can occur. Habitat loss can also refer to habitat degradation. In this instance, although habitat is present, it has been disturbed to the extent that compositionally and structurally it is dissimilar to reference habitat conditions.

This is the principal negative impact on terrestrial ecology associated with the proposed project, and is likely to cause, or at least be attended by, various secondary impacts (such as alien invasive species establishment).

1) Proposed project infrastructure for which significant vegetation clearing will be required include:

- The Power Plant Study Area (incorporating the Power Plant Site and construction camp - approx. 20 ha footprint;
- Powerline corridor (incl. adjacent maintenance track) - 25 km long, with a servitude width of approx. 200 m;
- Access road from the main CPF to the Power Plant Site - approx. 2 km, with a corridor width of approx.10 m; and
- Upgrade of Shortcut Road linking EN1 to the North – South Road – approx. 11 km, with a corridor width of approx. 10 m.

2) Other proposed infrastructure which will require minimal vegetation clearing include:

- Upgrade of the EN1 and R241 or North-South Road; and
- Establishment of beach landing site.

The significance of habitat loss and disturbance resulting from proposed project infrastructure is dependent on the type and condition of affected habitat. The proposed infrastructure sites are located in habitat characterised by the Open and Closed Woodland and patches of Low Thicket and Tall Forest vegetation communities (Golder, 2018). These are typical and widespread savanna habitat formations in the region, and are rated as having medium- and medium-high, high biodiversity value (Golder, 2018). We highlight the ecological sensitivity and importance of Govuro River Floodplain and pans located to the east of the river. These are rated as having high sensitivity value (Golder, 2018).

Table 51 provides the extent of potential habitat loss associated with each project component/alternative. A discussion of the impacts is presented in Table 52.

Table 51: Approximate extent of habitat loss

Infrastructure	Ha of Veg community lost	Approx. Habitat Loss (ha)
Power Plant Study Area	Open and Closed Woodland	137
	Low Thicket	0.1
	Transformed (Urban and Cultivation)	1.8
Powerline corridor	Open and Closed Woodland	391
	Low Thicket	77
	Tall Forest/Thicket	1.7
	Transformed (Urban and Cultivation)	6.6
Access road CPF to the Power Plant Site -	Open and Closed Woodland	1.8
	Transformed (Urban and Cultivation)	0.4
Upgrade of Shortcut Road linking EN1 to the North – South Road	Open and Closed Woodland	3.4
	Low Thicket	2.1
	Tall Forest/Thicket	0.05
	Permanent and Seasonal Wetlands (incl. river)	0.8
	Transformed (Urban and Cultivation)	5

A discussion of the impacts of habitat loss and disturbance associated with proposed infrastructure components is presented in Table 52.

Table 52: Habitat loss/disturbance associated with key infrastructure

Proposed Project Infrastructure	Potential Impacts
Power Plant study area (140 ha) and proposed powerline corridor	De-mining activities in 2015 resulted in the clearing of vegetation in the proposed Power Plant footprint (20 ha), and along the entire length of proposed powerline corridor. Vegetation in these footprint areas is thus disturbed and currently regenerating naturally. During the 2018 field visit it was observed that vegetation had recovered substantially following the original clearing – the herbaceous layer had regenerated significantly in all areas, while woody vegetation had established well in certain areas (Golder, 2018).

Proposed Project Infrastructure	Potential Impacts
	IFC PS6 (2012) defines natural habitat as areas composed of viable assemblages of plant and/or animal species of a largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. Demining activities included the stripping of herbaceous and small woody vegetation. No earth works was conducted. As a result, the soil profile was not disturbed and indigenous vegetation is returning. These areas thus retain their primary ecological function and their species composition comprises indigenous (native) plant species. Hence, these areas are classified as 'natural habitat', in line with IFC PS6 (2012). In light of this, vegetation clearing in these areas during construction will result in both the loss of natural habitat, albeit of a disturbed/recovering nature. This impact is rated of moderate significance before but can be reduced to **low** significance after mitigation.
<u>Access road</u> from the CPF to the Power Plant Study Area	The proposed access road will traverse across natural habitat comprising Open and Closed Woodland (1.8 ha). Vegetation clearing for the road will thus also cause both habitat loss and disturbance, and is rated an impact of **moderate** significance, both before and after mitigation.
<u>Shortcut Road</u> linking EN1 to the North – South Road	The Shortcut Road is currently a narrow, single vehicle track. Upgrading it will thus require widening and construction. Habitat along the track is mostly characterised by Open and Closed Woodland (3.4 ha that is mostly dominated by *Julbernardia – Brachystegia*) and very small pockets of thicket and forest. The track lies adjacent to a number of pans and crosses the Govuro River Floodplain – these habitats are natural, in line with IFC PS6 (2012) and have medium-high and high biodiversity value, and are therefore ecologically sensitive and important (read Golder, 2018). Approximately 0.8 ha of wetland habitat will be lost if this route is chosen as the preferred option. This impact is rated of *high* significance before mitigation but can be reduced to **moderate** significance with successful mitigation.
Upgrade of the <u>EN1 and R241</u> or <u>North-South Road</u>	These are both existing and well-used roads. The EN1 and R241 are major tar roads, with existing road verges, while the North-South Road is a broad gravel road. Minimal vegetation clearing is likely to be required to upgrade either route. Habitat loss and disturbance aligned to these project components is rated of **low** significance after mitigation.
Establishment of <u>beach landing site</u>	The three proposed beach landing options are located within (Seta and Maritima) and at the periphery (Briza Mar) of the town of Inhassoro. All three are existing beach access points, that are in current usage and consequently are disturbed sites (Golder, 2018), which will require minimal clearing of terrestrial vegetation during construction. Considering

Proposed Project Infrastructure	Potential Impacts
	the existing levels of disturbance, this is rated a **low** impact after mitigation.

Mitigation Measures

The final layout of the CTT Plant and the exact position of the powerline has yet to be confirmed. At this stage, only a conceptual layout is available.

Mitigation measures for this facility are thus focused on avoiding clearing important ecological features as far as possible, and limiting the extent of clearing to the absolute necessary for project activities:

- A targeted survey should be undertaken during the wet/growing season of the CTT footprint to locate, record and mark important ecological features, such as large trees (DBH >20 cm), geophytic plants and termite hills that should be avoided during construction activities. Based on collected data:
  - As far as possible, proposed infrastructure should be positioned to avoid clearing large trees (DBH >20 cm) and termite hills. Particular tree species that should be avoided during vegetation clearing are *Afzelia quanzensis* and *Dalbergia melanoxylon*; and
  - Geophytes growing within development footprints should be rescued and relocated to adjacent areas of undisturbed natural habitat.
- Vegetation clearing should be restricted to the proposed development footprints only, with no clearing permitted outside of these areas;
- Areas to be cleared should be clearly demarcated to prevent unnecessary clearing outside of these sites;
- If selected as the preferred road option, the alignment of the upgraded Shortcut Road should be re-routed to avoid impacting the adjacent inland pan/depression habitats;
- Topsoil stripped during construction should be stockpiled and used to rehabilitate disturbed areas; and
- A suitable rehabilitation programme should be developed and implemented in all disturbed areas. The programme should include active re-vegetation, using locally occurring indigenous grass and tree species:
  - Areas that should be considered priority sites for stabilisation and rehabilitation post-construction should they be negatively impacted include: a) coastal dunes at the selected beach landing site; b) Govuro River crossing point, and c) inland pan/depression habitats adjacent to the proposed Shortcut Road.

Table 53: Habitat Loss – Construction Phase

CONSTRUCTION PHASE											
Indicator of potential impact		Pre-mitigation					Post-mitigation				
		Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Vegetation clearing and earth works causing a loss or disturbance of natural habitat	Power Plant study area & powerline corridor	8	4	2	5	70	4	4	1	5	**45 Low**
	Access road to the Power Plant	8	4	2	5	70	6	4	1	5	**55 Mod**
	Shortcut Road	10	4	2	5	80	8	4	2	5	**70 Mod**
	EN1 and R241 or North-South Road	4	4	2	5	50	2	4	1	5	**35 Low**
	Beach landing site	4	4	2	5	50	2	4	1	5	**35 Low**

7.2.1.16 Establishment and spread of alien invasive plant species

Disturbances caused by vegetation clearing and earth works can create conditions conducive to the establishment and rapid spread of alien invasive vegetation. If left uncontrolled, alien species can spread exponentially, suppressing or replacing indigenous vegetation. This may lead to a breakdown in ecosystem functioning and a loss of biodiversity.

Alien invasive plants could potentially establish in all areas where construction activities will disturb existing vegetation. Recognised alien invasive plant species that were commonly recorded in the study area and may become problematic include *inter alia*; *Calotropis procera*, *Lantana camara* and *Ricinus communis*.

With proactive management, specifically the implementation of a targeted alien invasive species control programme, this impact can be reduced to one of **low** significance (Table 54).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Mitigation Measures

- An alien invasive species control programme must be developed and implemented at both temporary construction sites and permanent operational sites;
- The programme must include:
  - The use of both mechanical and chemical control treatments, as required;

  - Provision for periodic follow-up treatments; and
  - Regular monitoring.
- The implementation of the programme should be overseen by an ECO officer during construction, and the environmental manager during the operational phase.

Table 54: Establishment and spread of Alien Invasive species – Construction Phase

CONSTRUCTION PHASE										
Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Establishment and spread of alien invasive plant species	8	4	1	4	52 Mod	6	4	1	2	**22 Low**

7.2.1.17 Loss of flora species of conservation concern

Vegetation clearing during the construction phase may result in the destruction of floral species of conservation concern - two such tree species have been recorded in the Power Plant study area, namely *Afzelia quanzensis* and *Dalbergia melanoxylon* (Lower Risk - Near Threatened).

The loss of flora species of conservation concern is rated a moderate impact before mitigation, but this can be reduced to a **low** significance with the effective implementation of the required mitigation measures (Table 55).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Mitigation Measures

- Wherever practical, trees of conservation concern should be avoided during construction activities; and
- If avoidance is not possible, replacement trees should be planted during rehabilitation at a ratio of 3:1, (i.e. three replacement trees of the same species, for every one tree lost).

Table 55: Loss of Floral species of conservation concern – Construction Phase

CONSTRUCTION PHASE										
Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Loss of flora species of conservation concern	8	1	1	5	50	6	1	1	3	**24 Low**

7.2.1.18 Death or injury of fauna

Small and less mobile species may be trapped, injured and killed during vegetation clearing and earth works. Fauna that are of particular concern in this regard include:

- Fossorial[10] mammals (e.g. moles, rodents);
- Nesting birds (ground and tree nesting); and
- Reptiles and amphibians.

Other common causes of fauna injury, death or disturbance include:

- Vehicle-wildlife collisions access roads;
- Hunting, snaring and poisoning of larger fauna by construction workers and contractors; and
- Fauna becoming trapped/caught in infrastructure, such as fences and excavations.

It is anticipated that vegetation clearing and earth works during construction may cause injury or death to several less mobile taxa (e.g. tortoises, nesting birds). This impact is rated moderate prior to mitigation but can be reduced to a residual impact of **low** significance with careful and proactive management (**Table 56**).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Mitigation Measures

- An ECO should be on-site during vegetation clearing to monitor and manage any wildlife-human interactions. The ECO should be trained in *inter alia*, snake handling;
- Fences (or other suitable obstacle/deterrent) should be erected to prevent fauna gaining access to construction areas, such as open trenches and voids;
- A low speed limit (20 - 40 km/h) should be enforced on site to reduce wildlife-collisions;
- The handling, poisoning and/or killing of on-site fauna by construction workers and contractors must be strictly prohibited; and

[10] Organism adapted to digging and life underground.

- This prohibition needs to be clearly stated in project management policies and communicated to all employees and contractors through suitable induction training and on-site signage.

Table 56: Death or Injury of Faunal Species – Construction Phase

CONSTRUCTION PHASE										
Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Death or injury of fauna	8	4	2	4	56 Mod	6	4	2	2	**24 Low**

7.2.1.19 Sensory disturbances to fauna (artificial lighting and noise)

Sensory disturbances caused by artificial lighting and noise can affect certain fauna taxa, such as nesting birds and bats. Construction activities will cause disturbances to fauna in areas where there was previously little anthropogenic disturbance. This impact is rated moderate before mitigation and **low** after mitigation (Table 57).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Mitigation Measures

- General noise abatement equipment should be fitted to machinery and vehicles;
- Noise shields, including earthen berms, should be constructed around sites of noise origin;
- Plan the lighting requirements of facilities to ensure that lighting meets the need to keep the site secure and safe, without resulting in excessive illumination. Possible options include:
  - Zoning of areas of high and low lighting requirements;
  - Movement-activated lights as opposed to permanent lights; and
  - Reducing height and angle of lights.

Table 57: Sensory disturbance to Fauna – Construction Phase

CONSTRUCTION PHASE										
Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Sensory disturbances to fauna	6	4	2	4	48	4	4	2	2	**20 Low**

7.2.1.20 Contamination/pollution of soil and water resources

During the construction phase, soil and water resources may be contaminated by leaks and spills of fuel (e.g. petrol, diesel) and lubricants from construction vehicles and other machinery and equipment, and from the spillage of chemicals from poorly sealed containers.

This impact is rated moderate before mitigation. However, with the implementation of mitigation measures concerning the maintenance of construction vehicles and machinery, and the handling and storage of construction fuels/chemicals, this impact can be maintained at a **low** significance after mitigation (Table 58).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Mitigation Measures

- Develop protocols to manage the storage, handling and disposal of all chemicals and other hazardous substances used on-site during all phases of the proposed project. Protocols should also include provision for the correct clean-up of potential spills and leaks; and
- Regularly maintain and service all vehicles and machinery to minimise the potential for leaks and spills of fuels.

Table 58: Contamination of soil and water resources – Construction Phase

CONSTRUCTION PHASE										
Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Contamination of soil and water resources	8	2	3	4	52 Mod	6	2	2	2	**20 Low**

7.2.1.21 Secondary habitat loss/modification due to resource exploitation

This is both an indirect and potentially cumulative impact. It essentially concerns the facilitation of natural resource exploitation by local communities that may result from the proposed project. Mechanisms generally include a combination of improved access to remote or previously inaccessible sites, and human population influx.

Ecosystem services feature strongly in the livelihood strategies of local people, with activities such as slash and burn agriculture, wood harvesting (for charcoal/fuel and building material) wild fruit collecting and livestock grazing all common. Natural habitat in the area, particularly in close proximity to the EN1 and R241 roads, has already been modified – mostly for subsistence agriculture, and as a result of tree harvesting for fire wood and charcoal production.

It is anticipated that the proposed project may promote an influx of people into the area, and a concomitant increase in natural resource use across the landscape. This may lead to accelerated habitat loss and disturbance.

This impact is difficult to alleviate; however, it can be reduced to one of **low** significance with successful mitigation (Table 59).

These impacts are not affected by the choice of power technology option as the same footprint is affected, or by route selection as they will both require crossing of the Govuro River with temporary bridge construction and road upgrades.

Mitigation Measures

- Implement the findings of the social and labour plan; and
- Monitor the progression of secondary habitat transformation using aerial/satellite imagery to identify any problem areas and target for further management actions.

Table 59: Secondary habitat loss – Construction Phase

CONSTRUCTION PHASE										
Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Secondary habitat loss/ modification due to resource exploitation	8	5	2	4	60	6	5	2	3	**39 Low**

7.2.1.22 Activities at Temporary Beach landing site affecting Marine Receptors

It should be noted that all activities pertaining to the beach landing in terms temporary jetty construction, operation (transhipment, barging, transport) and decommissioning of temporary jetty will all occur within the CTT project construction phase. These impacts and mitigation measures are all dealt with in the following section.

Construction of the temporary jetty

The construction of the preferred temporary beach landing site will involve the construction of a new jetty from the beach into the water, which will either be 14 m wide x 100 m long (1,400 m^2), or 20 m wide x 80 m long (1,600 m^2). The chosen beach landing site will also require some road upgrades from the beach landing site along the chosen route to the CTT site. Although the proposed sites are currently or have in the past, been used for beach access, the upgrade of the access roads will result in additional disturbance and loss of primary dune habitat; in addition, the construction of the jetty will result in the loss of a minimum of 1,400 - 1,600 m^2 of sandy beach habitat. Since the proposed sites are already being used for beach access for boats, it is unlikely that these areas are important turtle nest sites due to existing levels of disturbance.

Therefore, the likelihood of direct impacts of loss of nest sites, or mortality or injury of nesting turtles or incubating eggs as a result of construction activities (e.g. site clearance, earthworks) is considered low.

There is a potential that construction workers or people attracted to the construction sites (e.g. people seeking employment or opportunities) could increase hunting pressure on beach-nesting turtles as well as increase in fishing pressures within the area and thus the likelihood of Dugong becoming captured as bycatch. The application of the required mitigation measures (particularly appropriate population influx management and education programmes) could reduce the intensity of hunting and fishing pressure as well as the probability of the predicted impacts for nesting turtles and Dugong, resulting in a residual impact of low significance (Table 60). Also, to avoid increasing fishing pressures within important Dugong habitat, the Contractor shall be instructed to obtain all fish for consumption in the construction camp from sources well away from the project area, which will be reflected in the Local Content Management Plan.

Mitigation measures

- New areas of primary dune and beach habitat disturbance and associated vegetation clearance should be minimised wherever possible. Areas proposed for vegetation clearance should be clearly marked and no heavy vehicles should travel beyond the marked works zone;
- Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks;
- Ecological clerk of works (ECOW) to be appointed for duration of construction works;
- The Proponent must enforce a complete ban on wildlife harvesting (hunting/trapping/fishing) for all project personnel, including any such activities by any person within the mining lease area;
- The development of worker and community education programmes by the Proponent and Contractor(s), which focus on the value of conservation of species such as sea turtles and dugong, and the generation of tourism potential, can contribute to the alleviation of hunting pressure on affected fauna species and reduce local people’s reliance on consumption of bush meat; and
- An Influx Management Plan for the Project should be implemented to manage access control, prevent unplanned growth in housing development and promote regional economic development, at the same time reducing pressure on ecosystems of concern and associated species for provision of natural resources.

Table 60: Temporary beach landing sites – construction impacts on marine receptors

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Loss of natural habitat (primary dunes and sandy beaches)	6	3	1	5	**Mod 50**	4	3	1	3	**Low 24**
Direct injury/mortality of nesting turtles/eggs	6	4	5	2	**Low 30**	4	4	5	1	**Low 13**
Indirect injury/mortality of nesting turtles/eggs	8	5	5	4	**Mode 72**	4	4	5	3	**Low 39**
Indirect injury/mortality of Dugong	8	5	4	4	**Mod 68**	8	5	4	3	**Mod 51**

Operation of the temporary jetty

The operation of the temporary beach landing sites will involve barging of large project components to shore, from where they will be transported via road to a laydown area, and then to the CTT site itself. It is anticipated that a maximum of 2 components could be shipped in a week to the site, thus Option 1 (Gas Turbines) would take 20 weeks and Option 2 (Gas Engines) would take 15 weeks (Chapter 2.0, Project Description), suggesting that the temporary beach landing sites will be operated on at least 7-10 occasions, over the course of a minimum of 20 weeks (5 months), with the actual duration likely to be extended due to the waiting period of up to 3-4 months between some of the shipments. It is likely that the total duration could be between 8 - 15 months with long periods of no activity.

The operation of the temporary beach landing sites could cause alteration of local hydrodynamics due to the presence of the jetty, influencing sediment transport, erosion and accretion on Primary dune and sandy beach habitat.

During operation, deterioration of water quality and benthic sediment as a result of contamination with hydrocarbon fuels, oils and/or lubricants from barges and heavy equipment is probable. Discharge of ballast water could result in the introduction and/or spread of invasive marine algae (e.g. *Acanthophora spicifera, Gracilaria salicornia*), which have the potential to substantially alter natural sandy beach or seagrass habitats. The intensity of the potential impact could be high, causing changes to a high proportion of affected ecosystems of concern (sandy beaches, seagrass beds) within the CHAA. The duration of the impact would be permanent and would extend regionally; there is a high likelihood that this impact could occur within the CHAA without appropriate management and mitigation. The application of the required mitigation measures can reduce the intensity and likely extent of potential impacts as well as the probability of them occurring in the first place, reducing the residual impact to one of low significance (Table 61).

Mitigation measures

- Monitor erosion and accretion of sands on either side of the jetty and employ appropriately designed engineering measures to prevent any significant impacts on sandy beach habitat upshore and downshore of the jetty where necessary;
- Routes for transfer of heavy equipment should be clearly marked and no heavy vehicles should travel beyond the marked works zone;
- Prohibit access to personnel outside of the defined access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks;
- Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, transhipment vessels and heavy equipment are minimised/eliminated. Daily maintenance and monitoring checks of vessels should be conducted;
- Frequent monitoring of marine water and sediment quality should be implemented for the duration of transhipment and barging activities, focussing on the anchorage point, landing site and the designated barging route between them;
- Strict controls on ballast water management for both barges and transhipment vessels must be enforced by The Proponent, in line with the relevant MARPOL standards (see Section 3.2). High risk ballast water (that coming from ports and coastal waters outside of Bazaruto Bay) should not be discharged within the CHAA under any circumstances. Tank-to-tank transfer of ballast water should be enforced for all barges and transhipment vessels associated with the Project and should be documented and monitored by at all times; and
- Monitoring for the introduction and/or spread of invasive marine algal and faunal species should be conducted on a regular basis for the duration of barging and transhipment activity, so that any introductions can be addressed timeously.

Table 61: Temporary beach landing sites – operational impacts on marine receptors

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	intensity	Duration	Geographic Extent	Probability	Significance
Alteration of hydrodynamics - Loss/ disturbance of natural habitat (primary dunes and sandy beaches)	6	2	2	5	**Mod 50**	4	3	1	3	**Low 24**
Compaction from access roads – permanent loss/disturbance of natural habitat (primary dunes and sandy beaches)	4	2	1	5	**Low 35**	4	2	1	3	**Low 24**
Water and benthic contamination from petroleum, oils and lubricants (primary dunes and sandy beaches, seagrass beds)	6	2	2	5	**Mod 50**	4	2	2	2	**Low 16**

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	intensity	Duration	Geographic Extent	Probability	Significance
Ballast discharge – spread of invasive species- Loss/ disturbance of natural habitat (primary dunes and sandy beaches, seagrass beds)	8	5	3	4	**Mod 64**	6	5	2	3	**Low 39**

Decommissioning and removal of the temporary jetty

The decommissioning of the temporary beach landing sites will involve the removal of the jetty structure, leaving a minimum footprint of 1400-1600 m^2 in the sandy beach habitat zone. Over time, natural hydrodynamic patterns will re-establish and ultimately, the sandy beach habitat is expected to be restored.

Disturbances arising during decommissioning will be transient and local, with the significance of predicted impacts expected to be low. The significance of predicted impacts can be further reduced through the application of the required mitigation measures.

The removal of the jetty infrastructure and associated heavy vehicle works is likely to cause some transient water quality and benthic contamination with sediment as well as petroleum, oils and lubricants. Following completion of decommissioning, the intensity of the impact is expected to be low, and site based only, resulting in a residual impact of low significance (Table 62).

Mitigation measures

- The extent of sandy beach habitat disturbance should be minimised wherever possible. Areas proposed for works should be clearly marked and no heavy vehicles should travel beyond the marked works zone;
- Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks; and
- Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, transhipment vessels and heavy equipment are minimised/eliminated. Daily maintenance and monitoring checks of vessels should be conducted.

Table 62: Temporary beach landing sites – decommissioning impacts on marine receptors

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Alteration of hydrodynamics - Loss/disturbance of natural habitat (primary dunes and sandy beaches)	4	1	2	5	**Low 35**	4	1	1	3	Low 18
Water and benthic contamination from petroleum, oils and lubricants (primary dunes and sandy beaches, seagrass beds)	6	1	2	5	**Mod 45**	4	1	1	3	**Low 18**

7.2.1.23 Activities at Anchorage Point affecting Marine Receptors

Establishment of Anchorage Point

The construction of the anchorage point will involve placement of the anchoring system on the seabed. Depending on the system being used, some excavation for the anchor may be necessary. In any case, some habitat loss and degradation in the footprint and immediate surrounds of the anchorage point is predicted. The previously identified anchorage locations from the existing maritime maps that are located in the BANP have depths of around 15 to 20 m, therefore seagrass bed habitat is unlikely to be affected as it typically occurs in shallow and subsidiary waters of less than 5 m depth. However, coral reef systems off the coast of Bazaruto may be affected, and further surveys will be undertaken prior to anchorage points being selected in order to confirm that sensitive habitat such as corals are avoided.

The intensity of the potential impact of loss of coral reef habitat is expected to be low since the identified anchor points are not considered to be above coral reefs, though a potential impact would have a duration that is long-term since restoration of hard coral reef habitat is likely to be difficult (although some coral may establish on the structures once usage has ceased). Prior to mitigation, an impact of moderate significance on natural coral reef habitat is predicted. The successful implementation of the required mitigation measures may limit the intensity and confine the extent of the impact to the site only, resulting in a low residual impact.

The potential loss/disturbance of the coral reef/seabed habitat during anchorage placement could result in the loss of habitat for endemic gastropod species receptors; however, the low intensity of effects on the overall population of these species, and limited extent ensure that the impact would be of low significance.

The placement of the anchorage points within Bazaruto Archipelago National Park and resultant effects on seabed habitat and associated species is also considered a low intensity impact; however, the impacts must be considered at the national/international scale, resulting in an overall impact of high significance prior to mitigation. Mitigation of the impact focusses solely on the relocation of the proposed anchorage points to suitable sites outside of the National Park boundary, which would change the geographic extent of effects to site-based, minimise the probability of impacts to BANP, and reduce the residual impact to one of negligible significance (Table 63). Anchorage points located outside the BANP are currently being investigated. If no possible alternative anchorage points are found outside the BANP (in line with the process described in Section 2.9.4 of this ESIA), it is possible that anchorage points within the BNP could be selected.

Mitigation measures

- The extent of seabed disturbance should be minimised wherever possible. Areas proposed for works should be clearly marked and no excavation or disturbances should occur beyond the marked works zone;
- Site-specific surveys for coral reef and endemic gastropods should be conducted in advance of placement of the anchorage points to confirm anchor points will not be on coral reefs or seagrass beds; and
- Anchorage points should be located outside of the boundary of the Bazaruto Archipelago National Park/IBA as well as popular recreational sites (dive/snorkelling sites), and a buffer of at least 250 m should be maintained between the outer extent of the boundary and the anchorage points/navigation routes of the transhipment/barging vessels.

Table 63: Anchorage points – construction impacts on marine receptors

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Loss/ disturbance of natural habitat (coral reef)	4	4	2	5	**Mod 50**	2	4	1	5	**Low 35**
Loss of habitat for endemic gastropods	4	4	2	4	**Low 40**	2	2	1	4	**Low 20**
Placement within Bazaruto NP/IBA	4	4	5	5	**High 65**	4	4	1	1	**Negligible 9**

Operation at Anchorage Points

The activities at the anchorage points will involve mooring of the transhipment vessel. It is understood that the vessel will not be anchored for extended periods of time and will most likely be anchored for 1-2 weeks at a time to offload the heavy and over-sized equipment with up to 3-4 months between shipments over a period of 8-15 months. The presence of the transhipment vessel could give rise to impacts including contamination of the local marine water and sediment quality with hydrocarbon fuels, oils and/or lubricants, and disturbance of migratory/congregatory seabird species associated with Bazaruto Archipelago Important Birding Area (IBA).

The intensity of the potential impact of marine water and sediment contamination could be moderate, and the duration short-term, persisting for the lifetime of the use of the anchorage points. Impacts are likely to affect local water and sediment quality, which would have knock-on effects on underlying natural habitats such as coral reefs. The application of the required mitigation measures can reduce the severity of potential impacts as well as the probability of them occurring in the first place, reducing the residual impact to one of low significance.

Disturbance of migratory/congregatory seabird species associated with Bazaruto Archipelago IBA is likely to be of low intensity, and transient – only occurring when the transhipment vessel is moored at the anchorage point. The geographic extent of the impact is considered at the global scale due to possible effects on species for which the IBA is designated; the transient nature of the disturbances results in an overall impact of moderate significance prior to mitigation. Again, focusing the mitigation measures on the relocation of the proposed anchorage points to suitable sites outside of the National Park boundary and away from popular recreational sites, would change the geographic extent of effects to site-based, minimise the probability of impacts to bird species associated with Bazaruto Archipelago IBA, and reduce the residual impact to one of negligible significance (Table 64).

Mitigation measures

- Strict controls should be put in place to ensure that leakages of hydrocarbon fuels, oils and/or lubricants from barges, transhipment vessels and heavy equipment are minimised/eliminated. Daily maintenance and monitoring checks of vessels should be conducted;
- Anchorage points should be located outside of the boundary of the Bazaruto Archipelago National Park/IBA (if feasible alternative locations are found and if such points do not increase the environmental or social impacts) and away from popular recreational sites, and a buffer of at least 250 m should be maintained between the outer extent of the boundary and the anchorage points/navigation routes of the transhipment/barging vessels; and
- Ensure that all vessels and machinery are in sound mechanical order, do not have any oil leaks and are fitted with appropriate mufflers to minimise nuisance affecting migratory/congregatory seabird species. Other measures include restrictions in operating hours for heavy machinery and vessels.

Table 64: Anchorage points - operational impacts on marine receptors

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Water and benthic contamination from petroleum, oils and lubricants (coral reefs, seagrass beds)	6	2	2	5	**Mod 50**	4	2	2	2	**Low 16**
Disturbance of migratory/congregatory seabird species	4	1	5	5	**Mod 50**	4	1	1	2	**Negligible 12**

Decommissioning of Anchorage Point

After the beach landing and transhipment activities have concluded, it is expected that the anchorage points will remain in situ on the seabed, and no further usage will be made. No impacts on species or ecosystem receptors are anticipated.

Impacts of Barge Movements on Marine Receptors

Large heavy equipment and components required for the construction of the power plant will be transferred from the transhipment vessel onto a barge capable of moving on the high tide into very shallow water adjacent to the beach to offload its cargo onto the temporary jetty at the beach landing site. As the tide subsides, the barge rests on the sand and the equipment will be off-loaded.

Chapter 2.0, Project Description suggests that barging will be required on at least 7 - 10 occasions, over the course of a minimum of 20 weeks (5 months), with the actual duration likely to be extended due to the waiting period of up to 3-4 months between some of the shipments. The actual number of barging movements may also be greater than 7 - 10 movements, depending on the size of the load that the barges can transport. It is likely that the total duration could be between 8 - 15 months with long periods of no activity.

The movements of the barges from the anchorage points to the beach landing points will cross Dugong habitat north of Bazaruto Archipelago National Park, with the potential to separate some of the largest feeding grounds of the north from other feeding grounds and/or preferred breeding habitats of the south as a result of acoustic and/or physical disturbances, creating barriers to movement for this species. The intensity of the potential impact on Dugong movements could be high and are considered at the national scale given the level of protection assigned to this species in Mozambique; but the impacts will be transient, only occurring at disjunct times of barge movements. The probability of the impact occurring is assessed as being moderate, resulting in an impact of moderate significance prior to mitigation. The application of the required mitigation measures, specifically the presence of a Certified Marine Mammal Observer on all barge movements, reduces the intensity of the potential impact for both species, resulting in a residual impact of low significance.

Barge strikes are possible, as Dugong are very slow moving (average 10 kmph, typically 5 - 8 kmph, short bursts of up to 20 kmph) and are typically concentrated in shallow waters (<5 m depth) where seagrass beds occur. Barge strikes could also affect the *Endangered* Indian Ocean Humpback Dolphin, which is resident in the coastal waters of the Study Area. The intensity of the potential impact is high, and effects would be long-term, lasting until such a time as Dugong/Indian Ocean Humpback Dolphin recovered from the loss of the affected individuals. The potential effect is assessed at the national scale for nationally-protected Dugong, and at the international scale for the globally *Endangered* Indian Ocean Humpback Dolphin. Prior to mitigation measures being implemented, there is a very high probability of barge strike for Dugong, and a moderate probability of barge strike for Indian Ocean Humpback Dolphin which is a faster-swimming, more agile species. Impacts on Dugong and Indian Ocean Humpback Dolphin prior to mitigation are High and Moderate respectively. The application of the required mitigation measures, specifically strict speed restrictions of 5km/h such that the boats would be traveling slower than the speeds of the mammals, as well as the presence of a Certified Marine Mammal Observer on all barge movements, reduces the intensity of the potential impact for both species, resulting in residual impacts of low significance.

The barge movements may cause seabed scour in areas of shallower water, which could affect seagrass beds which are the preferred foraging habitat for Dugong. In the context of the extent of this habitat in the CHAA, the potential impact could be of moderate intensity, with the loss being medium-term, persisting until such a time as the barge movements cease (after approximately 12 - 15 months) and seagrass beds recover. Impacts would be local sites and are considered definite. Prior to mitigation, the significance of the impact of loss of natural primary dune and sandy beach habitat will be moderate. The application of the required mitigation measures reduces the intensity of the impact to low, as well as the probability of the impact occurring, resulting in a residual impact of low significance Table 65).

Impacts of Large Vessels

Similar to the impacts of barge movements in the Bazaruto Bay area, the transhipment vessel will also need to adhere to a number of mitigation measures in order to limit potential impacts on the marine environment when entering the Bazaruto Bay area, as listed below for the barges and large vessels.

Mitigation Measures

- Strict speed restrictions must be enforced on barges and the transhipment vessel sto protect Dugongs (and Indian Ocean Humpback Dolphin) from vessel strikes in Bazaruto Bay. The maximum allowable speed should be <5 kmph to allow Dugong to move out of the way of oncoming vessels, minimising the risk of collision;
- A Certified Marine Mammal Observer (MMO) must be employed by the Proponent or the Contractor responsible for such activities to observe and monitor all barge and transhipment movements. The MMO will have authority to influence the speed and direction of vessel movements where any potential risks to marine mammals are identified. If useful for reducing collision risks with Dugongs, Indian Ocean Humpback Dolphin, or sea turtles, the MMO or other trained staff shall be aboard a small boat ahead of the barge to spot these marine creatures and ensure that they leave the pathway in front of the barge; and
- Barges and the transhipment vessel must be routed via specific vessel lanes/channels that avoid potentially important areas of seagrass habitat. These routes needed to be clearly marked with buoys (no Styrofoam to be used).

- Strict controls on ballast water management for both barges and transhipment vessels must be enforced by The Proponent, in line with the relevant MARPOL standards. High risk ballast water (that coming from ports and coastal waters outside of Bazaruto Bay) should not be discharged within the CHAA under any circumstances. Tank-to-tank transfer of ballast water should be enforced for all barges and transhipment vessels associated with the Project and should always be documented and monitored.

Table 65: Barge and transhipment vessel movements - operational impacts on marine receptors

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Barrier to movement (Dugong)	8	1	4	3	**Mod 52**	4	1	4	3	**Low 27**
Barge/vessel collisions causing injury/mortality (Dugong)	8	4	4	5	**High 80**	4	4	4	2	**Low 24**
Barge/vessel collisions causing injury/ mortality (Indian Ocean Humpback Dolphin)	8	4	5	3	**Mod 51**	4	4	5	2	**Low 26**
Loss disturbance of natural habitat (seagrass beds)	4	4	2	5	**Mod 50**	2	4	1	5	**Low 35**

7.3 Bio-Physical Environment

7.3.1 Operational Phase

7.3.1.1 Decrease in Ambient Air Quality

Technology Option – Gas Turbines

The Closed Cycle Gas Turbine (CCGT) configuration is characterized by a high number of power generators (up to 9 in total) and provides large flexibility to meet any power plant load maintaining high efficiency. It is based on three modules for electric power generation, each one constituted by two Gas Turbines; two Heat Recovery Steam Generators and one Steam Turbine, with the balance of plant units is common to the three-generation modules, providing all the utilities necessary for appropriate and safe operation of the Plant. Emission parameters and rates were considered and simulated for PM_{10} NO_2 and SO_2 which resulted in the significance rating of Low (Table 66).

Table 66: Air Quality impact: Gas Turbines - operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Impact of PM_{10}	2	4	2	5	**Low 40**	2	4	2	5	**Low 40**
Impact of NO_2	2	4	2	5	**Low 40**	2	4	2	5	**Low 40**
Impact of SO_2	2	4	2	5	**Low 40**	2	4	2	5	**Low 40**

Mitigation measures

Measures aimed at further reducing or mitigating NO_2 impacts from gas turbines engines include:

- An increase in stack height (if feasible); and
- Control Technologies:
  - Selective catalytic reduction (SCR);
  - Selective non-catalytic reduction (SNCR);
  - Catalytic combustion; and
  - Wet Low Emissions (WLE).

Technology Option – Gas Engine

The Open Cycle Gas Engine (OCGE) configuration is characterized by up 24 Gas Engines with a N+1 sparing philosophy (one extra engine on standby) and provides large flexibility to meet any power plant load maintaining high efficiency. The plant will be designed having four identical modules, each module containing six gas engines, all feeding into a common stack per module. Emission parameters and rates were considered and simulated for PM_{10} NO_2 and SO_2. Operational phase impacts are demonstrated to be of low significance for PM_{10} and SO_2, additional mitigation will not be required for these parameters. Impacts for NO_2 were predicted to be moderate pre-mitigation. Following the application of mitigation measures, the impact significance was found to be low (Table 67).

Table 67: Air Quality impact: Gas Engines - operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Impact of PM_{10}	2	4	2	5	**Low 40**	2	4	2	5	**Low 40**
Impact of NO_2	4	4	2	5	**Mod 50**	2	4	2	5	**Low 40**
Impact of SO_2	2	4	2	5	**Low 40**	2	4	2	5	**Low 40**

Mitigation measures

Measures aimed at reducing or mitigating NO_2 impacts from reciprocating gas engines include:

- An increase in stack height (where feasible); and
- Control Technologies:
  - Low NO_X burners;
  - Homogeneous Charge Compression Ignition (HCI); and
  - Flue-Gas Recirculation (FGR).

7.3.1.2 Increase in Mozambique's National Green House Gas emissions

Technology Option – Gas Turbines

From the results in the Greenhouse Gas (GHG) specialist study, it can be seen that without mitigation, the CTT project will contribute between 7.1% and 7.4% to the total annual GHG emissions for the first five years (2021 – 2025), and between 28.4% and 34.3% for the next 20 years (2025 – 2045) without mitigation. With mitigation, the CTT project will contribute between 7.7% and 8.0% to the total annual GHG emissions for the first five years (2021 – 2025), and between 28.4% and 37.1% for the next 20 years (2025 – 2045).

Given that with CCGT, the CTT project will contribute between 7.1% and 8.0% to Mozambique's annual GHG emissions for the first 5 years and between 28.4% and 37.1% for the next 20 years, the significance of the impact is rated as **high** as it is not an insignificant contribution.

As mentioned previously, the contribution of the energy sector to the total annual GHG emissions of Mozambique was 5.9 $MtCO_2e$ in 2013, and that the GHG emissions of the energy sector was also growing on average 2.2%, per annum. It is estimated that the Gas Turbines Option for the CTT project will increase the GHG emissions from the Mozambican energy sector by between 69.2% and 330%.

Product Unit Intensity

Benchmarking the potential GHG emissions resulting from a project against emitters in the same sector can also be used to assess the significance of impacts of a project. In order to allow for comparison, the average emissions intensity per product unit (i.e. CO_2e per product unit) is typically used. Given that the product unit of the CCT project is power (GWh), the emissions intensity per product unit is CO_2e/GWh.

It is estimated that the CTT project using CCGT will generate 2,338 GWh per annum in years 1 to 5, and 3,200 GWh per annum in years 6 to 25 (Foster Wheeler, 2014b) [11]. The CCT project will therefore generate a total of 75,682 GWh during the operational phase. If the CTT project emits an estimated 31,409,398 tCO_2e during the operational phase the GHG emissions intensity is approximately 435.5 tCO_2e/GWh or 435 gCO_2e/kWh.

According to Cai et al. (2013), the average emissions intensity of power plants in the United States using closed cycle gas turbines is 441 gCO_2e/kWh. The average efficiency of these plants was 50.6%. The emissions intensity of the CTT project using CCGT, with a net electrical efficiency of between 50.4% and 52.7%, is estimated to 435 gCO_2e/kWh, which is approximately 1% less than the industry average. As a result, the impact is considered to be **low**.

Pre-defined Thresholds

The European Bank of Reconstruction and Development (EBRD) developed thresholds which can be used for benchmarking the magnitude of annual emissions of a project – see Table 68.

Table 68: Benchmark thresholds for annual CO_2e emissions (EBRD, 2010)

GHG emissions (tCO_2e/a)	Qualitative rating
<10,000	Nominal/Negligible
10,001 – 25,000	Low
25,001 – 100,000	Medium-Low
100,001 – 1,000,000	Medium-High
>1,000,000,001	High

It is estimated that the GHG emissions associated with Gas Turbines for the CTT project will be 1,068,174 tCO_2e per annum for the first 5 years (2021 - 2025), and 1,303,426 per annum for the next 20 years (2025-2045). Assuming a design life of 25 years, the annual emissions of the CTT project will be on average 1,256,376 tCO_2e. As such, the magnitude of the annual emissions of the use of CCGT is also rated as **high** in terms of the thresholds presented in (Table 69).

Technology Option – Gas Engines

It can be seen that without mitigation, the CTT project will contribute between 8.2% and 8.6% to the total annual GHG emissions for the first five years (2021 – 2025), and between 35.3% and 42.7% for the next 20 years (2025 – 2045) without mitigation. With mitigation, the CTT project will contribute between 8.9% and 9.3% to the total annual GHG emissions for the first five years (2021 – 2025), and between 35.3%

[11] Note that the total output was increased by on average 12% to account for possible increase in the net electrical power output from 400 MW to 450 MW.

and 46.1% for the next 20 years (2025 – 2045). Mitigation outlined in Table 69 can also be applied to Gas Engines.

Given that with OCGE, the CTT project will contribute between 8.2% and 9.3% to Mozambique's annual GHG emissions for the first 5 years and between 35.3% and 46.1% for the next 20 years, the significance of the impact is rated as **high** as it is not an insignificant contribution**.** It is estimated that the Gas Engines Option for the CTT project will increase the GHG emissions from the Mozambican energy sector by between 80.3% and 411%.

It is important to note that 93% of Mozambique's 2,308 MW operating capacity is generated by hydro (SADC, 2016). As a result, the contribution of the energy sector to the country's total GHG emissions is relatively small. Further to this, and any large-scale fossil fuel-based power plant, regardless of its operational efficiency, will make a significant contribution to Mozambique's total GHG emissions.

Product Unit Intensity

It is estimated that the CTT project suing OCGE will generate 2,424 GWh per annum in years 1 to 5, and 3,200 GWh per annum in years 6 to 25 (Foster Wheeler, 2014a)[12]. The CTT project will therefore generate a total of 76,112 GWh during the operational phase. If the CTT project emits an estimated 38,625,930 tCO_2e during the operational phase, the GHG emissions intensity is approximately 507.5 tCO_2e/GWh or 507 gCO_2e/kWh.

According to Cai *et al.* (2013), the average emissions intensity of power plants in the United States using natural gas internal combustion engine (NGICE) is 619 gCO_2e/kWh. The emissions intensity of OCGE is estimated to be 507 gCO_2e/kWh, which is approximately 19% less than the industry average. As a result, the impact is considered to be **low**. It is worth noting however that the average efficiency of the NGICEs in the United States was 32.8%, whereas the net electrical efficiency of OCGE is estimated to be between 45.4% and 45.9%. This indicates that the technology used included in the United States sample may be older than what is proposed for the CTT.

It is also worth noting that the South African Department of Environmental Affairs recently commissioned a study to measure the GHG emissions of fossil fuel fired power stations, including a gas to power plant in Sasolburg (DEA, 2016). It was estimated that the gas to power plant would emit on average 241 gCO_2e/kWh. It was however found that during the study, the plant was only emitting 172 gCO_2e/kWh. Given that the CTT project may utilise similar gas engine technology as the Sasolburg plant, the actual GHG emissions of the CTT project could potentially be lower than the predicted values.

Pre-defined Thresholds

It is estimated that the GHG emissions associated with the CTT project using OCGE will be 1,239,845 tCO_2e per annum for the first 5 years (2021-2025), and 1,621,335 per annum for the next 20 years (2025 - 2045). Assuming a design life of 25 years, the annual emissions of the CTT project will be on average 1,545,037 tCO_2e. As such, the magnitude of the annual emissions of the use of OCGE is rated as **high** in terms of the thresholds presented in Table 69.

[12] Note that the total output was increased by on average 12% to account for possible increase in the net electrical power output from 400 MW to 450 MW.

Mitigation measures

Table 69: GHG emissions mitigation measures for CCGT and OCGE - operational phase

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
Operational Phase				
Stack emissions	Contribution to GHG emissions	Plant inefficiencies	Installation of probes in stacks to allow for continuous monitoring of stack emissions.	Operations manager

7.3.1.3 Groundwater Quality Deterioration

The operational phase activities that could potentially impact on the **quality of the groundwater resource** include the irrigation of effluents, accidental spillages and overflows from surface water impoundments, materials handling and waste/waste water generation associated with the power plant operation.

The sanitary effluent and treated oily water effluent streams are to be irrigated to the surrounding environment. There is a potential to pollute the local aquifer systems should non-compliant effluent be irrigated. As there is expected to be minimal surface flow of the irrigated water, with almost all of the water draining to underground, the perimeter boreholes should be regularly monitored to assess any potential contamination. The impact is considered to be of moderate significance but can be reduced to **low** with mitigation (Table 70).

The evaporation pond will serve as the local pollution control dam at the CTT plant site. The pond will handle onsite wastewater streams including the ultrafiltration reject, brine, cooling water blow down, as well as non-compliant sewage and treated oily water effluents streams from the CTT plant. The water qualities of these streams will include very high salts, total suspended solids, oils as well as other contaminants. Liner failure and leakages and inadequate capacity of the evaporation pond to handle higher than anticipated waste stream volumes could potentially result in spillages to the surrounding environment. Spills from the evaporation could cause local ground water pollution. The impact is considered to be of high significance but may be reduced to moderate with mitigation.

This potential for groundwater contamination can also result from poor housekeeping that may result in accidental spillages and storage of hazardous chemicals; poor waste management and other waste disposal practices. All of these impacts are rated **low** and can be reduced to **negligible** after mitigation. Waste management measures need to be in place to ensure that impacts are minimised. The impacts rated will be the same for the two technology options.

Mitigation measures

The oily water effluent and sewage effluent streams must comply with required discharge water quality standards for treated effluent as stipulated in terms of the Mozambican and IFC standards. Continuous monitoring of the effluent streams is required prior to irrigation to determine compliance to discharge standards. Non-compliant effluent should be discharged to the evaporation pond.

Measures for containment of spills and warning systems for leaks must be included in the design of the evaporation pond. The protocols that should be applied in the event of a spill in the operational phase should be developed and documented in the EMP. A clean-up plan should be prepared and carried out in this event.

The protocols that should be applied during the operational phase should be developed and documented in the EMP. The protocols should address the following:

- Storage of new and used oils in bunded areas;
- No co-handling of reactive liquids or solids;
- Creation and monitoring of an inventory of chemicals held on site;
- Storage of hazardous or toxic substances securely and controlled use thereof;
- Availability and accessibility of HAZOP sheets of all chemicals; and
- Waste disposal according to protocols and in designated containers/areas only.

A groundwater monitoring network needs to be established on site that is targeted at specific potential sources of groundwater contamination.

Table 70: Groundwater Deterioration: CCGT & OCGE - Operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Groundwater deterioration - Irrigation of Effluents	10	4	2	4	**Mod 64**	6	4	2	2	**Low 28**
Groundwater deterioration - Spills from the evaporation pond	10	4	2	5	**High 80**	8	4	2	4	**Mod 56**
Groundwater deterioration - Accidental spillages and Hazardous materials	4	3	2	2	**Low 18**	2	2	2	2	**Negligible 12**
Groundwater deterioration – Waste management	4	3	2	2	**Low 18**	2	2	2	2	**Negligible 12**

7.3.1.4 Decline in groundwater levels

Technology Option – Gas Turbines

Raw water for the Project will be supplied from aquifers in the area and treated accordingly. Two boreholes of differing water quality and abstraction rates are currently being considered as the source of raw water to the CTT site, T9 and W5A. Alternatively a new borehole may be installed at the Power Plant site. The selected borehole (water source) will be used to supply either of the two technology options. The CCGT option requires a water supply of 25.9 m^3/h. Clean stormwater harvested will also be used to offset borehole water supply. In addition to the Power Plant water supply it is estimated that an additional 0.44 m^3/h will be required for potable use on site. This will add additional pressure on the supply boreholes from which the Sasol already abstracts 8.3 m^3/h for the CPF water requirements.

The scenarios of various abstraction rates and water requirements were simulated in a simplified numerical model and the water level decline at each borehole was simulated as:

- Gas Turbine @ W5A: Water level is 28 m below the steady state water level; and
- Gas Turbine @ T9: Water level is 0.16 m below the steady state water level.

It can thus be seen that the rate of water abstraction that is required significantly impacts borehole W5A, which is likely to result in a water level decline in other potential supply boreholes in close proximity of the CPF.

Based on the simulations the impact is considered to be a high-moderate rating before mitigation (Table 71). However, with mitigation and management of abstraction boreholes, the impact of water level decline can be reduced further to being low in close proximity of the abstraction's wells only.

Mitigation measures

Mitigation and management of abstraction boreholes need to include continuous level and abstraction volume monitoring. It is proposed that additional boreholes be used to augment the water supply from W5A and T9, as the required abstraction is likely to not be sustainable in the long-term from only the two boreholes. With the addition of other water supply boreholes, the impact can be reduced to low.

All abstraction boreholes should be set up and managed so that the sustainable yield is not exceeded during a 24-hour period, and to always allow for boreholes to recover sufficiently between abstraction cycles.

Table 71: Decline in Groundwater: Gas Turbines - Operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Groundwater level decline- additional water abstraction	8	3	3	5	**Mod 70**	6	3	2	3	**Low 33**

Technology Option – Gas Engines

Raw water for the Project will be supplied from aquifers in the area and treated accordingly.

Two boreholes of differing water quality and abstraction rates are currently being considered as the source of raw water to the CTT site, T9 and W5A. Alternatively a new borehole may be installed at the Power Plant site. The selected borehole (water source) will be used to supply either of the two technology options. The Gas Engine option requires a water supply of 3.39 m^3/h. Clean stormwater harvested will also be used to offset borehole water supply. In addition to the Power Plant water supply it is estimated that an additional 0.44 m^3/h will be required for potable use on site. This will add additional pressure on the supply boreholes from which the Sasol already abstracts 8.3 m^3/h for the CPF water requirements.

The scenarios of various abstraction rates and water requirements were simulated in a simplified numerical model and the water level decline at each borehole was simulated as:

- Gas Engine @ W5A: Water level is 0.115 m below the steady state water level; and
- Gas Engine @ T9: Water level is 0.055 m below the steady state water level.

It can thus be seen that the rate of water abstraction that is required does not significantly impact the abstraction boreholes W5A and T5, and that the aquifer yield can sustain the required abstraction.

Based on the simulations the impact is considered to be of **low** rating before mitigation. However, with mitigation and management of abstraction boreholes, the impact of water level decline can further be reduced.

Mitigation measures

Mitigation and management of abstraction boreholes need to include continuous level and abstraction volume monitoring. All abstraction boreholes should be set up and managed so that the sustainable yield is not exceeded during a 24-hour period, and to always allow for boreholes to recover sufficiently between abstraction cycles.

Table 72: Decline in Groundwater: Gas Engine - Operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Groundwater level decline- additional water abstraction	6	4	2	3	**Low 36**	4	4	2	2	**Low 20**

7.3.1.5 *Increase in Ambient Noise levels during operational phase*

Technology Option – Gas Turbines

The increase in noise levels caused by the CTT plant was simulated and is illustrated in Figure 131 and Figure 132 below for day-time and night-time increases respectively:

- The extent of the noise impact caused by the Gas Turbine is considerably less than for the Gas Engine option, especially during the night;
- During day-time no households are affected by the 55-dBA contour. Therefore, the thresholds of the WHO for residential areas is fulfilled;

- During day-time the 3-dB contour is in close proximity to the Gas Turbines and does not affect any households thereby satisfying the thresholds of the WB and IFC;
- Although the noise impact contours extend further during night-time no households fall within the 45-dBA contour and the threshold of the WHO for residential areas during night-time is met;
- In terms of the increase in ambient noise levels no households fall within the 3-dB contour;
- Therefore, generally speaking the noise impact caused by the Gas Turbines is significantly smaller than by the Gas Engines (discussed further below); and
- According to SANS 10103 there will be no community reaction to the increase in ambient noise levels.

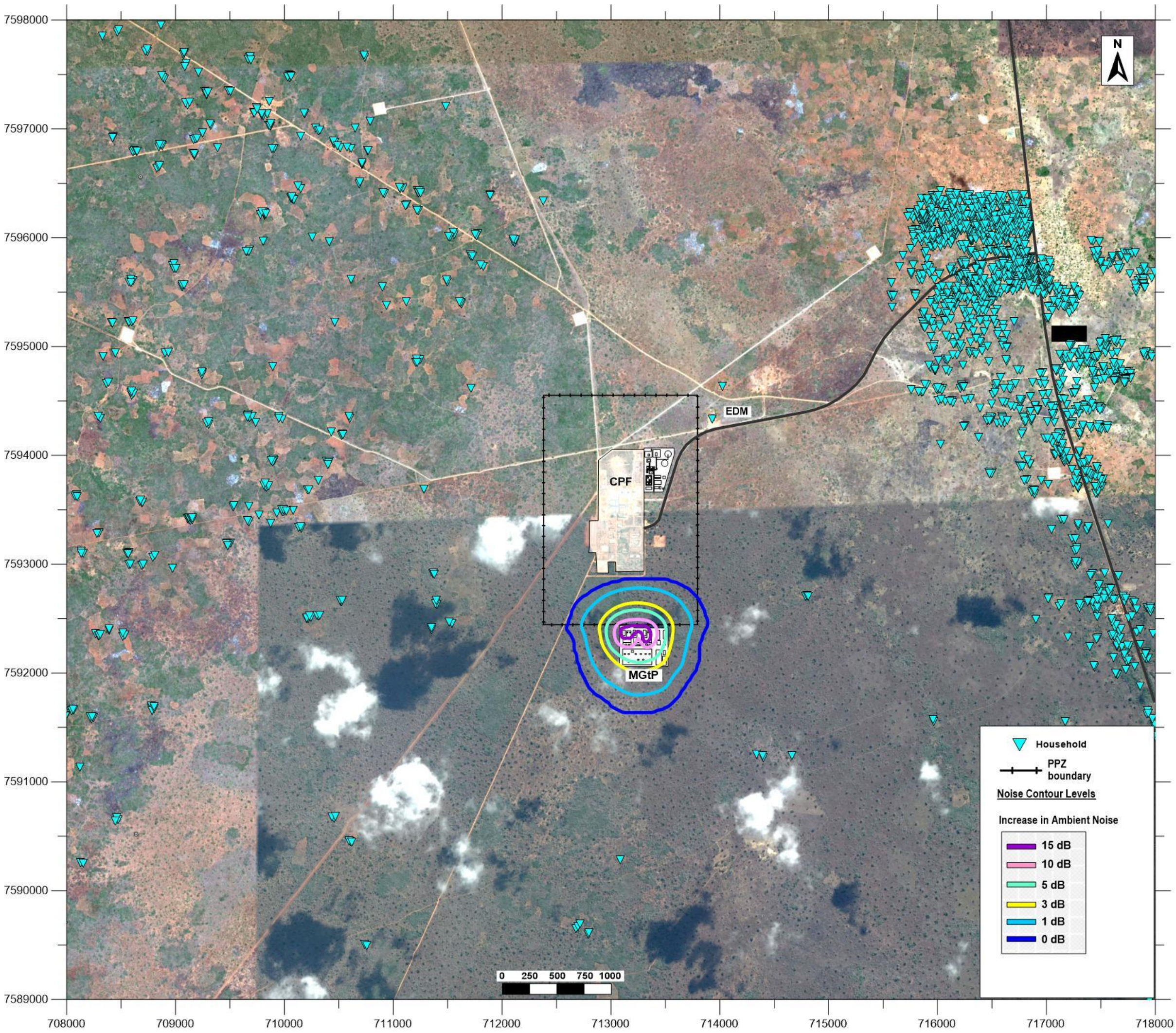


Figure 131: Gas Turbine day-time noise impact expressed as contours of the increase in ambient noise levels during operation

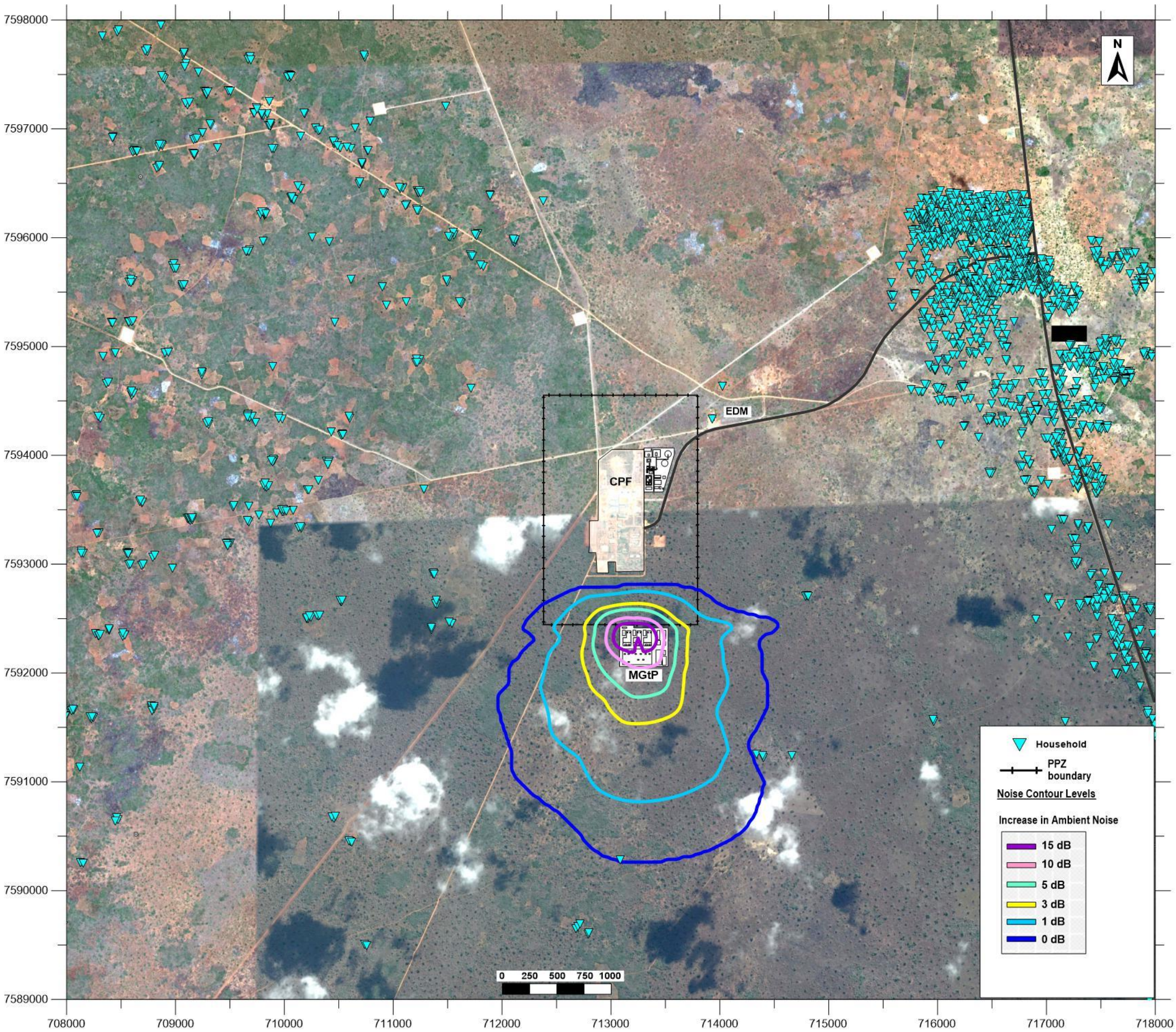


Figure 132: Gas Turbine night-time noise impact expressed as contours of the increase in ambient noise levels during operation

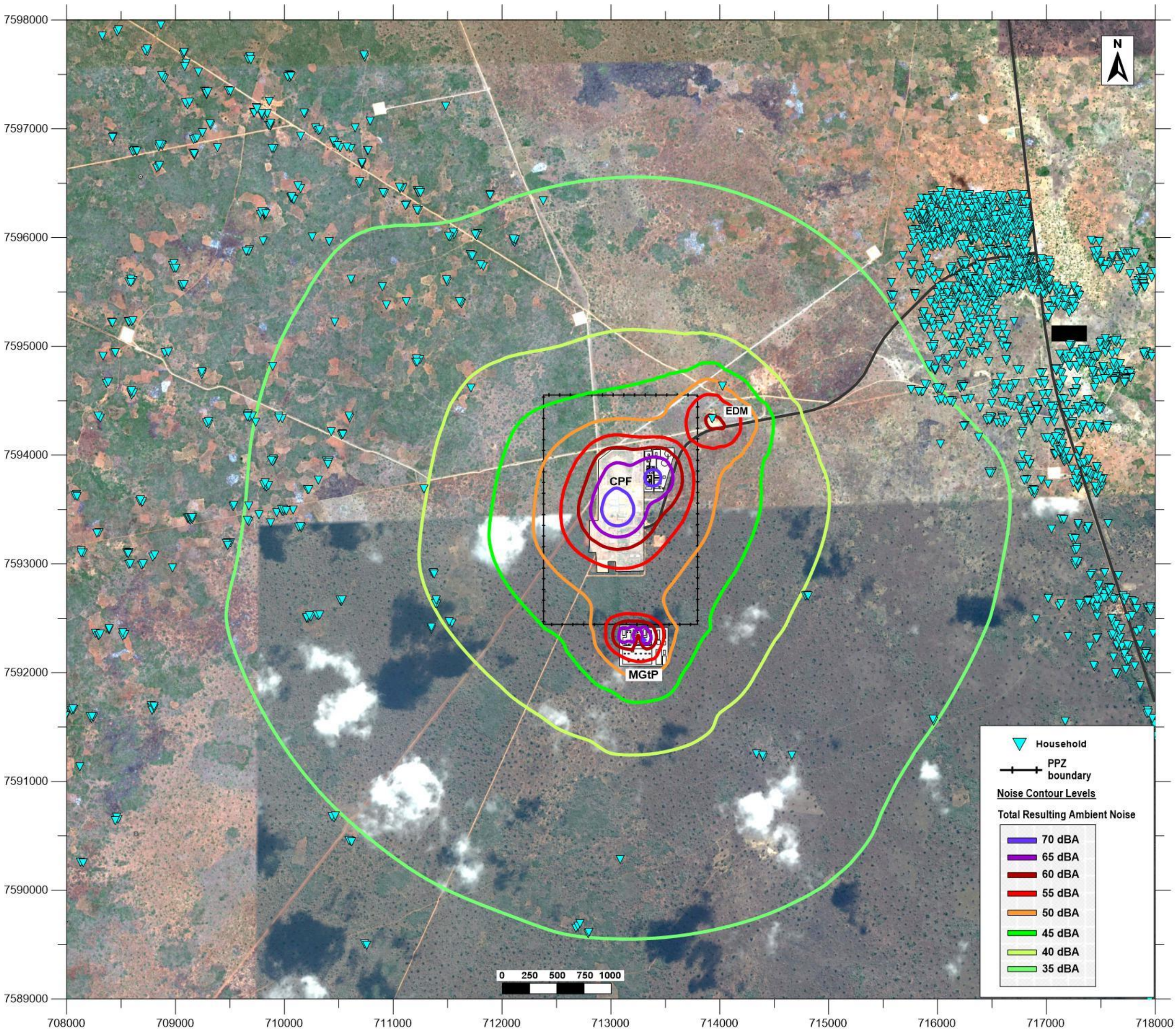


Figure 133: CCGT night-time noise impact expressed as contours of the resulting total ambient noise levels during operation

Table 73: Gas Turbines: Day-Time noise impact: Operational Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Resulting total ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**
Increase in ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**
Sleep disturbance	1	1	1	0	**Negligible 0**	1	1	1	0	**Negligible 0**

Table 74: Gas Turbines: Night-Time noise impact: Operational Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Resulting total ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**
Increase in ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**
Sleep disturbance	1	1	1	0	**Negligible 0**	1	1	1	0	**Negligible 0**

Technology Option – Gas Engines

The noise impact expressed in terms of the resulting total and the increase in ambient noise levels during day- and night-time are presented in Figure 134**,** Figure 135 and Table 75.

- During day-time the contours of the resulting total ambient noise levels of 55 dBA are located in close proximity of the CTT plant, and no households are included by it. Therefore, the threshold of the WHO for residential areas is fulfilled;
- During day-time the 3-dB contour, which serves as a significance indicator, does not affect any households thereby satisfying the threshold of the WB and IFC;
- During night-time the extent of the noise impact contours is considerably further than during day-time. The reason for this is that meteorological and other atmospheric conditions enhance the propagation of noise over longer distances during night time;
- However, in terms of the resulting total ambient noise levels no households fall within the 45-dBA contour and the threshold of the WHO for residential areas during night-time is met;
- In terms of the increase in ambient noise levels a small number of households fall within the 3-dB contour, i.e. they will experience a significant noise impact. A larger number of households will experience insignificant to negligible noise impact; and
- According to SANS 10103 the community response to the increase in ambient noise levels will be ‘little’ with ‘sporadic complaints’.

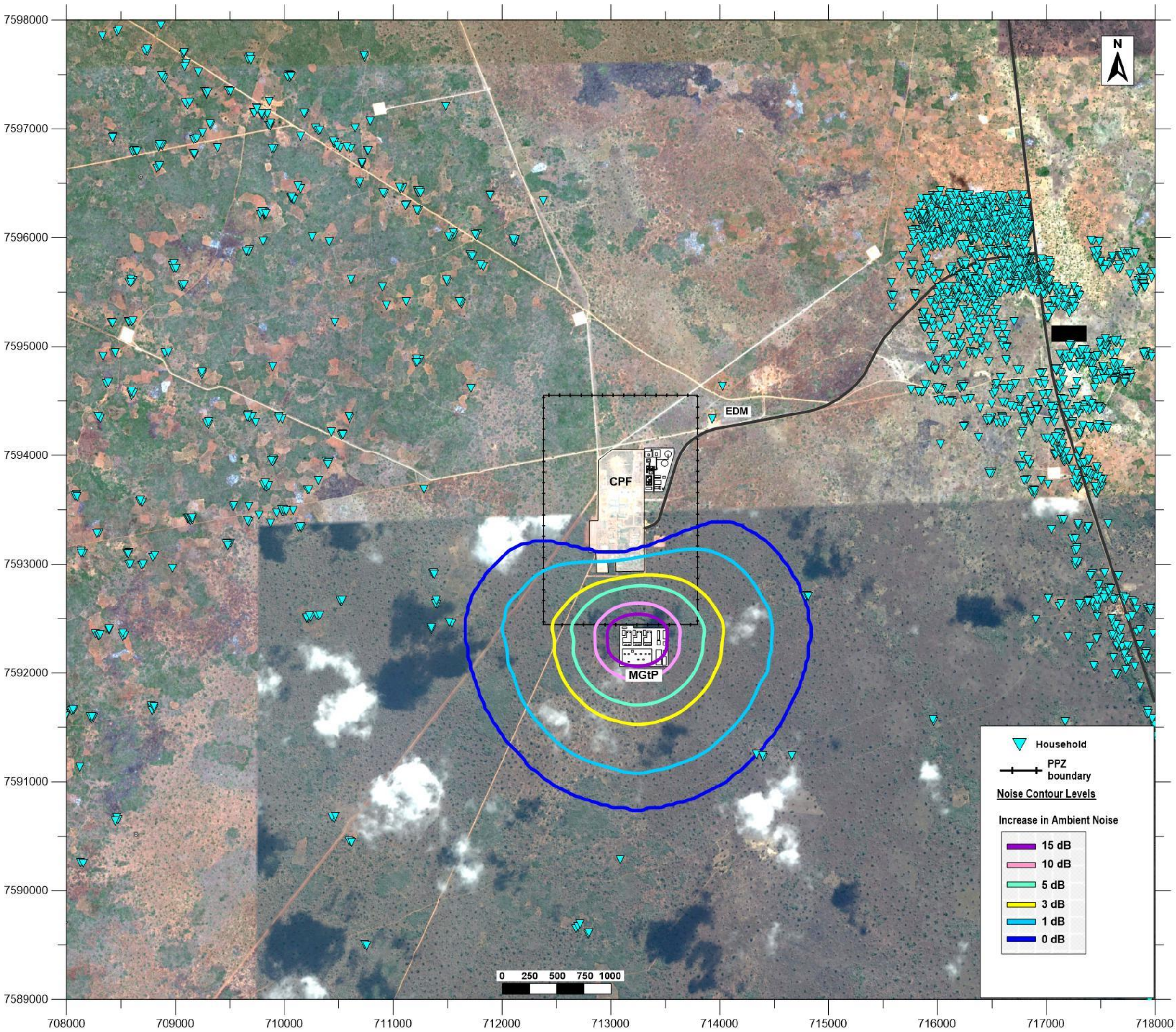


Figure 134: Gas Engine: Day-time noise impact expressed as contours of the increase in ambient noise levels during operation

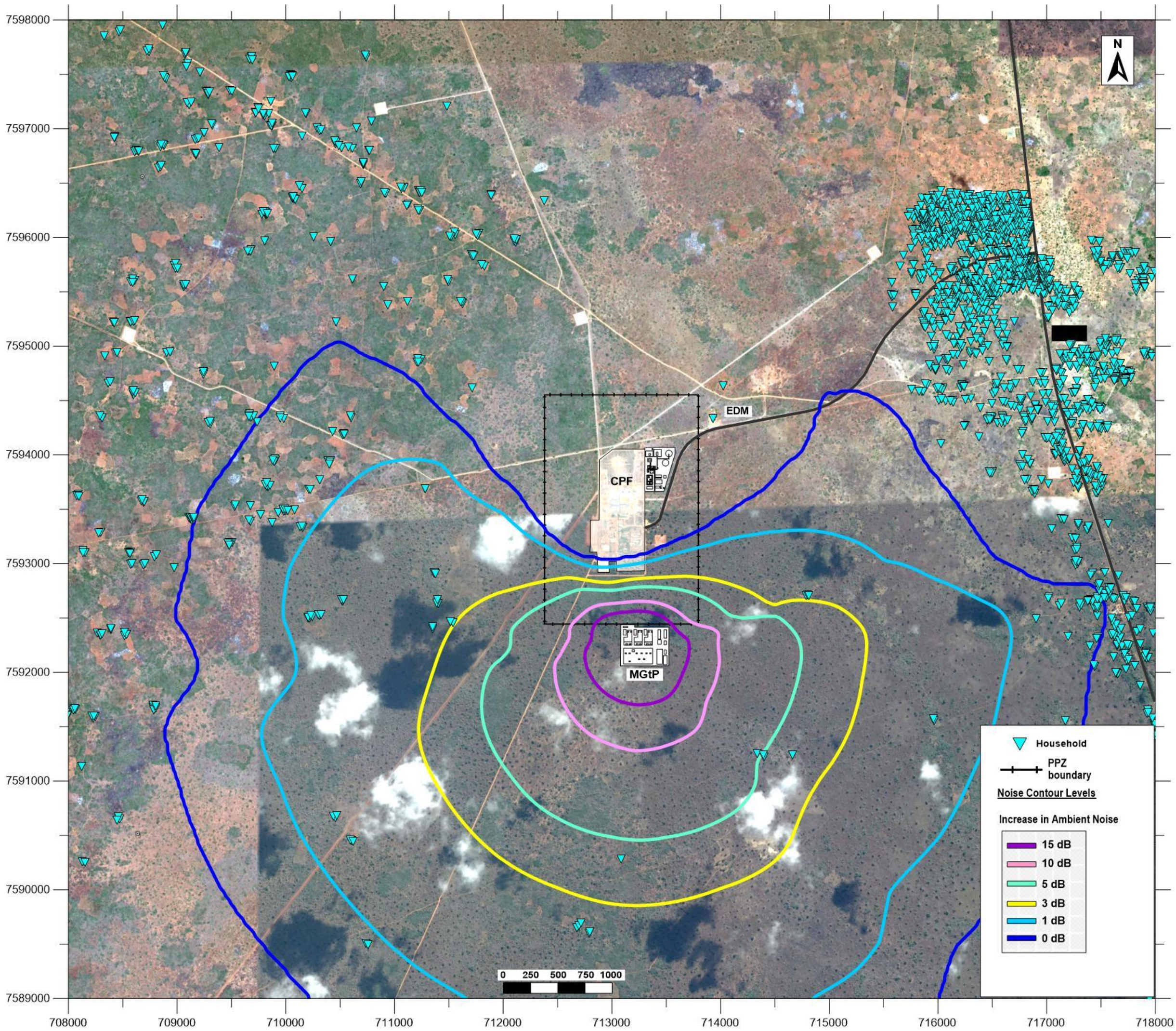


Figure 135: Gas Engine: Night-time noise impact expressed as contours of the increase in ambient noise levels during operation

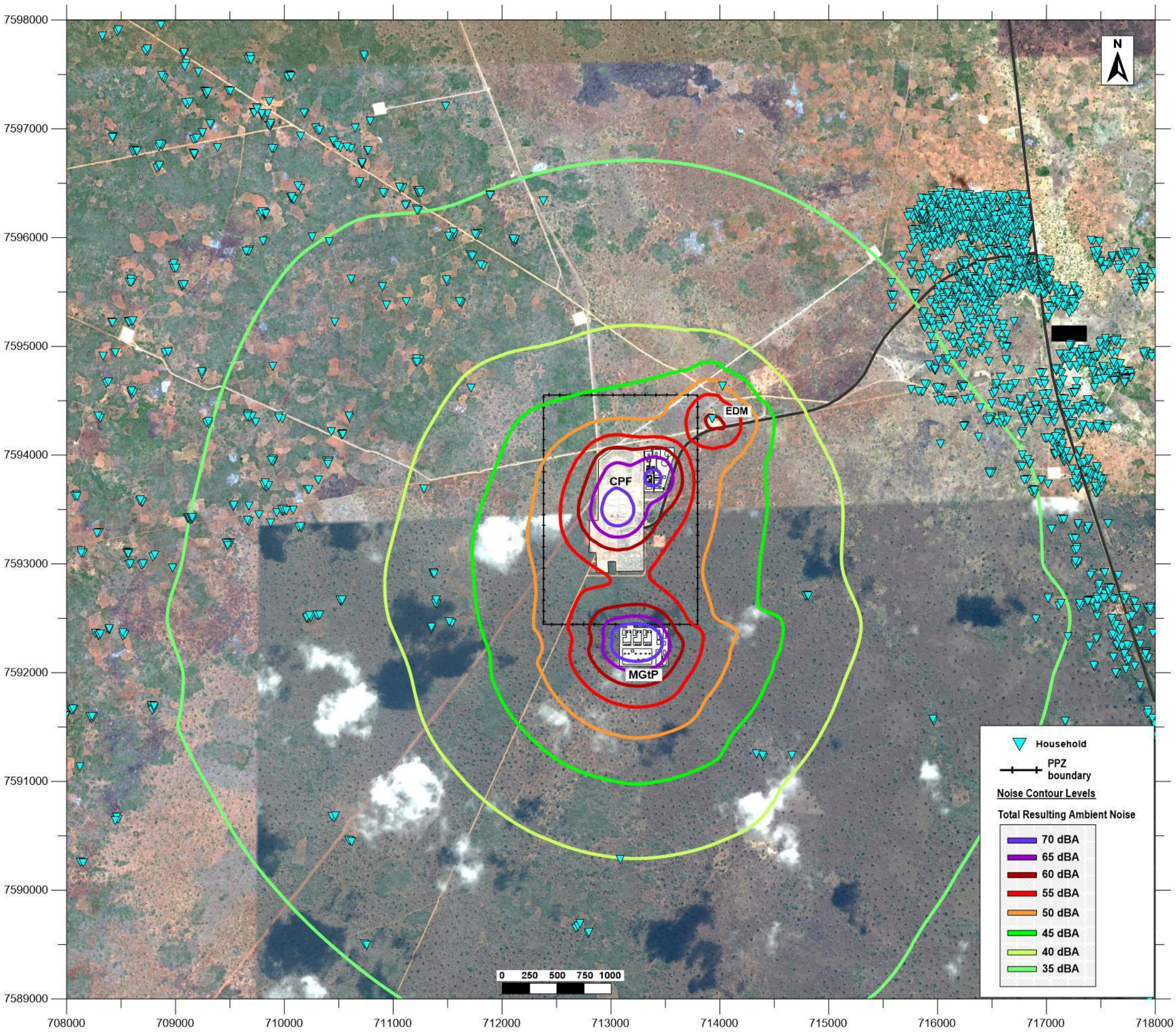


Figure 136: Night-time noise impact expressed as contours of the resulting total ambient noise levels during operation.

Further analysis shows that the extent of the noise impact is largely determined by the noise emissions from the cooling fans. Therefore, if mitigation measures are to be considered the noise emissions from these fans need to be reduced where possible. In view of the absence of further technical details it was not meaningful to further investigate the application of any noise control measures at this time due to the various technology options and possible suppliers for each still not known at the time (Table 75).

Table 75: Gas Engine Day-Time noise impact during operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Resulting total ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Increase in ambient noise levels	1	2	1	3	**Negligible 12**	1	2	1	3	**Negligible 12**
Sleep disturbance	1	1	1	0	**Negligible 0**	1	1	1	0	**Negligible 0**

Table 76: Engine Night-Time noise impact during operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Resulting total ambient noise levels	2	4	2	4	**Low 32**	2	4	2	4	**Low 32**
Increase in ambient noise levels	6	4	2	4	**Moderate 48**	6	4	2	4	**Moderate 48**
Sleep disturbance	1	4	2	1	**Negligible 7**	1	4	2	1	**Negligible 7**

7.3.1.6 Soil Contamination

During the operational phase an increased presence and use of vehicles and machinery is expected on site. As in the case of the construction phase, the potential for leakages of oil and diesel from the machinery is more likely and could cause contamination of soils and the shallow groundwater. The significance of the impact is moderate. To reduce the probability of the leakages of oil and diesel from the machinery and earthmoving vehicles, it is required that dedicated laydown areas for equipment are established. With the appropriated mitigation measures, the significance of the impact can be low (Table 77). The impacts will be same for both the CCGT and OCGE technology options.

Mitigation

- Ensure proper handling and storage of hazardous chemicals and materials (e.g. fuel, gasoil, cement, concrete, reagents, etc.) as per their corresponding Materials Safety Data Sheets (MSDS);
- Maintenance of vehicles and equipment should be carried out in designated appropriate facilities fitted with spills containment, floors and sumps to capture any fugitive oils and greases;

- Ban the use of fire as a site clearance activity and establish fire breaks to minimise potential soil contamination and protect site areas;
- Implementing regular site inspections for materials handling and storage as well as pipeline monitoring; and
- Development of detailed procedures for spills containment and soils clean up.

Table 77: Soil Contamination – Operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Soil contamination	4	5	1	3	**Low 30**	4	2	1	2	**Low 14**

7.3.1.7 Soil erosion

During the operational phase, soil erosion is expected to most likely occur along the untarred roads within the project area as well as in areas where vegetation has been removed without the construction of any surface cover (concrete, or road surface, or gravel). This significance of the impact is moderate. With the appropriated mitigation measures, the significance of the impact can be low (Table 78). The impacts will be same for both the CCGT and OCGE technology options.

Mitigation

- Contractors (in particular heavy machinery contractors) need to be restricted to designated areas as defined by the Environmental Department;
- The procedures on land clearance and soils handling needs to be followed;
- Implement, monitor and control soil erosion minimisation procedures within project footprint;
- Implement measures to protect soil stockpiles from erosion. Minimise stockpile height to <1.5 m (if soil is stockpiled on construction site); and
- Investigate the use of binding agents for roads as an alternative to water dust suppression.

Table 78: Soil Erosion – Operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Soil erosion	4	5	1	5	**Moderate 50**	4	3	1	2	**Low 16**

7.3.1.8 Soil compaction

Similar to the activities related to the impact of soil contamination, the compaction of soils may still occur with the prevalence of heavy machinery and vehicles. The increased traffic on unprepared soil surfaces (areas not designated for machinery and vehicles) will apply pressure to the soils, resulting in compaction, and potentially further erosion. This impact will therefore have a moderate significance. With the appropriated mitigation measures, the significance of the impact can be low (Table 79). The impacts will be same for both the CCGT and OCGE technology options.

Mitigation

- Remove and place soils in dry state when possible;
- Loosen soil through ripping and disking prior to revegetation; and
- Limit unnecessary trafficking and movement over areas targeted for soil removal.

Table 79: Soil Compaction – Operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Soil compaction	4	5	1	5	**Mod 50**	4	3	1	3	**Low 24**

7.3.1.9 Impacts on Surface Water Quality

Once operational, the CTT project is not expected to have a significant impact on the associated aquatic ecosystems. The current road crossings, although utilised by local people for access to the Govuro River, do not appear to be severely impacted. No people were seen bathing or washing clothes at Govuro River crossings, likely due to the brackish nature of the water. Once recovered, the water pipeline crossing of the Govuro River will pose little threat as a leak would result in groundwater entering the river. Contamination of surface water entering the watercourse is possible, particularly around the power plant where hydrocarbons have the potential to spill (Table 80). The impacts will be same for both the CCGT and OCGE technology options.

Impacts on water quality during operation are likely to result from the following activities:

- Service roads and traffic may contribute to increased sediment inputs from erosion and dust; and
- Spills into the aquatic ecosystem occurring from operational incidents.

Mitigation measures

During the operational phase, the following mitigation measures and response plans are required to avoid and minimise contamination of the Govuro River and any other aquatic resources which will result with an impact significance of Low:

- Monitor the pipelines for leaks and spills on a regular basis;
- Repair damaged structures immediately to avoid excessive spills;

- Contain spills to avoid degrading water quality downstream;
- Any accidental spillages or impacts to the aquatic and riparian ecosystems must be cleaned up and rehabilitated – a spillage management/action plan should be in place to address such situations;
- Maintain service roads to avoid erosion and excessive dust formation; and
- Design and implementation of a suitable long-term water and habitat monitoring programme, as well as an aquatic biomonitoring programme.

Table 80: Impacts on Surface Water Quality - Operational phase

Indicator of potential impact		Pre-mitigation					Post-mitigation				
		Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Impacts on Water Quality	Govuro River crossings	4	4	2	3	**30 Low**	4	4	1	2	**18 Low**
	Inland, floodplain depressions/ Non-perennial waterbodies	6	4	4	3	**42 Low**	6	2	4	2	**24 Low**

7.3.1.10 Loss of aquatic biota of conservation concern

During the operational phase, disturbance to the instream biota is expected to be minimal. It is expected that after construction, aquatic biota should recover quickly as the habitats are rehabilitated and re-colonisation takes place (crossings of the Govuro River). Rejuvenation of the site will result in fish moving back into the area. As no major flow modifications are expected, stream connectivity will remain the same, and allow for the free movement/migration of fish species to, from and within the Study Area (Table 81). The impacts will be same for both the CCGT and OCGE technology options.

Mitigation measures

A monitoring plan should be implemented to assess any changes in biological responses downstream of the river crossing sites.

Table 81: Loss of aquatic biota of conservation concern - operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Loss of aquatic biota of conservation concern	8	5	4	2	**34 Low**	8	5	3	2	**32 Low**

7.3.1.11 Establishment and spread of alien invasive plant species

Alien invasive plants will continue to be problematic in all areas disturbed during the construction phase. With correct management during the operational phase, this impact can be reduced to one of **low** significance (Table 82).

Proposed Mitigation Measures

- Continue to implement the alien invasive plant species control programme, with regular monitoring informing any revisions to overall strategy, priority sites, control methods and follow-up treatments.

Table 82: Spread of alien invasive species - Operational Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Establishment and spread of alien invasive plant species	8	4	1	4	52	6	4	1	2	**22 Low**

7.3.1.12 Death or injury of fauna

Post construction, the main causes of death/injury to fauna during the operational phase are likely to be related to:

- Vehicle collisions and fauna entering operational sites (plants, offices, camps) accidentally or for food where they may be exposed to death/injury. Particularly susceptible taxa include *inter alia*; tortoises, snakes, chameleons, frogs Vervet Monkey; and
- Potential powerline collisions/electrocution by large bird species. Several birds of conservation concern, including *inter alia*; vultures, various other raptors, cranes and flamingo have been recorded in the area and are known to be susceptible to collisions/electrocutions linked with powerlines.

Death or injury of fauna resulting from vehicle collisions and their entering of operational sites is rated an impact of **low** significance both before and after mitigation. It is best practise however, to ensure that mitigation measures are in place to reduce potential incidents and manage them correctly when they do occur.

Before mitigation powerline collisions/electrocutions by large bird species is rated an impact of moderate significance. This impact can be reduced to a **low** significance with the correct implementation of mitigation measures (Table 83).

Proposed Mitigation Measures

- Selected on-site environmental staff should be trained in snake handling and be familiar with capturing and removing other faunal taxa;
- A low speed limit (20 - 40 km/h) should be enforced on site to reduce wildlife collisions;
- Powerlines should be designed to be 'raptor friendly'. Devices/designs that should be considered include staggered insulators, raptor-protectors and/or perch deterrents;

- Bird and Bat flight diverters shall be installed along the transmission line to reduce limit collisions, prioritizing areas with higher presence of vultures and other vulnerable bird species; and
- Periodic monitoring along the power lines should be undertaken by an ornithologist to ensure that raptor friendly devices installed on power lines are effective.

Table 83: Death or injury of fauna - Operational Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Death or injury of fauna	8	4	2	2	28	6	4	2	2	**24 Low**
Powerline collisions/electrocutions (e.g. vultures, raptors, cranes)	10	4	2	4	64	6	4	2	3	36 Low

7.3.1.13 Sensory disturbances to fauna (artificial lighting and noise)

General operational activities may cause disturbances to fauna. The significance of this impact is rated moderate before mitigation but can be reduced to **low** significance with effective management (Table 84).

Proposed Mitigation Measures

- Ensure that all noise abatement equipment fitted to machinery and vehicles is in working order.

Table 84: Sensory disturbance to fauna - Operational Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Sensory disturbances to fauna	6	4	2	4	48	4	4	2	2	**20 Low**

7.3.1.14 Contamination/pollution of soil and water resources

During the operational phase, several potential sources of contamination/pollutants associated with operations may impact local water resources in the event of spills, leaks or incorrect management. These include spills from the evaporation pond and the improper management of discarded sludge from the pond; spills from the first flush pump; discharge from the clean stormwater sump; and the irrigation of effluents into the surrounds:

- The overall significance of this impact prior to mitigation is moderate. With correct mitigation, as per the proposed measures outlined in the surface water impacts assessment and geohydrology report, this impact can however, be reduced and maintained at a low significance (Implement the findings of the social impact assessment, specifically concerning the development/updating of a detailed Influx Management Plan; and
- Monitor the progression of secondary habitat transformation using aerial/satellite imagery to identify any problem areas and target for further management actions (Table 85).

Proposed Mitigation Measures

- Develop a well-designed storm water management plan for the Plant, ensuring the separation of clean and dirty water, and the containment and correct disposal of potentially contaminated water. All wastewater discharged from the site must comply with the appropriate Mozambican and IFC standards;
- Follow protocols to manage the storage, handling and disposal of all chemicals and other hazardous substances used on-site during all phases of the proposed project. Protocols should also include provision for the correct clean-up of potential spills and leaks; and
- Regularly maintain and service all vehicles and machinery to minimise the potential for leaks and spills of fuels.

Table 85: Contamination of soil and water - Operational Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Contamination of soil and water resources	10	4	2	4	64	6	4	2	2	24

7.3.1.15 Secondary habitat loss/modification due to resource exploitation

An influx of people into the area may lead to an increase in natural resource use, and accelerated habitat loss and disturbance. This impact is can be reduced to **low** significance with effective management (Table 86).

Proposed Mitigation Measures

- Implement the findings of the social impact assessment, specifically concerning the development/updating of an Influx Management Plan; and
- Monitor the progression of secondary habitat transformation using aerial/satellite imagery to identify any problem areas and target for further management actions.

Table 86: Secondary Habitat loss - Operational Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Secondary habitat loss/modification due to resource exploitation	8	5	2	4	60	6	5	2	3	**39 Low**

7.4 Bio-Physical Environment

7.4.1 Decommissioning Phase

7.4.1.1 Decrease in Ambient Air Quality

Air quality impacts during this phase are associated with the decommissioning of the key project components and ancillary infrastructure. Specific activities that would generate impacts include earthworks, site levelling, demolition of infrastructure, topsoil placement/dressing, vehicle usage and backup power generation. It is therefore assumed to be the same for both technology options with a low significance as per the impact assessment matrix below (Table 87).

Table 87: Decommissioning phase impact assessment matrix for both technologies

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Impact of PM_{10}	4	2	2	5	**Low 40**	2	2	2	5	**Low 30**
Impact of NO_2	4	2	2	5	**Low 40**	2	2	2	5	**Low 30**
Impact of SO_2	4	2	2	5	**Low 40**	2	2	2	5	**Low 30**

Mitigation measures

Decommissioning phase impacts are anticipated to be of low significance mitigation measures may be implemented to further reduce impacts, such measures include:

- Particulates (PM_{10}):
  - Wet suppression (wet misting during material handling activities);

- Covering or keeping stockpile heights as low as practicable to reduce their exposure to wind erosion and thus dust generation;
- Progressive rehabilitation and re-vegetation of exposed areas as soon as possible following infrastructure has been removed;
- Reduction in unnecessary traffic volumes;
- Routine inspections to identify areas of unpaved roads that are increasingly dusty;
- Maintenance work to be undertaken on these areas including watering, application of dust suppressants, compaction, dust removal and/or utilisation of soil aggregate;
- Vehicles and machinery to be serviced regularly to reduce the generation of black tailpipe smoke;
- Speed control and the institution of traffic calming measures; and
- No burning of waste onsite.

- Trace Gasses (NO_2 / SO_2):
  - Maintain and service all vehicles, backup power generation and other equipment regularly to ensure that emissions are kept to a minimum;
  - Where possible, use low sulphur fuels to reduce SO_2 emissions;
  - Vehicles and machinery should be turned off when not in use to avoid unnecessary idling (i.e. idling should be limited to a maximum of three minutes on site); and
  - No burning of waste onsite.

7.4.1.2 Green House Gas emissions

Impacts similar to that of the construction phase are expected during the decommissioning phase and therefore the mitigation as outlined within Table 44 can be applied during the decommissioning phase.

7.4.1.3 Groundwater Quality Deterioration

During decommissioning of the site several activities are likely to result in the potential deterioration of groundwater quality.

The decommissioning of plant infrastructure, specifically the oil storage tanks, evaporation pond, sewage treatment plant and oily water treatment system could result in storm water run-off and soil contamination in the vicinity of these facilities. Contaminated soil has the potential to cause pollution of groundwater. This impact has been rated as a moderate significance.

Spillage of oils, fuel and chemicals during decommissioning can result in the pollution of water resources if due care is not taken. The impact is also rated with a moderate significance.

Mitigation measures

The protocols that limit potential pollution from the effluent facilities should be applied during the decommissioning phase should be developed and documented in the ESMP. The protocols should address the following:

- Storage of new and used oils in bunded areas;
- No co-handling of reactive liquids or solids;

- Creation and monitoring of an inventory of chemicals held on site;
- Storage of hazardous or toxic substances securely and controlled use thereof; and
- Availability and accessibility of HAZOP sheets of all chemicals.

The mitigation measures will reduce the impacts to a **low** significance (Table 88).

Table 88: Groundwater Deterioration – Decommissioning phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Groundwater deterioration– soil contamination	8	2	2	4	**Mod 48**	8	2	2	2	**Low 24**
Groundwater deterioration– Accidental spillages and Hazardous materials	8	2	2	4	**Mod 48**	6	2	2	2	**Low 20**

7.4.1.4 Increase in groundwater levels

Water supply requirements will be reduced during the decommissioning phase, since no more water supply will be required for the Power Plant site. Initially there may still be water supply needs during the demolishing of infrastructure, but afterwards all water abstraction will cease resulting in the likely recovery of water levels to pre-operation levels which is rated as having a positive significance (Table 89).

Mitigation measures

There are no mitigation measures proposed that will further enhance this positive impact.

Table 89: Decline in Groundwater level – Decommissioning phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Groundwater level decline – reduction in water abstraction	6	5	2	4	**Positive +52**	6	5	2	4	**Positive +52**

7.4.1.5 Increase in Ambient Noise Levels during Decommissioning

Decommissioning will entail the dismantling of infrastructure, removal of equipment and earthworks to reshape and rehabilitate the terrain. Therefore, it is assumed that the noise impact will be very similar to or less than that occurring during the construction phase, therefore the same significance rating can be determined.

Table 90: Noise impact – Decommissioning phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Resulting total ambient noise levels	1	2	1	3	**Neg 12**	1	2	1	3	**Neg 12**
Increase in ambient noise levels	1	2	1	3	**Neg 12**	1	2	1	3	**Neg 12**
Sleep disturbance	1	1	1	0	**Neg 0**	1	1	1	0	**Neg 0**

7.4.1.6 Soil Quality impacts during Decommissioning

The following activities may impact negatively on the soil quality whilst the activities are being carried out:

- Spreading of sub-soil and topsoil, profiling and contouring of the area to preserve natural drainage lines; and
- Re-vegetation of disturbed areas and rehabilitation of areas disturbed by project activities, such as plant infrastructure and removal of pipeline.

The main potential impacts on the soil and land resulting from the activities underway during the decommissioning of the site is the potential change in land use, degradation of soil quality, soil contamination, soil compaction, insufficient soil volumes available for surface rehabilitation actions and erosion. Land disturbances, as expected during the decommissioning, generally affect the soil stability and erodibility. The impact analysis is provided in Table 91.

Mitigation

The mitigation measures for the same impacts detailed during the construction phase apply during the decommissioning phase of this project. If the mitigation measures as stipulated during the construction phase are strictly adhered to, there will be sufficient soil for rehabilitation.

Table 91: Soil Quality Impact analysis for decommissioning phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Soil quality degradation	8	5	2	5	**Mod 75**	6	2	1	3	**Low 27**
Soil contamination	4	5	1	3	**Low 30**	4	2	1	2	**Low 14**
Soil erosion	8	5	1	4	**Mod 56**	4	4	1	3	**Low 27**
Soil compaction	8	5	1	5	**Mod 70**	8	3	1	5	**Mod 60**
Insufficient soil for surface rehabilitation	10	5	1	5	**High 80**	6	2	1	3	**Low 27**

7.4.1.7 Impacts on the Aquatic environment

It is unlikely that decommissioning activities (e.g. dismantling infrastructure) are likely to cause additional disturbances to the aquatic ecosystems associated with the CTT Project that are not discussed within the construction phase impacts. Therefore, the same mitigation measures apply and that will result in an impact significance of Low or negligible.

Proposed Mitigation Measures

In order to minimise the impacts during decommissioning of the proposed CTT Project (pipe and bridge crossings) on the aquatic ecosystems, it is necessary to minimise the impacts on water quality, including contamination, flow and sedimentation. This can be accomplished by the following means:

- Where possible, place decommissioning activities as close to the existing road servitudes as possible to limit unnecessary clearing:
  - Avoid non-perennial bodies of water such as flooded borrow pits/drainage canals and floodplain depressions where possible.
- Decommission the Govuro River crossings during the dry season so as to limit the amount of impact on the sites, particularly in terms of flow diversion and surface water runoff following rainfall;
- Implement low-impact decommissioning techniques to minimise the impact on the river system, especially during the diversion of any water during decommissioning (if required):
  - *E.g. low-impact techniques are those that make use of on-site construction waste (i.e. rock substrate, topsoil) for use as non-structural fills or landscaping/rehabilitation materials.*

- Where possible, keep decommissioning activities out of the riparian areas, floodplain and inland depressions, and clearly demarcate no-go areas:
  - Limit movement of vehicles and activities (e.g. spoil heaps) to the demarcated zone only; and
  - Restrict vehicles to service roads.
- Monitor the water quality downstream of the river crossing sites during decommissioning on an at least bi-annual basis. Information from this monitoring can be used to quickly implement management actions should a significant decrease in water quality downstream of the crossings be observed. More frequent surface water quality monitoring may be required during decommissioning; this should be implemented in agreement with the mitigation measures set out in the surface water impact assessment section;
- To ensure that any adverse impacts are reduced, the project team must ensure that any accidental spillages or impacts to the aquatic and riparian ecosystems are cleaned up and rehabilitated immediately in accordance with the Engineering, Procurement and Construction (EPC) spill management plans;
- In line with the terrestrial ecological impact assessment report, vegetation clearing and rehabilitation mitigation measures should be implemented;
- A suitable rehabilitation programme should be developed and implemented in all disturbed areas. The programme should include active re-vegetation, using locally-occurring indigenous grass and tree species; and
- Monitor the water quality and habitat downstream of the river crossing sites during construction on an at least bi-annual basis (see Surface Water chapter) and implement an early warning system that would trigger a survey of the biological responses, should water quality or habitat alterations warrant this.

Table 92: Impact assessment table – Decommissioning phase

Indicator of potential impact		Pre-mitigation					Post-mitigation				
		Intensity	Duration	Geographic	Probability	Significance	Intensity	Duration	Geographic	Probability	Significance
Impacts on Water Quality	Temporary bridge structures across Govuro River and tributaries	6	2	2	3	30	6	2	2	2	20
	Govuro River pipeline	6	2	2	3	30	6	2	2	2	20
	Inland, floodplain depressions/ Non-perennial waterbodies	8	5	3	3	48	8	2	2	2	24
Habitat Changes	Macro-channel habitat and riparian vegetation loss or alteration	6	2	1	5	45	4	2	1	4	28

Indicator of potential impact		Pre-mitigation					Post-mitigation				
		Intensity	Duration	Geographic	Probability	Significance	Intensity	Duration	Geographic	Probability	Significance
	In-stream channel habitat loss or alteration	4	2	2	3	24	4	2	1	2	14
Loss of aquatic biota of conservation concern		8	5	4	3	51	8	5	4	2	34

7.4.1.8 Spread of Alien Invasive Plant Species

Decommissioning activities (e.g. dismantling infrastructure) are likely to cause additional disturbances, which may promote alien invasive plant colonisation. With effective management during the closure phase, the residual impact is rated as one of **low** significance (Table 93).

Proposed Mitigation Measures

- Continue to implement the alien invasive plant species control programme, with regular monitoring informing any revisions to overall strategy, priority sites, control methods and follow-up treatments;
- Rehabilitate all disturbed areas, ensuring the establishment of viable coverage of indigenous vegetation; and
- Areas that should be considered priority sites for stabilisation and rehabilitation post-construction include coastal dunes at the selected beach landing site and the Govuro River crossing point and river approaches.

7.4.1.9 Contamination of soil and water resources

During the dismantling of project infrastructure there is potential for contaminants that have been stored and used on site during operation, such as sludge, fuels, chemicals effluent to be spilled or leaked into the environment. There is also potential for leaks and spills of hazardous substances from vehicles and machinery used for decommissioning activities.

The significance of this impact prior to mitigation during the decommissioning and closure phase is moderate. With correct mitigation, it can however be reduced to a **low** significance.

Proposed Mitigation Measures

- Follow protocols to manage the storage, handling and disposal of all chemicals and other hazardous substances used on-site during all phases of the proposed project. Protocols should also include provision for the correct clean-up of potential spills and leaks; and
- Regularly maintain and service all vehicles and machinery to minimise the potential for leaks and spills of fuels.

Table 93: Spread of Alien Invasive species - Decommissioning Phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Establishment and spread of alien invasive plant species	8	4	1	4	**Mod 52**	6	4	1	2	**Low 22**
Contamination of soil and water resources	10	4	2	4	**Mod 64**	6	4	2	2	**Low 24**

7.5 Socio-Economic and Cultural Environment

This chapter presents socio-economic and cultural impact assessment for predicted construction, operation and decommissioning impacts arising from the CTT project activities. It is important to note that certain technology options, beach landing site options and associated transport route options may have a different suite of impacts and mitigation measures. In such cases, these are presented in that particular section below under separate sub-headings for ease of comparison. Where there is no material difference in impact between options, this is stated, and impacts and mitigation measures apply to all options.

This chapter summarises the impacts and mitigation measures proposed, with more detailed information presented in the specialist reports contained in Volume 3.

This section briefly highlights aspects of the receiving socio-economic environment that would represent significant risks to the proposed development. The potential social risks, which the project might be exposed to are discussed below;

- Community expectations:

Considering the socio-economic conditions in the project area, community expectations regarding the proposed project are anticipated to be related to employment and the implementation of CSI initiatives. Expectations must be managed by informing communities as to exactly what to expect from the proposed CTT project in terms of employment opportunities and CSI programmes.

- Social unrest and community opposition

The failure to manage community expectations may result in unrest, such as social mobilisation against the project. It is recommended that stakeholder engagement (including grienavce redress) and community liaison are on-going in order to manage expectations, as well as any grievamces:

- Risks associated with physical and economic displacement

Should CTT fail to manage the displacement process in an open, transparent and appropriate manner, this can result in delays to the project implementation schedule if affected people are not satisfied with the process. Additionally, it may also result in reputational risk if it is perceived that the Proponent is not following due process.

The social impacts and mitigation measures identified are further presented in the sections below.

7.5.1 Construction Phase

7.5.1.1 Changes to the land surface

Archaeological Sites

There are no known archaeological sites located within an area expected to be impacted by a change to the land surface. All known archaeological sites are located sufficiently distant from project infrastructure to be unaffected, or are located adjacent to existing roads, which will not be widened. There is potential, however, for unknown archaeological sites, which may exist beneath the surface or as undiscovered surface scatters, to be directly impacted during site preparation and construction works through changes to land surface. In the worst-case scenario (pre-mitigation), this could result in a very high severity, permanent, internationally significant impact.

Cultural Sites

There are a number of cultural sites that could potentially be directly impacted by changes to land surface. These include those located along the southern transport route option, which is to be widened and improved, and those along the proposed overhead electricity transmission line. Potentially impacted sites comprise:

- Burials – BU-110 and BU-111 (transport route), and BU-105, BU-106, BU-107, BU-108 and BU-109 (powerline);
- Cemeteries – CE-18, CE-106 and CE-107 (transport route), and CE-104 and CE-105 (powerline);
- Churches – CH-107 and CH-108 (transport route); and
- Sacred Places – SF-01, ST-02 and SP-01 (transport route).

In the worst-case (pre-mitigation), this could result in a very high severity, permanent impact at high value sites (burials, cemeteries and sacred places).

There is also potential for accidental damage to unknown or undiscovered cultural sites (e.g. undiscovered burial or an undisclosed sacred site). In the worst-case (pre-mitigation), this could result in a very high severity, permanent impact at high value sites (Table 94).

Mitigation

The potential for impacting currently undiscovered archaeological remains will be mitigated through the immediate preparation and adherence to a Chance Find Procedure (CFP) in accordance with Mozambican heritage legislation (Decree 27/1994). The CFP will form a component of the Cultural Heritage Management Plan (CHMP), which will seek to manage and monitor all cultural heritage effects for the project's lifetime. The CFP must be updated during the lifetime of the project to make provisions for a course of action in the event that artefacts are accidently disturbed. The law states that assets must be disclosed to the local authority within 48 hours of discovery. The CFP will meet requirements for accidental cultural heritage disturbance as stipulated by both IFC and Mozambican Law. The CFP will be presented to the relevant local authority for approval. If significant archaeological remains are discovered, the need for excavation and 'preservation through record' may be required. In this case, the loss of *in situ* preservation of archaeological remains would be balanced by improved understanding of the archaeological record in a relatively understudied region.

Impacts to the identified cultural sites can be avoided by selecting the northern transport route (which already exists and requires no widening), and through re-alignment of the proposed overhead electricity transmission line, so as to avoid the identified burial and cemetery sites. It will be paramount that the Proponent continues to engage with the local community so as to avoid and accidental direct damage to unmarked (and unrecorded) graves along existing road routes and/or other previously unidentified cultural sites in the vicinity. The CHMP should include measures for dialogue during the construction phase between the Proponent and local community in relation to the avoidance of unmarked graves and previously unknown cultural assets.

Table 94: Changes to land surface: Construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Impact of changes to land surface on undiscovered archaeological remains (worst case)	10	5	5	5	**High 100**	10	5	5	2	**Low 40**
Impact of changes to land surface on cultural sites	10	5	2	5	**High 85**	10	5	2	2	**Low 34**

7.5.1.2 Ground Pollution

There are six natural sacred places, three cemeteries three locations of traditional medical practice and one archaeological site located in close proximity to project infrastructure that may be impacted by the release of pollution to the environment. Sites SF-02, SP-102, SP-105, CE-19, CE-20, CE-21, MP-101, MP-102, MP-103 and AR-103 are all located adjacent to the existing R241 and EN1 roads (northern access route option). Sites SF-01, ST-02 and SP-01 are located along the proposed southern access route. As such, the potential for project related pollution is limited to spillages or leakage from construction vehicles. Sacred watercourses in particular, may be damaged in such a way that prevents normal cultural activity from resuming.

In the case of the three sites along the southern access route, it is already predicted that, if construction of that route were to go ahead, these sites could be destroyed or damaged. If they were to survive direct disturbance from construction activity, the potential impact of ground pollution could act cumulatively to impact these sites.

In the worst-case (pre-mitigation), this could result in a high severity, permanent, local, impact at high value sites (sacred places) (Table 95).

Mitigation

Impacts to SF-01, ST-02 and SP-01 can be voided by selecting the northern transport route (which already exists and requires no widening).

Ground pollution impacts will be mitigated through regular vehicle maintenance, in keeping with best practice on pollution prevention. An Emergency Response Plan will be prepared to react to accidental spillages from construction vehicles. The CHMP should also include measures for long-term dialogue between the Proponent and local community in relation to the environmental monitoring of sacred places (watercourses).

Table 95: Impact of Ground pollution on heritage resources: Construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Impact of ground pollution	8	5	2	2	**Low 30**	8	5	2	1	**Low 15**

7.5.1.3 Change in Environmental Setting (Cultural)

There are no assets in close proximity to the proposed power plant site, and so no impacts from noise, air or visual disturbance are anticipated. There are also no impacts from a change in environmental setting anticipated at the burial and cemetery sites along the proposed electricity transmission line as a result of air emissions during construction (assuming the alignment of the route is altered to avoid direct disturbance, as discussed above).

Cultural sites adjacent to the proposed transport route, are expected to experience noise, air and visual impacts as a result of construction traffic. This will be limited to the construction period and will only occur during delivery of equipment and materials. Potentially impacted sites comprise:

- Burials – BU-110 and BU-111 (high value);
- Cemeteries – CE-18, CE-19, CE-20, CE-21, CE-106 and CE-107 (high value);
- Churches – CH-102, CH-106, CH-107 and CH-108 (low - medium);
- Sacred Places – SF-01, F-02, ST-02, SP-01, SP-102 and SP-105 (high); and
- Locations of Traditional Medical Practice (MP-101, MP-102 and MP-103).

In the worst-case (pre-mitigation), this could result in a moderate severity, short term, local, impact at high value sites (sacred places) (Table 96).

Mitigation

The CHMP should include plans to monitor changes to the environmental setting during the construction phase of those assets highlighted above. This may also include measures for the demarcation of sensitive areas (e.g. roadside sites) to prevent accidental damage via the laydown of materials etc. during construction and/or additional planting or screening to protect sites. The full requirements of the CHMP are summarised below.

Table 96: Change of environmental setting: Construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Impact of change in environmental setting	6	2	2	4	**Low 40**	6	2	2	1	**Neg 10**

7.5.1.4 Change in Demographics (Cultural)

It is anticipated that elements of intangible cultural heritage are susceptible to impacts resulting from demographic change (specifically influx), particularly during construction when a large proportion of the required skilled workforce will need to be sourced from outside the area. It is expected this influx will be limited to the construction period. This issue is considered in broader terms in the Social specialist report (i.e. beyond the impact solely on intangible cultural heritage), and details on mitigation (e.g. an Influx Management Plan) are presented in that report.

It is difficult to predict exactly how and when changes to intangible heritage will occur and some cultural change is inevitable. During the construction phase, the influx of workers or those seeking indirect benefits and socio-economic impacts that may result, together with any loss of access or changes in environmental setting of sites used for traditional activities, is likely to have an impact. Selecting the severity of this impact is subjective, with deviation from the local cultural norm perceived as either positive or negative by different people. Furthermore, an influx of migrants may either strengthen or weaken local cultural practices over the project lifetime.

If impacts were to occur, pre-mitigation, they would be of unknown and therefore, of very high severity (on a worst case/don’t know basis), local and short - medium term in duration (Table 97).

Mitigation

The CHMP should provide measures for the maintenance of community access to sacred sites and facilitate respect for local intangible cultural heritage, tradition and taboos through continued community liaison. It is suggested that the presence of culturally significant places are highlighted to contractors and sub-contractors during the site induction process as project cultural awareness training.

Table 97: Impact of demographic change: Construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Impact of demographic change	10	2	2	4	**Mod 56**	6	2	2	2	**Low 20**

Summary of General Cultural Heritage Mitigation

A CHMP should be developed by the Proponent to manage and monitor all cultural heritage effects for the project's lifetime in line with PS 8 and Mozambican heritage legislation (Law 10/1988 and Decree 27/1994). The CHMP should include:

- The preparation of a project-specific, 'site ready' Chance Find Procedure (CFP) to detail the requirements of the Mozambican Archaeological Heritage Protection Regulations (Decree 27/1994) which enforce the reporting of any archaeological assets to the local authority within 48 hours of discovery. The CFP will set out the course of action to be followed in the event that any cultural heritage artefacts are recovered. The CFP should be provided to all contractors and consultants on the project site during all construction activity and incorporated within the project's 'site induction' process. It will remain in place for the lifetime of the project;
- Demarcation of 'no go' sensitive areas e.g. sacred forests, sacred trees, sacred pools, medicinal bush, cemeteries (i.e. mitigation by avoidance). Although these sites may not be directly affected by construction activities there is a potential for disturbance of community access routes to cultural sites and to the environmental setting of the sites themselves;
- Enhancement or protection of environmental setting may be required and should be discussed in conjunction with local community e.g. through planting/screening;
- It may be necessary to demarcate of areas to be avoided (e.g. by noisy, dust-inductive) construction vehicles at certain times of the day/year so as to avoid disturbance of traditional ceremonial activities in close proximity of construction routes;
- Maintaining community access to sacred sites and facilitating respect for local intangible cultural heritage, tradition and taboo will ensure that the negative socio-cultural effects are effectively managed – regular platforms for community liaison are required in this regard. It is suggested that the presence of culturally significant places are highlighted to contractors at any early stage, e.g. during site induction; and
- Continued liaison between the Proponent and local cultural leaders to facilitate the identification of any cultural sites not yet shared by the community and potentially affected by the proposed project. The CHMP must set out plans for stakeholder identification and a programme for long term consultation in this regard.

Visual Impacts caused by Airborne dust clouds and dust pollution

- Airborne dust clouds caused by construction activities are usually far more visible than the activities that cause them and can in windy conditions be propagated over great distances. However, the project construction site will not be vast, and this impact is also somewhat sporadic or intermittent in nature, and this impact is therefore rated as having a moderate level of visibility within the study area;
- In terms of visual exposure, the majority of resident as well as transient receptors are located more than two kilometres away from the power plant and transmission line sites and so this aspect is scored as being low;
- Regarding visual intrusion, airborne dust clouds are usually perceived as visually unappealing and negatively impact surrounding areas due to dust fallout. In addition, construction-related dust is often a highly irritating source of nuisance to those affected by it and is therefore rated as high;

- Furthermore, the number of potential resident visual receptors (mostly low-income local inhabitants) number in the several thousands, even though they may not attach particularly high levels of value to the visual appearance of the project site and its surroundings, and the receptor sensitivity is therefore scored as moderate. This aspect has the same rating score for all other visual impacts identified for the construction, operational and decommissioning phases, respectively; and
- With particular reference to the beach landing sites, the formation of dust clouds during construction is expected to occur sporadically/intermittently and is rated as having a moderate level of visibility, and the level of visual intrusion of airborne dust clouds and associated dust fallout was rated as high.

Mitigation measures

- Water down any large bare areas associated with the construction and rehabilitation phases as frequently as is required to minimise airborne dust;
- Rehabilitate temporary bare areas as soon as feasible using appropriate vegetation species;
- Place a sufficiently deep layer of crushed rock or gravel over parking surfaces for vehicles and machinery;
- Apply chemical dust suppressants if wet dust suppression is insufficient; and
- Implement a dust bucket fallout monitoring system.

With the implementation of the mitigation measures as outlined above the impact significance can be reduced to a Low.

Table 98: Visual intrusion by air borne dust clouds – construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Airborne dust clouds and dust pollution	6	2	2	5	**50**	4	2	2	5	**40 Low**

7.5.1.5 Negative Visual aesthetics due to alteration of site topography and loss of vegetation cover

- During construction, the power plant complex footprint area will be cleared of vegetation and levelled to create one or more artificial terraces, in order to accommodate the power plant infrastructure. In addition, the transmission line servitude will for safety reasons also be cleared of trees and shrubs, and a number of temporary clearings will also be created for materials laydown purposes. The level of visibility of this impact will however be less than that of the other construction-related activities or of the operational infrastructure and is therefore rated as low in terms of visual sensitivity;
- The majority of resident as well as transient receptors are located more than two kilometres away from the power plant and transmission line sites, therefore the level of visual exposure of this impact is scored as being low; and
- The removal of existing vegetation and earthworks that will occur prior to construction will essentially remove all existing land cover, and to some extent introduce geometric / artificial terraces in the landscape. Given the relatively large scale and extent of these landscape alterations the level of visual intrusion is therefore rated as being moderate.

Given the fact that the site topography will be altered to allow for construction of the CTT plant and associated infrastructure, this impact is unmitigable.

Table 99: Alteration of site topography – construction phase impacts significance

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Alteration of site topography and loss of vegetation cover	4	2	2	5	**40**	4	2	2	5	**40 Low**

7.5.1.6 Visual Intrusion of Construction activities on site

- Construction-related impacts will occur within the construction site itself, the level of visibility of which is expected to systematically increase to that of the operational phase, as the infrastructure under construction nears completion. In addition, the presence of increased construction-related traffic and other associated activities will also have a visual impact, the level of visibility of which will fluctuate throughout the course of the construction phase. This aspect is therefore rated as moderate;
- The majority of construction-related impacts will occur on the construction sites themselves, which is located two or more kilometres from most potential receptors. However, the level of visual exposure of receptors to other construction-related impacts is also expected to fluctuate and increase to some extent, based on changing traffic volumes and other aspects dictated by the construction schedule. A conservative approach was adopted, and this criterion was accordingly scored as moderate;
- The level of visual intrusion of the power plant infrastructure under construction is expected to be comparatively high, as large construction sites are usually characterised by high levels of visual "clutter' and incongruous elements, regardless of how well they are managed. The additional scaffolding, construction machinery and vehicles, materials laydown and waste storage areas are all likely to be perceived as being visually intrusive and is therefore rated as high;
- With particular reference to the beach landing sites, construction-related impacts will occur within the urban area of Inhassoro, and the level of visibility will therefore be high to residents living near the construction sites. However, the level of visibility is expected to rapidly decrease as one moves away from the construction sites, due to the screening effect of existing buildings and structures. The construction-related activities will also result in an increase of traffic within the study area. The overall level of visibility of this aspect was therefore rated as moderate;
- The physical infrastructure itself as well as the associated construction site footprints of the beach landing site and pipelines will be notably smaller than that of the power plant. For this reason, the level of visual intrusion of the beach landing site and pipeline construction phase is rated as moderate;
- The degree to which the beach landing site will be visible will vary significantly, depending on the location of the receptor. The level of visibility inland is expected to be limited, as the majority of the beach landing site components will be completely screened off from view by the first few rows of houses. However, from the ocean the visibility will be 100% over a distance of many kilometres, even though the number of receptors within this area will be limited. Theoretically, the beach landing site would therefore be visible from slightly more than half of any circular study area delineated around it. However, given that half of the study area is essentially devoid of receptors for most of the time, a pragmatic approach was adopted, and this aspect was therefore rated as moderate; and
- The beach landing site infrastructure is expected to be visually intrusive, as the visually "solid" and strongly geometric shapes of the constructed jetty platform, barge and offloading machinery will contrast strongly with the flat horizon line (Figure 137). Furthermore, most of the machinery and vehicles are expected to be brightly coloured and will therefore contrast strongly with the light beach sand and deep blue ocean as backdrop. The level of visual intrusion of the breach landing site during the construction phase of the project is therefore expected to be high.

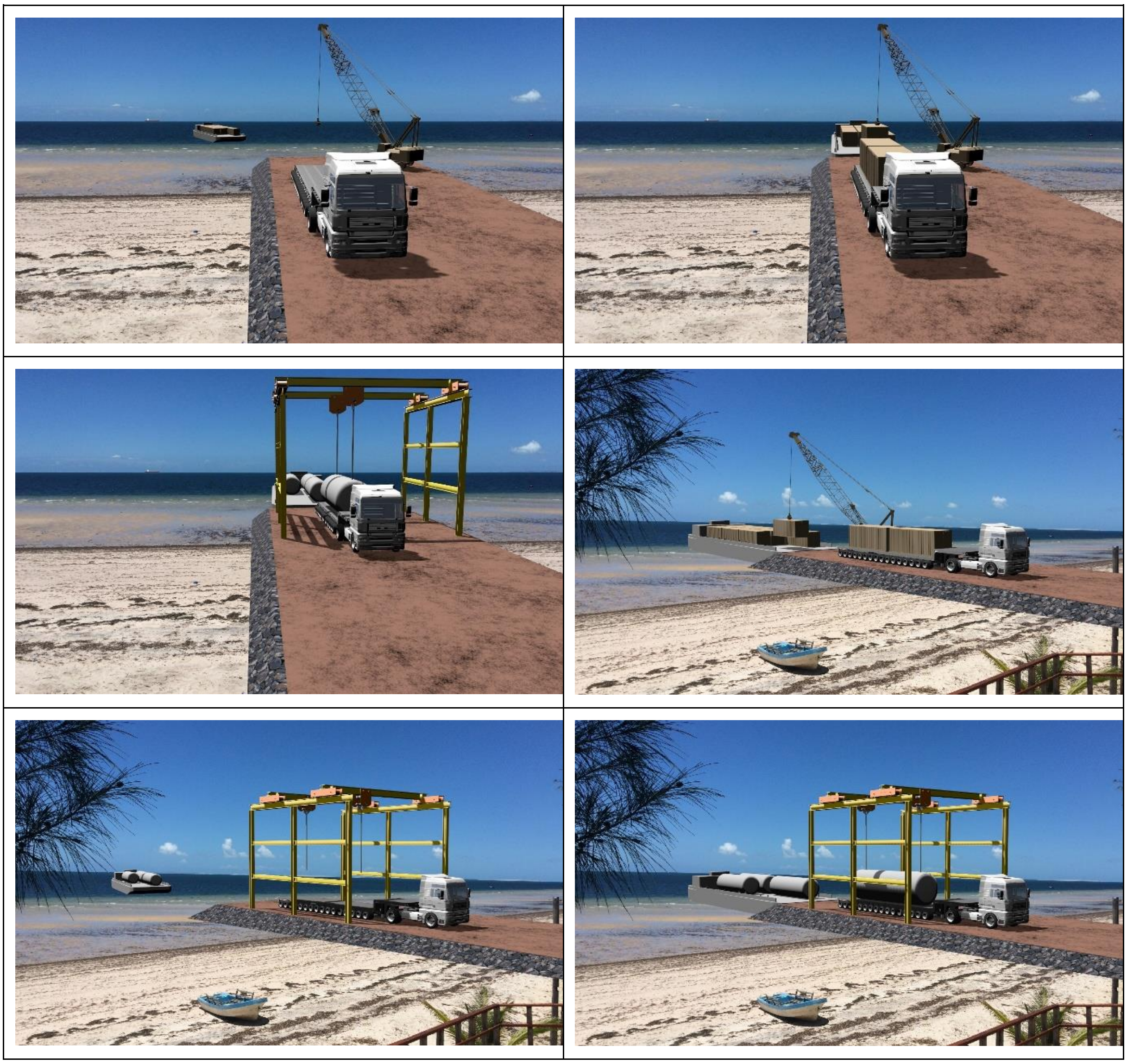


Figure 137: SETA beach landing site during various phases of equipment and material offloading

Mitigation Measures

- Maintain the construction and rehabilitation phase sites in a neat and orderly condition at all times;
- Create designated areas for: material storage, waste sorting and temporary storage, batching, and other potentially intrusive activities;
- Limit the physical extents of areas cleared for material laydown, vehicle parking and the like as much as possible and rehabilitate these areas as soon as is feasible; and
- Repair project related erosion damage to steep or bare slopes as soon as possible and re-vegetate these areas using a suitable mix of indigenous grass species.

Therefore, taking the above mitigation measures into account the impact is rated as having a low significance for the CTT site and the construction of the gas and water pipeline however is rated as having a moderation significance at the beach landing sites.

Table 100: Visual Intrusion of activities – construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Construction-related activity on site and infrastructure under construction at the CTT site	6	2	2	5	**50**	4	2	2	5	**40 Low**
Construction-related activity at beach landing site, and along water and gas pipeline corridors	8	2	2	5	**60**	4	2	2	5	**40 Low**
Visually intrusive beach landing site infrastructure	8	2	2	5	**60**	8	2	2	5	**60 Mod**

7.5.1.7 Light pollution at night

- The extent to which the illuminated plant under construction is visible at night should theoretically be the same as during the day-time. However, light pollution at night is particularly visible, as most of the visual detail that may camouflage a visual impact by day is not visible at night. A cursory overview of various online sources dealing with astronomy and star gazing indicate that relatively small towns may cause light pollution beyond a range of 20 miles/30 km. The visual impact is caused both as a result of direct glare, and indirect sky glow caused by the lights. The power plant and to a lesser extent transmission line construction sites also will be highly illuminated for security and safety reasons. For this reason, the combined level of visibility of the direct glare and indirect sky glow is rated as moderate, as this will likely be visible to some extent within a significant percentage of the study area;
- The level of visual exposure for this impact is expected to be the same as that of the previous two construction-related impacts and is therefore rated as low;
- Light pollution is specifically considered visually intrusive in areas that don't have high levels of existing night-time illumination, as is common in rural or remote locations. Given that the existing power plant is the only large infrastructure element in the study area and the rural, low-income nature of the area, the existing levels of night-time illumination in the study area is expected to be low. For this reason, the visual intrusion of construction-related light pollution is expected to be high;
- The transhipment vessel anchored at sea will basically be fully visible from any location within the entire area surrounding it, up to the Mozambique mainland and Bazaruto island shorelines. This translates into an area with a radius of at least 10 km or more, depending on the final position of the anchor site. However, the number of visual receptors within this area will be small and limited to fishermen and tourists at sea, as well as a small number tourist destinations along the Bazaruto Island coastline, depending on the final location of the anchorage point.

The greatest percentage of affected receptors will however therefore be residents and tourists along the shoreline, located 10 km or more away from the source of the visual impact. The overall level of visibility of light pollution from the transhipment vessel anchored offshore was therefore rated as moderate; and

- As previously mentioned, light pollution at night is usually considered particularly intrusive in settings with no or very limited levels of existing/background artificial illumination. However, fishing boats, larger transhipment vessels and tourist cruise liners do travel along the Mozambique coast from time to time and are therefore not an uncommon site. Even though the project transhipment vessel will be anchored in one location for a period of approximately a week or two at a time during the 6 to 9 months construction period, and therefore constitute a frequent source of light pollution, the distance from the mainland and island coastlines is significant. The result is that the lights from the ship will not be bright or visually dominant (Figure 138), and their level of visual intrusion will at worst be moderate.

Figure 138: Transhipment vessel anchored at sea as seen from the Inhassoro coastline during the night (note location on horizon within yellow circle)

Mitigation Measures

- Identify zones of high and low lighting requirements, focusing on only illuminating areas to the minimum extent possible to allow safe operations at night and for security surveillance;
- Plan the lighting requirements of the facilities to ensure that lighting meets the need to keep the site secure and safe, without resulting in excessive illumination;
- Reduce the heights of light post where possible and develop a lighting plan that focusses on illuminating the required areas through strategically placed individual lights rather than mass light flooding;
- Utilise security lights that are movement activated rather than permanently switched on where feasible, to prevent unnecessary constant illumination;

- Fit all security lighting with ‘blinkers’ or specifically designed fixtures, to ensure light is directed downwards while preventing side spill. Light fixtures of this description are commonly available for a variety of uses and should be used to the greatest extent possible; and
- Eliminate any ground-level spotlights as these invariable result in both direct glare and increased sky glow and cannot be effectively mitigated.

Therefore, considering the above mitigation and the fact that the light pollution from the transhipment vessel is not feasible to mitigate, the impact has a significance rating of moderate for the transhipment vessel and low for the CTT site itself.

Table 101: Light Pollution at night – construction phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance*	Intensity	Duration	Geographic Extent	Probability	Significance*
Light pollution at night at the CTT plant	6	2	2	5	**50**	4	2	2	5	**40 Low**
Light pollution at night from transhipment vessel anchored off-shore	8	2	2	5	**60**	8	2	2	5	**60 Mod**

7.5.1.8 Loss of sense of place (Visual)

The overall sense of place of the study area is expected to be negatively impacted upon, as a consequence of the other impacts assessed above. As this is a resultant or cumulative and indirect impact of the other direct impacts listed above.

Table 102: Loss of sense of place – construction phase impacts significance

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance*	Intensity	Duration	Geographic Extent	Probability	Significance*
Loss of sense of place at CTT site	6	2	2	5	**50**	4	2	2	5	**40 Low**
Loss of sense of place during construction phase (resultant impact) at beach landing site	8	2	2	5	**60**	8	2	2	5	**60 Mod**

Employment opportunities

Most households within the project area face major socio-economic challenges such as poverty, unemployment and lack of adequate social infrastructure and services, construction related employment has the potential to generate an income for households during the construction period to support their dependants. The proposed CTT project will require a construction workforce for the establishment of new infrastructure. Consequently, 850 (CCGT) and 690 (OCGE) vacancies will be available during the construction phase for the two respective power generation technologies. In addition to job opportunities, informal trading is likely to occur during the construction phase. For instance, the locals, who will not be able to secure employment from the client might decide to sell food for the convenience of construction workers and contractors on site (as seen with many large-scale infrastructure projects).

Mitigation Measures

- Directly affected communities should be given special consideration in terms of the benefits arising from the project. The local resident status of applicants should be verified in consultation with community representatives;
- Where feasible, promote the creation of employment opportunities for women and youth;
- A monitoring system should be established to ensure that the client honours local employment policies; and
- Development of a local content management plan (includes local employment and procurement of local good and services). Local content shall be strongly encouraged except: (i) no purchase of bushmeat or other local wildlife products shall be allowed; and, (ii) all fish to be served in the construction camp shall be sourced well away from the project area, to avoid stimulating increased fishing activity within Bazaruto Archipelago National Park (BANP) or other sensitive marine habitats. Local content must be properly managed to seek to avoid temporary inflation in locally produced goods that could lead to negative impacts with the completion of the construction phase.

7.5.1.9 Increased economic revenue

The capital expenditure on construction activities is likely to enhance economic benefits. During the construction phase, the client will require various goods and services. This is likely to generate economic opportunities for local small business, provided they are formalised and able to meet the client's procurement requirements. It is, however, anticipated that some of the required goods and services might not be available in the local study area. In this case, the client will procure from businesses elsewhere in the country or outside the country.

There are also expected to be positive increased economic revenues with regards to the informal sector as small businesses may receive more customers for the items they sell.

Mitigation Measures

- Local businesses should be given first preference during the procurement of required goods and suitably skilled and available services. However, no bushmeat or other local wildlife products shall be purchased. Furthermore, all fish served to project personnel at the construction camp shall be brought in from well outside the project area, to avoid stimulating increased fishing activity within the Bazaruto Archipelago National Park or adjacent areas of important habitat for Dugong and other threatened marine life.;
- Should the client appoint Sub-contractors, preference should be given to suitable local sub-contractors; and

- Development of a local content management plan (includes local employment and procurement of local good and services). The Local Content Plan shall prohibit the purchase of bushmeat or other local wildlife products in any quantity, as well as any bulk purchases of local fish (to avoid increasing local fishing pressures in the BANP or other sensitive marine habitats).

7.5.1.10 Improved infrastructure

Although the transportation of project infrastructure during the construction phase may result in deterioration of roads (if not actively managed). These aspects are detailed in the traffic study conducted by Golder (2018d). The proposed CTT project will contribute to improved infrastructure such as public roads.

It is anticipated that the client will upgrade roads and a bridge crossing where necessary (dependant on route selected from beach landing to CTT site). Consequently, this will improve public roads.

Mitigation Measures

- The deterioration of public roads over time must be monitored, and a maintenance plan must be negotiated with the National Road Administration, with specific mention of the Monitoring and Planning departments that should be consulted (Golder, 2018d).

7.5.1.11 Loss of land

During construction land will be lost due to the establishment of some of the project infrastructure, that will require land acquisition. Project infrastructure that will require land acquisition include:

- Proposed power plant site (CTT area);
- Construction camp and contractor laydown area;
- Transmission line;
- Water pipeline and access road;
- Proposed Vilanculos substation;
- Upgrade of the R241 and EN1 via the temporary Govuro River bypass bridge (Northern route option) or Upgrade of shortcut road linking EN1 to the North-South road via the pipe bridge, which will require to be upgraded (Southern route option); and
- Establishment of beach landing site and laydown area at one of the three current options being evaluated.

During construction, it is likely that access to portions of land currently used for subsistence and commercial agricultural purposes may be lost (ACER, 2018). The impact that the various infrastructure components may have on access to agricultural land during construction are identified below:

- CTT plant:

Permanent loss of access will occur in the case of agricultural activities taking place within the footprint of the CTT plant. During the survey undertaken in the project area, no agricultural activities were identified on the plant site. However, a previous survey in the area in 2014 identified two machambas within the footprint of the site.

- Transmission line and water pipeline:

A number of machambas were recorded within the 100 m corridor of the transmission line and water pipeline. During the construction of the transmission line and water pipeline, it is likely that access to these machambas will be restricted. Furthermore, in the event of no agricultural activities being permitted within the 100 m corridor of the transmission line and water pipeline or in the event of access roads being constructed within these corridors, land or portions thereof may be lost on a permanent basis.

- Northern transport route:

This will not require any additional land take as the existing R241 and EN-1 route will be followed, and no additional widening of these existing roads is anticipated.

- Southern transport route:

In the event of the 'southern transport route' being chosen as the preferred option for the transport of equipment from the beach landing site to the project site, it is likely that there may be damage to machambas in areas where the access road will be widened. Such losses will be considered permanent as the widened road is likely to remain in situ following the completion of construction.

At this early stage of project development, the amount of land required for the CTT project is difficult to definitively quantify as a result of options that remain for the logistics and transport corridors. An estimation is presented below.

- Gas to Power Plant, including the 100 m PPZ – 145 ha;
- Gas pipeline – 20 ha assuming a 2 km pipeline with a 100 m PPZ[13];
- Transmission line – 250 ha assuming of 25 km transmission line with a 100 m PPZ[14]; and
- 110 ha for the water pipeline (11 km pipeline with a 100 m PPZ)[15].

A policy of avoidance will be followed at all times and through the careful alignment of project infrastructure, particularly the transmission line, it is anticipated that actual impacts will be less than those recorded in the RPF.

Mitigation Measures

- Land owners should be identified and compensated accordingly as per the Resettlement Action Plan (RAP) that is currently being undertaken.

7.5.1.12 Physical and economic displacement

The nature and extent of physical and economic displacement will largely depend on the chosen beach landing site and transport route. Therefore, this impact has been assessed considering the current preferred scenario. Some of the proposed Project activities will result in displacement-related impacts which include both physical and economic displacement to make way for the proposed Project infrastructure. The current scenario analyzes all homesteads and associated infrastructure within the 100 m corridor of the transmission line, water pipeline and a new gas pipeline, and 100 m from the CTT

[13] Reduces to 1.2 ha Based on the assumption that a special licence for activities in a PPZ (Land Law, Article 9) will be issued

[e] There exists a likelihood that the Project will receive a decree permitting a 50 m servitude for the transmission line, reducing the land area to 125 ha, of which there is a 15 ha exclusion zone (6 m servitude).

[15] Current tests on water availability are indicating that the water pipeline will not be required, however the impacts have been analyzed in the RPF as an option.

plant as affected families. Such infrastructure will generally be inclusive of houses, bedrooms, outside kitchens, outside bathrooms, toilets, granaries and cattle kraals, chicken runs and so forth.

During construction, the proposed beach landing site, associated infrastructure and the presence of construction machinery may have a negative impact on the fishing and tourism sectors. Access to specific areas for fishers might be temporarily restricted while the construction of the temporary pier and the increased activity in the area may have an impact on catch volumes. These may impact income levels and the livelihoods of the affected parties. These were issues that were raised by members of the Inhassoro Fishing Association during the initial consultation regarding the project. The presence of the temporary pier and large construction machinery (barge, large trucks to transport infrastructure, cranes, etc.) may have a negative impact on the tourism industry in the area. Through discussions with the potentially affected lodges, viz. those immediately adjacent to the proposed sites, it was noted that the presence of such infrastructure and machinery is likely to result in the lodges being less attractive for tourists, resulting in lost income. The table below provides the number of people, households, structures and machambas to be resettled.

Estimated resettlement required per phase (ACER, 2018)

	Transmission Line		Water Pipeline
	100 m corridor	50 m servitude	100 m corridor
People	48	5	214
Households	11	2	42
Structures	51	8	170
Machambas	14	11	18*

*This is inclusive of the seven machambas requiring economic resettlement and a further 11 machambas associated with the households requiring physical resettlement.

A total of 12 grave sites, seven near the transmission line route and five in the vicinity of the water pipeline route, were recorded. Importantly, some sites are family cemeteries and, therefore, contain more than a single grave. During construction, some of these graves may need to be exhumed and reburied. Impacts on cultural heritage are further described in the Cultural Heritage Impact Assessment with appropriate mitigation measures (Golder, 2018b).

Mitigation Measures

- Seek to re-align the transportation route to avoid any sensitive receptors along the route and thus the need for resettlement or compensation (associated with the southern transport route options); and

- If resettlement or compensation is unavoidable, then Project-affected people must be identified and compensated accordingly viz.; the client will have to develop a comprehensive resettlement action plan in accordance with national legislation and IFC standards (currently an abbreviated resettlement action plan/framework has been prepared as a first step).

7.5.1.13 Temporal disturbance to fishing activities

Fishing is one of the livelihood activities within the project area. The coastal villages utilise the beach area for communal fishing. Unfortunately, during the construction period fishing activities will be disrupted considering that heavy equipment and pre-fabricated components of the power plant will be brought in by ship and transferred by barge and landed on the selected beach landing site. Consequently, this will result in fishing restrictions which might affect the following:

- Reduced fish quantity for household consumption and sale:

These beach landing activities are expected to occur infrequently – approximately for a 2-week period every 3 to 4 months. The number of trips undertaken daily during the 2-week window is dependent on the tides, however it is expected that there will be only one or two barge movements per day. This may still have restrictions on communal fisherman over this period.

Mitigation Measures

- Communication, Safety and awareness measures (such as educational campaigns) should be put in place to alert and inform community members about the duration, nature and schedule for the delivery of heavy equipment and pre-fabricated components which will be transhipped and barged to the beach landing site.
- Should the beach landing site and barging activities disrupt the economic livelihood of local fisherman (despite the implementation of the measures described here), compensation agreements should be reached between the project proponent and the affected parties according to the resettlement and compensation plan.

7.5.1.14 Population influx

The study area has already experienced a significant influx of people in search of work and business opportunities. It is likely that this existing impact will continue to increase considering the proposed CTT project. Consequently, this will have social implications such as:

- Increased pressure on local resources, infrastructure and social services which are already not adequate and enough for the local people; and
- Increased social pathologies such as drug and alcohol abuse, prostitution, gender violence, increased incidence of sexually transmitted diseases and other communicable diseases.

Mitigation Measures

- It is required that the client develops/ update a comprehensive influx management plan (taking into consideration World Bank Group policies on induced labour influx) aimed at identifying areas of potential influx and appropriate influx management measures. Additionally, relevant stakeholders should be engaged and consulted during the development of the detailed influx management plan.

7.5.1.15 Inflation

Population influx and increased economic activity in the study area will increase demand for goods and services. Consequently, the increasing pressure on existing supplies may increase prices, resulting in inflation. Unfortunately, the locals will experience negative implications as the cost of living increases.

Mitigation Measures

- Community development plan should be aimed at supporting the development of local small businesses to increase the supply of goods and services and avoid escalating costs due to limitations in supply.

7.5.1.16 Exposure to Gender based violence and sexual exploitation and abuse

Due to the influx of employment and business seekers, it is likely that the women and children within the project area will be exposed to gender-based violence and sexual exploitation and abuse. The following factors are likely to induce and escalate gender-based violence and sexual exploitation and abuse within the project area in the form of sex-trafficking, prostitution, domestic violence, sexual abuse and drug abuse:

- Some men seeking employment and business opportunities within the project area are likely to pose a risk to women and children in terms of them being exposed to violence and sexual exploitation. As discussed in the SIA report, women and children have been identified as vulnerable in area;
- Access to disposable income might result in irresponsible financial expenditure such as spending money on drugs, alcohol and prostitution. Consequently, contributing to STIs; and
- Alcohol and drug abuse among construction workers can result in irresponsible behaviours that could escalate to violence or domestic abuse.

The health impact assessment further outlines the impacts related to sexual exploitation and drug abuse in the study area (Golder, 2018e).

Mitigation Measures

- Access to the construction site must be controlled to prevent sex workers from entering the construction camp; and
- Implement GBV and SEA campaigns (including educational awareness around risks such as sexually transmitted diseases) in the project affected communities.

7.5.1.17 Risk to community health and safety

The proposed project will see an increase in general construction vehicles bringing goods and raw materials to the site (from either Maputo or Beira), so both directions of the EN-1 road will see noticeable increases in construction vehicle numbers and traffic. In addition, certain equipment and components will be brought to the site via a beach landing and transport route from Inhassoro by special heavy vehicles capable of handling abnormally heavy and large dimension loads resulting in the following implications:

- Increased traffic volumes and the presence of heavy goods vehicles;
- Road accidents, mainly on the locals who are not accustomed to heavy traffic and heavy vehicles;
- Increased dust levels which may result in respiratory problems for the locals and construction workers; and
- Deterioration of roads, which will pose a safety risk to motorists.

These impacts are further described in the Traffic Impact Assessment (Golder, 2018d) and Health Impact Assessment (Golder, 2018e) with appropriate mitigation measures.

Mitigation Measures

- The client will need to engage with communities using a dedicated Community Liaison Officer (CLO) and have in place an effective Stakeholder Engagement Plan (SEP), inclusive of a Grievance Redress Mechanism (GRM) for communities to access;
- The client should consider implementing dust-suppression measures in areas where vehicles will use unsealed roads;
- The client's community health and safety plan should be in place and updated regularly; and
- Work camp management plan clearly specifying worker code of conduct should be in place.

Safe travelling speeds must be determined for the transportation vehicles and measures should be implemented to ensure that these restrictions are enforced. The client will also need to adhere to the traffic safety measures outlined in the Traffic Management Plan. Considering the above social impacts that are anticipated during the construction phase, and by applying the mitigation measures, the following impact significances can be deduced:

Table 103: Social impacts associated with the construction phase

Indicator of potential impact	Pre-mitigation					Post mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Employment opportunities	4	1	2	4	+28	6	1	2	4	+36
Increased economic revenue	4	1	3	4	+32	6	1	3	4	+40
Improved infrastructure	4	1	2	5	+35	6	1	2	5	+45
Loss of land	8	5	2	4	60	6	5	2	4	52
Physical and economic displacement	10	5	2	5	85	4	5	2	5	55
Temporal disturbance to fishing activities (access)	6	1	2	4	36	4	2	2	3	24
Population influx	8	1	2	5	55	6	1	2	2	18
Inflation	6	1	3	4	40	4	1	3	4	45
Exposure to gender-based violence and sexual exploitation and abuse	8	4	2	5	70	6	1	2	3	27
Risk to community health and safety	8		1	2	55	4	1	2	3	21

7.5.1.18 Health Impacts associated with the proposed project

The Health Impact Assessment identified five (5) potentially affected communities (PAC) that may be influenced by the proposed project (Figure 139). These PACs are recognized as a "working model" that may evolve and change as the demographic structure in the communities change due to Project, and non-Project related influences, and thus the need for regular review and as required, adaptation.

The PACs considered for the Project are divided between construction and operations. Below are the PAC's for construction phase:

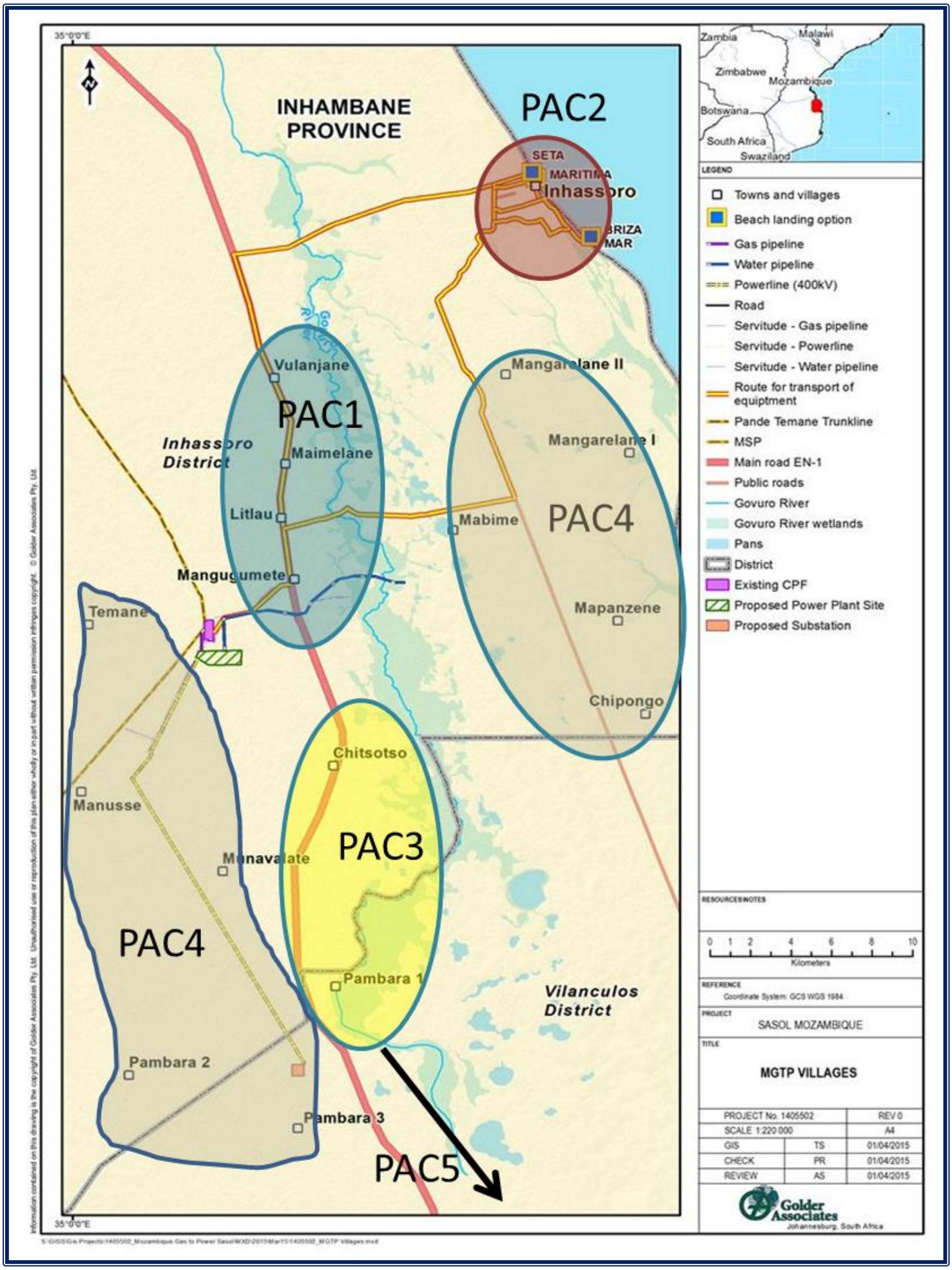


Figure 139: Potentially affected communities (PAC): construction phase

- Construction:
  - PAC1: Communities of Vulanjane, Mangungumete, Maimelane and Litlau given their proximity to the current CPF and proposed Project.

These communities are likely to experience cumulative impacts due to Project including project induced in-migration and increased traffic along the EN1;

- PAC2: Inhassoro Sede due to the temporary beach activities and transport of goods and indirect effects from the Project workforce;
- PAC3: The communities in the broader study area along the EN1 access route to Vilankulo. These include Chitsotso and Pambara 1;
- PAC4: The communities in the broader study area including Pambara 2 and 3, Munavalate, Temane, Mangarelane, Chipongo, Mapanzene, Mabime and Manusse; and
- PAC5: Communities in the regional study area including those along the transport access road (EN1) and Vilankulo.

7.5.1.18.1 Communicable Diseases Linked to the Living Environment

There is the potential for an increased risk for the transmission of communicable diseases from the incoming workforce to the community in the study area. This will be more marked in construction, with limited impacts persisting into operations. Communicable diseases are generally spread by close contact via the respiratory route and are often associated with poor socio-economic conditions, or where people work or live in close quarters to one other. During especially construction the workforce will reside in an accommodation camp in close quarters to one another, and also work in relative proximity. This may increase the risk for spread in the workforce and ultimately in the community. PAC 1, 2, & 3 may be affected during the construction phase.

Reduced air quality because of direct Project activities (dust, oxides of nitrogen and sulphur) and indirect influences (focal in-migration and increased use of biomass fuels) has the potential to increase the risks for acute and chronic respiratory conditions. This may pre-dispose the community to a higher risk for acquiring communicable diseases from bacterial and viral origin. The risk will be higher in construction. PAC's 1, 2, 3 & 5 may be affected by reduced air quality.

Project induced in-migration (PIIM) maybe cumulative in nature due to the existing activities it is likely that the development of the Project will be an additional attractor due to its potential additional economic benefit. While PIIM is likely to be most marked in construction it is likely to persist into operations, likely in a cumulative manner with other gas related activities. It is noted that any effects of PIIM will be additional to that already experienced in the local study area, but with a potential for localised influx into Inhassoro during the temporary beach activities. PAC 1 & 2 will be mostly affected.

Mitigation Measures

- Project impact mitigation:
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Use as a guideline the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants;

    - As part of the Management of Population Influx Plan develop and implement initiatives to monitor the state of general environmental health conditions in the PACs and support the local authorities and communities in addressing noted challenges;
    - Support dust suppression activities on unsealed access roads through communities, especially where Project transport passes. This may include speeding regulations, wetting of roads and other methods; and
    - Develop a Community Health Information System (CHIS) to collect and monitor key community health indicators in a longitudinal fashion. This may require specific Health Systems Strengthening (HSS) in the local health facilities so that they can be used as a reliable source of information, and potentially support of Community Health Agent/ Agent Polyvalent Communitaire (CHA/APE) in the respective communities. There may be a need to support better diagnostics for TB in the study area and reporting on the District Health Information System (DHIS2).
- Occupational health, safety and environmental management:
    - Develop workplace health strategies as part of the occupational health plan or organisational health plan, to include:
        - A communicable disease strategy or c-EMP that has an initial workplace (including contractors and short-term labourers) focus, with the view to extend to manage potential community health impacts. It is important that core interventions are implemented at an early stage so that these are in place prior to the start of construction. The focus of the programmes should include malaria control, HIV/AIDS, TB and STI control and general and personal hygiene. This plan can potentially be expanded on the c-EMP developed for the CPF to include elements such as HIV, but also TB and other communicable disease risks that may originate from the workforce. This plan will need to have specific CMR provisions;
        - Plan and manage construction accommodation camps so that overcrowding does not occur during development of the Project. Develop a Camp Facilities Management c-EMP based on the IFC workers accommodation and camp facilities standards where applicable (25);
        - Ensure adequate space is available to reduce the need for any externally contracted workforce to stay in the surrounding community as this will place pressure on available housing and potentially increases rentals;
        - Develop a vaccine preventable disease programme for all employees, contractors and visitors based on risk for travellers and at risk occupations;
        - Develop effective fitness to work procedures and programmes (especially in-coming contracted workforce) to reduce communicable disease transmission by implementing an effective pre-deployment screening process for TB and other communicable conditions. Specific CMR provisions should be part of the procedure; and
        - Develop and/or extend outbreak preparedness policies and programmes to reduce the impact of any suspected or confirmed outbreak at the local level.
- Social development mitigation and management:
    - Support HSS with improved case detection and case management of TB especially from the three health centres and with support of APE programmes; and

- Support with development and extension of community based integrated management of childhood illness programmes in APEs.

Table 104: Impact evaluation: EHA#1- Communicable disease linked to the living environment during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Communicable disease linked to the living environment in construction	8	4	2	4	**Mod 56**	8	4	2	2	**Low 28**

7.5.1.18.2 Vector Related Diseases

Localised areas where the physical environment is altered or manipulated to support construction or operational activities may increase the available breeding habitats for mosquitoes and other vectors to breed in. This may potentially increase the number of suitable vector breeding sites leading to increased mosquito densities with an increased biting rate potential. This is most relevant in construction but may extend into operations. Malaria is a direct risk to the health of the workforce and workplace productivity, in both those living in site provided accommodation and the local community. PAC 1, 2, & 3 will be affected.

Table 105: Impact evaluation: EHA#2- Vector related diseases during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Vector related diseases in construction	6	4	2	4	**Mod 48**	6	4	1	2	**Low 22**

Mitigation Measures

- Project impact mitigation:
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Use as a guideline the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants;

    - Extend specific community-based malaria and vector controls as part of the communicable diseases strategy. Ideally this should be performed in partnership with the CPF and consider:
        - Support maintaining effective environmental health controls in the communities in close proximity to the Project and where influx has occurred and likely to occur in the future. The aim will be to address source reduction and vector densities through environmental control mechanisms by developing "Clean Community Campaigns". These can be managed by local community-based organisations in partnership with the communities with potential incentives to communities based on performance. These initiatives can possibly present additional value as a number of cross-cutting environmental health issues can be addressed in this way (for example hygiene and sanitation);
        - Evaluate opportunities to work with the district health authorities and national malaria control programme in extending support to deliver elements of the national programme in the local and broader study area. This will need to be investigated with these bodies but can include:
            - Logistics support of the supply chain of diagnostic kits and medications to the health centres,
            - Logistics support of the supply chain of insecticide treated bednets to the community;
            - Support with training and provision of diagnostic test kits to recognise potential cases of arbo-viral disease (especially dengue);
            - HSS of the APEs to support community based integrated management of childhood illness and advocacy on malaria prevention activities; and
            - Improved collection of data on the burden of disease from malaria and arbo-viral diseases. This information should be collated for use in the proposed CHIS as part of key indicator monitoring.
- Occupational health, safety and environmental management:
    - Use as a guideline (with review and as applicable revision) the malaria and vector control c-EMP developed for the CPF phase and adapt to the needs of the Project (including CMR). This should be included as part of the overall integrated communicable disease strategy, managed by a specialised team (or team that is trained) to consider the following workplace elements:
        - Develop and maintain strict environmental controls around earth works and related construction activities, so as to avoid the development of suitable vector breeding sites. Where environmental controls are not possible consider other options for source reduction including:
            - Covering of areas where water may collect as soon as possible;
            - Limit rutting on Project roads or water collection on road verges;
            - Limit earth-moving activities (such as borrow pits) to areas away from human settlements if this is possible; and
            - Consider larval source management with biological or chemical agents- with this managed by the vector control team. This should include considerations for mosquitoes that transmit arbo-viruses and include avoidance of collection of water in man-made containers (such as tyres) with the temporary beach storage area and construction lay-

down yard especially important areas to manage these potential sources.

- Awareness and education programmes in the workforce on how to prevent and effectively treat malaria;
- Bite prevention activities including effective physical barriers to prevent mosquito entry into accommodation units (screens), use of insecticide treated bednets and insect repellents;
- Develop a policy on the use of and compliance to malaria chemoprophylaxis in the non-immune workforce;
- Chemical vector control programmes; and
- Effective case management in the early detection and effective treatment of malaria and arboviral conditions.

- Malaria control activities should extend into operations with a slightly different focus. The o-EMP developed and currently on-going at the CPF can be reviewed and revised as applicable.

- Social development mitigation and management:

Extend support of the national malaria control programme into the local communities but in a longer term more strategic focus including elements such as indoor residual spray.

7.5.1.18.3 Soil-, Water- and Waste-related Diseases

The potential for pollution of surface and superficial groundwater sources. However, the most significant community health risks related to direct Project activities include:

- Discharge of inadequately treated water from the waste-water and sewerage treatment plants;
- Contamination of water from domestic waste from accommodation camps; and
- Spills of hydrocarbons or hazardous chemical substances on-site (in workshops etc.) or along transport corridors due to accidents or inappropriate handling.

The potential for these risks will be more marked in construction with the movement of products, but the draw down potential of water from ground water sources and potential for pollution of water bodies from domestic or camp activities will extend from construction for the duration of operations. PAC 1, 2, 3 & 5 may be affected.

Mitigation Measures

- Project impact mitigation:
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Use as a guideline the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants;
  - Develop and implement environmental control measures for surface and ground water as part

of c-EMP and o-EMP. This should include a review and application of the Water and Effluent Management as well as c-EMP and o-EMP;

- Ensure open and transparent communication with potentially affected communities on water quality and water availability as per the Project specific Grievance Procedure and Compliments and Complaints Register c-EMP and o-EMP;
- HSS to improve reporting of key water and sanitation related indicators for recording in the proposed CHIS; and
- HSS to support an improved outbreak response capability in the district to enable an effective response to a suspected diarrhoeal disease outbreak (e.g. cholera) as these can have potential business resilience and continuity risks.

- Occupational health, safety and environmental management:
  - Effective management of waste-water from the Project construction camp and related facilities, including sewerage treatment plants and discharge of waste water;
  - Conduct awareness and campaigns in the workforce (include contractors) on hygiene and sanitation to prevent pollution of community water sources. It is especially important to include field work crews that may work in proximity to communities;
  - Provision of chemical (or portable toilets) in remote work areas away from formal toilet infrastructure to prevent the need for the workforce to use the bush. Develop codes of practice that encourage the use of these facilities; and
  - As some workers will reside in the hotel or lodge in Inhassoro to support the temporary beach landing activities it is important that the waste management practices from these institutions is acceptable so as not to cause an indirect association impact. Therefore, these should be subject to review to ensure they are of the correct standard in selecting the facility.
- Social development mitigation and management:
  - Consider supporting specific water, sanitation and hygiene programmes in the wider community, especially increasing the number of improved community water points, development of latrines and waste management. These can be managed as per the 'Clean Community Campaigns' mentioned earlier as part of a broader environmental health management initiative.

Table 106: Impact evaluation: EHA#3- Soil, water and waste related diseases during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Soil, water and waste related diseases in construction	6	4	2	4	**Mod 48**	6	4	2	2	**Low 24**

7.5.1.18.4 Sexually-transmitted Infections and High Risk Sexual Practices, including HIV/AIDS

The workplace health risk related to HIV/AIDS and the impact on business have been well described in literature and will require planning and mitigation both from the community health perspective as described above, but also for workplace health, productivity and business resilience. The development of the Project has the potential to increase STIs and HIV transmission in the study area, which includes the PACs in proximity to the proposed construction site, the temporary beach landing and offload area, as well as along local and regional transport corridors. All five (5) PAC's may potentially be affected.

Mitigation Measures

- Project impact mitigation:
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Use as a guideline the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants;
  - As part of the proposed communicable diseases strategy develop and implement a clear management of the spread of HIV/AIDS and STIs policy and plan. This should align with the c-EMP previously developed for the CPF project with relevant revisions/ adjustments. This should include specific CMR provisions. Activities of the plan should be reported on. Workplace activities are described below with interventions in both the workforce and community including:
    - Information and awareness campaigns on HIV/AIDS and STIs in both the community and the workplace; and
    - Support for widespread availability and social marketing of condoms in the workplace, hot spots in the community (bars and taverns) and at the lodge/hotel in Inhassoro.
  - Align with the current HIV/AIDS and sex worker management o-EMP that is on-going for the CPF with relevant adjustments for the Project;
  - Evaluate the status of the camp and develop procedures to maintain a closed camp status to reduce opportunities of transactional sexual activity between the employees/contractors and vulnerable local communities. This should be in place and strictly enforced by all contractors;
  - Develop a plan with lodge/hotel management in Inhassoro to limit the entry of commercial sex workers onto the hotel property and for Project related residents to invite women (or men) into their accommodation;
  - Develop a code of conduct that restricts fraternization:
    - From the workforce with the local communities with a CMR developed that includes severe sanctions for non-compliance; and

    - Within the workforce and especially towards female employees that originate from the local community, as this group (especially cleaners and catering staff) may be vulnerable to advances from the male dominated workforce. This should specifically include a CMR and sanctions for non-compliance.
  - As part of the Traffic Access and Safety Management Plan c-EMP and o-EMP consider developing the following:
    - A specific HIV and STI prevention programme for long distance truck drivers. Awareness and education programmes and promotion of condom use will be important interventions. This will require contractor support and management and should include the road transport corridor. Consider NGO implementing partners that can support IEC programs along the transport corridors (for example Pathfinder). These should ideally be performed in association with the CPF;
    - Restrictions for Project associated vehicles (including contractors and service providers) from providing lifts to the local community; and
    - Consider the placement of Project specific truck stops within the Project fence line to prevent trucks stopping or overnighting in the local community. This should include the lay-down yard in Inhassoro as well as at the proposed plant site, and drivers should be provided accommodation and meals within these areas (or in the camps). Develop CMRs to enforce and monitor this.
  - Support HSS activities in the local health centres and with the APEs on the management of HIV, TB and STIs. Support improvements in the local ability to collect and report on data that feeds into the DHIS to support longitudinal data collection and analysis from this source. This information should in turn be fed into the CHIS as part of key disease indicator surveillance.
- Occupational health, safety and environmental management:
  - In addition to the elements above, the following should be considered as part of the communicable disease strategy on the management of the spread of HIV/AIDS and STIs policy and plan in the workplace:
    - Screen for STIs & hepatitis B/C virus as part of pre-employment fitness to work process. This should not restrict the final offer of employment, but all identifies cases that should be treated. Individuals who test positive should be referred for counselling to consider undergoing an HIV test; and
    - Develop a HIV testing and care/treatment programme based on the 90:90:90 principle[16] that includes the workforce and contractors. Treatment should be done in conjunction with the individual's private insurer, company or the public sector so that at the end of the construction or when the person leaves the Project they are maintained on treatment.
  - As part of the Camp Management Standards, ensure adequate entertainment and recreational facilities in camps to prevent the need for the workforce to seek entertainment opportunities in the community.

[16] The 90:90:90 principle has the target that 90% of a population is aware of their HIV status; 90% are on ART; and 90% having a reduction in viral load

- Social development mitigation and management:
  - Support HSS activities that may include:
    - Support awareness and behaviour change communication activities in the communities. The APEs will be a valuable intervention advocates but should also consider large scale community interventions using a variety of media (e.g. edutainment, sports events etc.);
    - Improving the ability to diagnose and treat HIV and STIs, including effective adherence programmes; and
    - Strengthen prevention of mother to child transmission programmes and data management of pregnant mothers as an indicator of HIV in the surrounding communities.
  - Evaluate opportunities for the empowerment of women and girls in the area to support livelihoods and reduce vulnerability of transactional sexual relationships.

Table 107: Impact evaluation: Construction: EHA#4- Sexually-transmitted infections and high risk sexual practices, including HIV/AIDS during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Sexually-transmitted infections and high risk sexual practices in construction	10	4	3	5	**High 85**	8	4	3	3	**Low 45**

7.5.1.18.5 Food- and Nutrition-related Issues

While this will be cumulative in nature with the CPF and other developments, the development of the Project should have a positive impact on the local economy. This is discussed in more detail in the socio-economic assessments, but as a general principle if sectors of the community benefit from the Project (directly or indirectly) it can stimulate the local economy and deliver benefits in reducing poverty and enabling the community to support their nutritional requirements, afford better healthcare services, improved education etc. This potential benefit will be most marked at the local level but should extend into the broader study area, especially if effectively supported. PAC 1, 2 & 3 may be affected by this impact.

While impacted households were compensated in 2014 the potential for physical relocation or economic displacement due to the Project activities is subject to on-going studies. This is important as reduced access to land for farming or other related subsistence activities may affect local livelihoods and potentially food security. This potential impact is likely to be experience in a localised area and should be addressed as part of any resettlement activities. Potential impacts at the temporary beach landing site will be experience for the duration of these activities, and this impact will be limited to PAC 1 & 2.

Mitigation Measures

- Project impact mitigation
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline.

These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;

- Use as a guideline the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants;
- Depending on the outcome of the resettlement and displacement studies that are on-going ensure that food security risks are considered as part of the RPF/RP and c-EMP; and
- Develop and implement the CHIS to longitudinally monitor the nutritional status in the PACs and broader study area. This may require specific HSS and use of APEs. A baseline may need to be established as part of this, which may entail conducting a nutrition and micronutrient deficiency (anaemia) survey.

- Occupational health, safety and environmental management
  - Support workplace communicable disease strategies as discussed in other sections.
- Social development mitigation and management
  - Evaluate opportunities to create local economic development initiatives associated with agriculture, farming and getting goods to market as well as other entrepreneurial activity. This should have the objective of supporting local food security and generating sustainable improvements in livelihoods.
  - HSS including community based integrated management of childhood illness and nutritional surveillance (middle upper arm circumference, wasting and stunting) through APEs.

Table 108: Impact evaluation: Construction: EHA#5- Food and nutrition related issues during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Food and nutrition related issue in construction	8	3	2	4	**Mod 52**	6	3	2	3	**Low 33**

7.5.1.18.6 Non-communicable Diseases (NCDs)

Other than chronic airways disease from reduced air quality, there should be no other direct community health impacts from NCDs, but the local population who are employed by the Project (and their families) will likely have an improved economic status and the potential 'well- worker" benefits may lead to lifestyle related risks that can lead to the development of NCDs. This poses a significant business risk (due to absenteeism and loss of trained skilled people) in a similar manner to HIV, but long-term complications may be more challenging to manage. Indirect impacts attributable to Project influences are likely to be of low significance and related to local economic development.

These are likely to be localised with changes in life-style and eating habits potentially pre-disposing the community to conditions including obesity, hypertension, diabetes, dental caries and some forms of cancer. PAC 1 will largely be affected.

Mitigation Measures

- Occupational health, safety and environmental management:
  - Develop wellness programmes in the workforce that include:
    - Awareness and education programs on nutrition and dietary practices, exercise and management of modifiable risk factors (smoking, salt and sugar intake etc.);
    - Manage the onsite catering facilities in the type of food and the size of portions that are provided. Seek guidance form dieticians to support the design of menus in the canteens;
    - Screen for NCDs as part of fitness for duty medical surveillance requirements. Use these opportunities to support health promotion activities. Surveillance of weight or body mass index as a predictor for NCDs can be used and supported by aggressive routine screening for hypertension, cholesterol and diabetes in higher risk groups, especially those working in safety sensitive roles; and
    - Ensure the on-site medical service is able to recognize, manage and effectively follow up chronic diseases. This will require specialized diagnostics including the use of Hb1Ac surveillance in diabetics and screening for early kidney, eye and heart disease.
- Social development mitigation and management:
  - Support HSS to support the surveillance of key NCDs in the proposed CHIS in collaboration with the district health authorities. These should include hypertension, diabetes, non-infectious chronic lung disease and cancers; and
  - Support school-based awareness and education programmes as they are the generation who are most likely to be affected by these diseases in the medium to long term. Work with the local educational authorities to incorporate these programs into the local curriculum and support sporting and other interventions that encourages exercise and a healthy lifestyle. These sporting activities are ideal opportunities to support awareness and education activities but should equitably focus on activities for boys and girls and focus on an extension into adult life.

Table 109: Impact evaluation: Construction: EHA#6- Non-communicable disease during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Non-communicable diseases in construction	8	2	2	3	**Low 36**	8	2	2	2	**Low 24**

7.5.1.18.7 Accidents and Injuries

The movement of vehicles for the transportation of equipment, goods and personnel has the potential to increase motor vehicle and pedestrian vehicle accidents. Children are especially at risk for pedestrian vehicle accidents and a noted vulnerable group. Due to the movement of heavy equipment from the temporary beach landing site and lay-down yard the most significant risk will be in Inhassoro and along the transport corridor on the R241 and the EN1 towards the plant site. In addition, light duty vehicles and conveyance of people of busses and good (such as supplies from Vilankulo or further afield) are additional risks. Other than the transport of goods to support construction activities from the temporary beach landing site and lay-down yard, the other potential impacts are considered cumulative in nature due to the on-going activities at the CPF. PAC 1, 2, 3 &5 may be affected.

Whereas PAC 2 may be affected by a risk for maritime accidents with community boats and barges (and ships) that will offload goods at the temporary beach landing site in Inhassoro. There are plans to mitigate these risks with a pilot boat to warn other seas users to steer clear of the barges, but there is a potential risks for offshore and nearshore accidents with these activities.

Mitigation Measures

- Project impact mitigation:
  - As per the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Revise and adjust the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants;
  - Develop a community security and safety management plan for the Project related to different activities. This should include emergency response plans for both community related accidents and also for the workplace, and should capacity and capability to deal with fire, rescue and chemical spill response, as well as medical emergency response. This plan will need to cater for both maritime and road traffic accidents. This should integrate or add to the Traffic Access and Safety Management Plan c-EMP developed for the CPF;
  - Develop an effective communication strategy with the local community on this plan so that there is an awareness of what the Project will be responsible for in term of accidents and injuries and where its responsibility ends. This is particularly important given the high rate of road traffic accidents on the EN1 that may not be associated with the Project. This strategy should be aligned with the Grievance Procedure and Compliments and Complaints Register c-EMP;
  - As per the Traffic Access and Safety Management Plan c-EMP developed for the Project that may include traffic calming measures, reduction of dust etc.;
  - Develop and implement road safety campaigns in the local study area and along access roads that targets roads users/pedestrians. A specific focus should include school children as a vulnerable group; and
  - As part of the proposed CHIS collect data and monitor trends of road traffic accidents and non-accidental injuries (assault etc.) in the study area.

Policy records, medical records and records from APEs may be useful sources of longitudinal data.

- Occupational health, safety and environmental management:
  - As part of the Projects Occupational Health and Safety Management Plan (OHSMP) develop (to include CMRs):
    - Ensure all aspects of occupational health and safety are addressed, including training, PPE use, compliance verification, risk assessment principles, etc.;
    - Ensure that the plan considers community exposure due to workplace hazards and appropriate controls; e.g. workers returning home with soiled work clothes and exposing their family to potential hazards (e.g. handling chemicals);
    - As part of the fitness for duty program, develop appropriate medical surveillance for drivers and shipping personnel that includes screening for chronic diseases (hypertension and diabetes), substance abuse and compliance with specific physical standards;
    - Develop specific workplace health and safety standards and procedures for the management of Project mobile equipment and machinery, including specific requirements for driver training, fatigue management, vehicle roadworthiness, over-speeding etc.;
    - Consider equipping all light duty and long-distance trucks with on-board electronic speed governors and fleet monitoring systems. Each contractor company should be mandated to send reports from vehicles that deliver goods to site as part of shipment acceptance; and
    - Develop and strictly enforce a drug and alcohol policy for all work-related vehicles and barges- including contractor transport vehicles that operate in the study area and along the road transport corridor.
  - Implement a social code of conduct policy for all employees to ensure that violence and other threatening behaviour is not tolerated on the site or within the broader community; and
  - Consider adopting the Voluntary Principles of Security and Human Rights in the security department, and if this is in place for the CPF adopt a similar process.
- Social development mitigation and management:
  - In partnership with the local authorities and other potential implementing partner/s and police, coordinate awareness and education campaigns about responsible driving including speed management, vehicle safety and pedestrian safety etc.

Table 110: Impact evaluation: Construction: EHA#7- Accidents and injuries during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Accidents and injuries in construction	10	2	3	5	**High 75**	10	2	3	3	**Low 45**

7.5.1.18.8 Veterinary Medicine and Zoonotic Diseases

Poor hygienic conditions and ineffective management of especially food waste from the construction camp and other areas, and any waste management facility that handles food or organic products (e.g. landfill) may attract rodents and other wild animals to these areas. This attraction may increase the number of rodents in the study area with the potential to transmit disease associated with poor sanitation. The increased number of rodents may also attract snakes into the area with the increased potential for snake bite in both the workforce and community. The spatial impact will be localised to where these practices may occur. This is however estimated to be limited to PAC 1 & 2.

Mitigation Measures

- Project impact mitigation:
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Restrict access of the community into any of the Project waste areas, including any landfills if they are developed. Waste pickers should not be allowed entry to these areas under any circumstances; and
  - Develop the capacity from the workforce where skilled (trained) personnel from the Project can respond to and remove a snake from workplace areas and the community and safely relocate it.
- Occupational health, safety and environmental management:
  - As party of general outbreak risk management, develop and implement a disease outbreak preparedness and response procedures (that include potential zoonotic diseases) that include business resilience and recovery elements. These will need to consider interaction with a broad range of stakeholders including the local community, district as well as national health authorities;
  - Consider hazards related to the potential for increased encounters with snakes as part of bush clearing activities in the early works and construction phase. Management measures should be implemented to reduce the risk of encounters with snakes, relocation of snakes, as well as the possibility of being bitten and immediate first aid management;
  - Review and revise the waste management c-EMP used for the CPF and make relevant for the current Project, and develop a Camp Facilities Management c-EMP that consider:
    - Effective waste management practices in all accommodation and work areas to reduce the risk for pests being attracted or proliferating in these areas. This will need to include controls on food waste and disposal, general camp cleanliness and hygiene and rodent control activities. If possible it would be ideal to incinerate all waste (where this is possible/ permissible);
    - Design, build and manage accommodation and camp facilities to prevent rodents from gaining access to accommodation, kitchens and food/water storage areas; and
    - Prohibit employees from keeping pets on the Project site and accommodation area and manage the control of stray pets that find their way onto the site.

  - Develop effective protocols and procedures for managing dog and snake bites from the Project's workplace medical service; and
  - If dogs are required for security purposes, ensure that they are appropriately vaccinated.
- Social development mitigation and management:
  - Support the improvement of veterinary public health services in study area. This can include awareness and education programmes in the community on animal husbandry and support to the local authorities in providing animal health services, especially preventive programs such as vaccinating and sterilizing dogs/cats.

Table 111: Impact evaluation: Construction: EHA#8- Veterinary medicine and zoonotic diseases during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Veterinary medicine and zoonotic diseases in construction	10	2	2	2	**Low 28**	8	2	2	1	**Negligible 12**

7.5.1.18.9 Environmental Health Determinants – Hazardous Chemical Substances

The Project will utilize different types of hazardous chemical substances in the construction and operations phases. Any potential impacts are likely to be localised with a small likelihood of long-term effects, but this is dependent on the type of chemical and exposure. Potential impacts may occur from spills, leaks and inappropriate disposal of products (for example florescent light tubes due to mercury content). They may also occur from the re-use of discarded containers that have stored hazardous chemical substances by the community for storing water or other domestic product. This is more likely in the construction period as there is a higher potential that more agents will be in use. PAC 1, 2, 3 & 5 may be affected.

Mitigation Measures

- Project impact mitigation:
  - Develop and implement mitigation measures and findings from the ESIA and general and hazardous waste management plan in alignment with the current c-EMP and o-EMPs in place at the CPF and determine if these are still fit for purpose;
  - Perform effective monitoring of emissions, water quality etc. and transparent reporting to stakeholders, including communities;
  - Develop appropriate hazardous chemical substances management programs in alignment with IFC PS3 guidance as well as the International Code of Conduct on the Distribution and Use of Pesticides;
  - Effective waste management so the communities do not use Project-related discarded containers that may have contained hazardous materials for collecting of water or storage of water or related domestic products; and

  - Pest control activities and associated selection of insecticides for malaria control and other pest control activities will need to be performed in alignment with national programs and policies. If products are used injudiciously, there is the potential to create a public health impact if insecticide resistance is introduced locally.
- Occupational health, safety and environmental management:
  - Develop a system that requires both environmental and health/safety approvals to request new hazardous chemical substances for procurement. The procurements department needs to be the gatekeeper and systems should be developed that prohibit any new substance coming onto site without approval. If the environmental and health/safety review raises a concern then the requesting user may need to suggest a safer alternative, and if this is not possible prepare a justification why the product is required and what measures will be put in place to manage any potential risks;
  - Undertake a risk assessment on all hazardous chemical substances on site and determine the specific human health risks that may potentially result from exposure to a product or by product of a process or emission. Develop specific workplace health, safety and environmental plans based on the risk assessments, with clear emergency preparedness and response capability (equipment and trained personnel) for hazardous materials management;
  - Ensure adequate personal protective, hygiene and washing facilities for employees that handle any form of pesticide. This should include dedicated personal protective clothing as well as showering and changing room facilities so that personnel are required to change potentially contaminated clothing before they go home, thus preventing exposures to their family unit or other workers;
  - Medical surveillance (including biological monitoring) of employees handling hazardous chemical substances should be incorporated into the Projects OHSMP; and
  - Ensure effective and on-going contractor management with all occupational health, safety and environmental programs.

Table 112: Impact evaluation: Construction: EHA#9- Hazardous chemical substances during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Environmental health determinant: hazardous chemical substances in construction, operations and decommissioning	8	3	2	4	**Mod 52**	8	3	2	2	**Low 26**

7.5.1.18.10 Social Determinants of Health

Social determinants that may influence health and well-being at the local level will be described in more detail in the specialist social and economic studies, but elements relevant to health and well-being will be discussed in this section.

The holistic model of health and well-being acknowledges that the health status of a population is affected by factors known as health determinants (Figure 140).

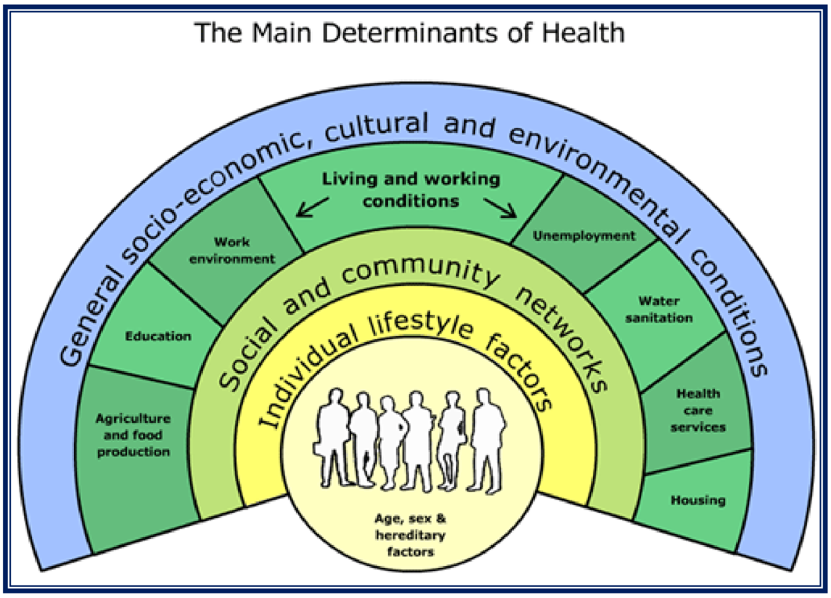


Figure 140: Determinants of health

The Project is relatively technical with a high level of skill required to construct and operate the power plant and associated infrastructure. As a result, there will only be a limited number of job opportunities available to the portion of the local population who are relatively unskilled (about 120 for the CCGT and 100 for the OCGE in construction, and only 40 - 50 in operations).

Although limited, these employment opportunities will have a positive effect on the local economy as individuals and their families may benefit directly and more money will circulate in the local communities with a potential increased uptake of services and purchase of goods (multiplier benefits as discussed below).

However, the employment opportunities may bring about some negative consequences (or perceived consequences):

- Unfulfilled expectations that the Project will employ vast numbers of people and reduce poverty in the area, especially in the light of limited other opportunities; and
- Employment for a short period of time may change local practices from subsistence farming/fishing to earning a paid wage. While positive in this period, it may be challenging for the individual (especially men) to revert back to fishing and farming once the employment opportunities cease.

These impacts are more likely to be experienced in the broader area where the community may have an expectation for additional jobs. It is also likely to be a cumulative impact with the effects of the CPF and related activities in the area, with PAC 1, 2, 3, &4 being affected. Furthermore, the development of the Project may result in the additional development of facilities or services in the local communities to take advantage of the improved local economic conditions; including hotels, restaurants, services etc. These associated facilities could employ additional people from the community or distribute wealth and create multiplier effects in stimulating local economic growth.

The potential for exposure to gender based violence and sexual exploitation and abuse as well as Project related expectations that have the potential to influence social harmony in the study.

PIIM, stress on or competition for limited resources, altered lifestyle practices and possible development of increased levels of social ills such as sex work and substance abuse are some of the factors that may impact on the traditional values and social harmony in the study area as a result of the Project development. However, with the mitigation described below, it is possible to convert this impact into a positive benefit.

Mitigation Measures

- Project impact mitigation:
  - As per findings related to local economic development as discussed in the social impact assessment and related management measures;
  - Develop and implement procedures for communication and management of expectations related to the realistic benefits of the Project in terms of employment and local economic development;
  - Develop an effective stakeholder engagement strategy with authorities, communities and other parties so that there is a mutual ownership of any intervention in the community (whether impact mitigation or social development), with the intent to support the ultimate sustainability of activities;
  - Attempt a gender balance in the workforce noting the limitations in number of employees and ability to employ females in some forms of manual labour. Where possible non manual tasks should be reserved for women, and support CMRs as part of this;
  - Where these are effective support the roles of traditional authorities in the study area in the proactive management of social ills and social discord. This may require support with community cohesion activities and be considered as part of the Population Influx Plan;
  - Support the district and traditional authorities with local policing initiatives and an effective justice system so that crimes are rapidly dealt with, respecting human rights and based on Mozambican regulations; and
  - Restrict mixing of the contracted migrant workforce and the local community by managing effective accommodation camps, by employing a closed camp status.
- Social development mitigation and management:
  - Evaluate opportunities to create an effective linkage programme where local businesses are used in support of the Project and opportunities are leveraged where small enterprises are created to support these businesses. Any of these interventions should be conducted in alliance or partnership with the CPF project and for this reason it would be important to understand what activities the CPF were supporting to determine if the Project could support or enhance these;
  - Evaluate opportunities for the empowerment of women and girls in the area, as a specific vulnerable group. Microfinance and self-reliance/co-operative schemes may be such an option to stimulate entry into the cash economy and become financially independent;
  - Promotion of gender-based programs as mentioned above under local economic development; and
  - Training and skills development in local communities- especially in youth. This should have a focus to support local entrepreneurs and local business development.

Table 113: Impact evaluation: Construction: EHA#10- Local economic development and employment

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Local economic development and employment in construction and operations	Positive									
Social harmony, inequalities and Project expectations in construction and operations	8	3	2	4	**Mod 52**	Positive				

7.5.1.18.11 Cultural Health Issues and Health Seeking Behaviour

PIIM may mean that the capacity of the available formal public health services will not be able to meet the demands of the community. There is a general inability of the formal sector to meet any increased requirements. This may generate an increased demand for informal health services including use of traditional medicine and purchase of medications from clandestine street pharmacies. These are likely to provide a lower standard of care, lead to delayed diagnosis and not allow for the accurate reporting of the burden of disease as these cases are not recorded anywhere. In addition, local economic development may lead to the influx of people touting their services as traditional healers, or the development of clandestine street pharmacies. An increased demand may increase this type of service offering. PAC 1 & 2 will be mostly affected.

Mitigation Measures

- Project impact mitigation:
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Use as a guideline the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants; and
  - This element will need to specifically focus on impacts on increased demand in available health services as discussed in section 8.2.12 and their ability to effectively serve the needs of the PACs. While Mangugumete health centre was developed by the CPF project it faces numerous operational challenges that may require HSS so that the additional potential PIIM due to the Project does not create an impact. Any intervention should be performed in association/partnership with the CPF as part of a broader strategy.
- Occupational health, safety and environmental management:
  - As described in section 8.2.12 develop effective Project medical services so that any increased demand for healthcare does not originate from the Project.

The medical services and facilities c-EMP and o-EMP used for the CPF should be reviewed and revised as required for the current Project.

- Social development mitigation and management:
  - Evaluate HSS activities to support improved health seeking behaviours, with the proposed support of the APEs and related awareness and education and community based care a potential option; and
  - Support the local authorities in the regulation of clandestine pharmacies and traditional healers, including supporting collaboration between the health centres/APEs and recognised/respected traditional healers.

Table 114: Impact evaluation: Construction: EHA#11- Cultural health issues and health seeking behaviour

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Cultural health issues and health seeking behaviour in construction and operations	6	3	2	3	**Low 33**	4	3	2	2	**Low 18**

7.5.1.18.12 Health Services, Infrastructure and Programmes

In the construction phase the relatively large construction workforce will require an effective medical service to manage worker emergency care, primary healthcare and occupational health needs. The available public health service has limited capacity to manage this increased demand, especially during the construction phase. There is the risk that it will be overburdened if the workforce needs to utilise these services to the potential detriment to the local community. In addition, the workforce may not accept the standard of care provided at these facilities.

This potential impact is likely to be most marked in construction but can extend into operations. Spatially it will be experienced in PAC1 and PAC2.

Mitigation Measures

- Project impact mitigation:
  - Use the c-EMP and o-EMP Management of Population Influx Plans used for the CPF development or other Sasol related developments as a guideline. These may need to be reviewed and revised as required to ensure effectiveness and to cater for the potential cumulative effect of the Project;
  - Use as a guideline the c-EMP and CMR elements of the Employment and Labour Management plan developed for the CPF to support the requirements and local applicability of the Project. This will be an important element of the Management of Population Influx Plans as it will be designed to limit the attraction of job seeking migrants;
  - This element will need to specifically focus on impacts on increased demand in available health services and their ability to effectively serve the needs of the PACs.

While Mangugumete health centre was developed by the CPF project it faces numerous operational challenges that may require HSS so that the additional potential PIIM due to the Project does not create an impact. Any intervention should be performed in association/partnership with the CPF as part of a broader strategy;

- Consider supporting health programme initiatives in the study area that may be impacted by the increasing demand related to PIIM (these can overlap into social development management). If the CPF has a current strategy the Project should align or seek to expand this, and if not it would be beneficial for the two Projects to work in a coordinated fashion. These will be considered as specific HSS activities and should be supported in partnership with the provincial and district health authorities. A formal gap analysis with the local authorities will need to be conducted to understand health programmes that have been affected by influx of people and support provided on that basis. These may include:
  - Outreach and facility based child health and vaccination programmes;
  - School health programmes such as deworming activities;
  - Supply chain of medication and consumables (adequacy of stock and range of stock);
  - Malaria programmes including availability of bednets, rapid diagnostic test kits and treatment;
  - HIV programmes including availability of medication for anti-retroviral and prevention of mother to child transmission programmes; and
  - As with other sections support of the APE activities.
- A specific HSS activity should be to consider the support of the DHIS2 system in the recording and reporting of data. This should in turn support the objective of monitoring key selected indicators as part of the proposed CHIS.

- Occupational health, safety and environmental management:
  - Use as a guideline the medical services and facilities c-EMP and o-EMP used for the CPF (with review and revision) for the current Project to support the development of an appropriate site based medical service. As part of this plan review opportunities to integrate the planned services (either fully or partially) for the Project, with those currently available on the CPF. This may limit duplications and waste of resources. However, it is important that the medical service for the Project cater for effective primary care, occupational health and emergency care. Systems to refer more complex cases either on an elective or emergency basis will need to be developed. The objective behind this scope is to limit the need for the workforce to utilise the local and district public health services so as not to overburden them. Access to workplace medical services will need to include contractors and visitors so they also don’t need to use the available public health services;
  - The team working in Inhassoro will also need to access the medical services in the plant construction site; and
  - Use as a guideline (with review and revision) the CPF medical waste c-EMP and o-EMP to support Project requirements.
- Social development mitigation and management:

- HSS as per other sections. This may need to include specific support of the Mangugumete health centre.

Table 115: Impact evaluation: Construction: EHA#12- Health services, infrastructure and programmes during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Health services, infrastructure and programmes in construction	8	3	2	4	**Mod 52**	6	3	2	2	**Low 22**

7.5.1.19 Traffic impacts associated with the Construction phase of the project

The Traffic impact assessment conducted could not significantly differentiate between Gas Turbines or Gas Engines, but rather evaluated the various beach landing sites and the two transportation routes currently under consideration by the Proponent. The number of abnormal loads being transported for the two technologies differ slightly, consequently the impacts were determined to be the same for both technologies.

Impact on Existing Traffic in terms of Delay

The various route options from the different beach landing sites are compared below (Table 116) in terms of the high-level impact of the construction, and abnormal load trips on the existing traffic in terms of delays experienced. The significance rating given below has taken into consideration the mitigation measures stipulated below.

Table 116: Delay due to Construction Phase Traffic

Route Type	Route Option	Impact of Construction Vehicles Trips on Existing Traffic (Delays)	Impact of Abnormal Loads on Existing Traffic (Delays)
Main Roads	Option 1A – From Seta	Low	Moderate
	Option 2A – From Brisa Mar	Low	Moderate
	Option 3A – From Maritima	Low	Moderate
Back Routes	Option 1B – From Seta	Low	Low
	Option 2B-1 – From Brisa Mar (Dirt Roads)	Low	Low

Route Type	Route Option	Impact of Construction Vehicles Trips on Existing Traffic (Delays)	Impact of Abnormal Loads on Existing Traffic (Delays)
	Option 2B-2 – From Brisa Mar (Sand Tracks)	Low	Low
	Option 3B – From Maritima	Low	Low

Mitigation Measures

- Indicate areas where heavy vehicles will be expected with adequate signage; and
- Ensure that at least two vehicles accompany every abnormal load; one vehicle in the front and one at the back.

Construction vehicle traffic impacts

If is estimated that the frequency of construction vehicle deliveries to the site will peak between month 15 to 19 but will start slowly and will decrease toward the end of the construction period. The impact of the construction vehicles will be more visible toward the access from the EN1 to the CTT access road and is discussed below and evaluated in Table 117**:**

- **Adequate turning lane lengths** are required to ensure enough queueing space for turning vehicles in order to prevent conflict with fast moving through traffic;
- **Generation of dust** will be higher on routes that do not have a protective blacktop layer or that are not protected with a dust prevention layer or dust prevention treatment. For construction vehicles generation of dust will also be form the sand / materials that are transported;
- **Risk of vehicle collision** will be higher on roads with more background traffic and less on dirt road and tracks. However, the probability of a collision will be higher where fast travelling vehicles needs to pass slow moving construction vehicles;
- **Risk of pedestrian accidents** is lower in areas of less traffic movement. However, the risk increases significantly in areas that allow heavy vehicle traffic through residential areas, which should normally be shielded from frequent heavy vehicle traffic; and
- **Degradation of roads** increases significantly with an increase in vehicle load and is dependent on the type of pavement structure.

Table 117: Construction Vehicle Traffic Impact

Route Option	Turning Lane Lengths	Generation of dust	Risk of vehicle collision	Risk of pedestrian accidents	Degradation of Public Roads
Construction Vehicles on EN1 & CTT Access Road	Low, only inadequate in certain identified areas	Moderate	Moderate	Moderate	Moderate

Mitigation Measures

- EN1/CTT Access northern approach: add minimum 30 m right turning lane with a 45 m taper to allow for safe queueing. EN1/CTT Access northern approach: add minimum 30 m left turning lane with 45 m taper;
- Cover materials with tarpaulins where possible alternatively wet sand and/or provide other means of protection. Treatment of dirt/sand roads near communities would be advisable;
- Indicate areas where heavy vehicles will be expected with adequate signage;
- Clearly indicate pedestrian crossings;
- Educate drivers on potential areas of high pedestrian and cyclist activity;
- Educate community on dangers of construction vehicles new to their area; and
- Upgrade roads and bridge crossing where necessary. The deterioration over time must be monitored and a maintenance plan must be negotiated with the ANE (National Road Administration) with specific mention of the Monitoring and Planning departments that should be consulted.

Abnormal Vehicle Traffic Impacts

The route (and beach landing site) chosen for abnormal vehicles comes with other traffic related impacts due to the infrequent transport of abnormal loads these are discussed below and evaluated in Table 118**:**

- **Generation of dust** will be higher on routes that do not have a protective blacktop layer or that are not protected with a dust prevention layer or dust prevention treatment;
- **Risk of vehicle collision** will be higher on roads with more background traffic and less on dirt road and tracks. However, the probability of a collision will be higher where fast travelling vehicles needs to pass abnormally long and slow moving abnormal vehicles;
- **Risk of pedestrian accidents** is lower in areas of less traffic movement. However, the risk increases significantly in areas that allow heavy vehicle traffic through residential areas, which should normally be shielded from frequent heavy vehicle traffic; and
- **Degradation of roads** increases significantly with an increase in vehicle load and is dependent on the type of pavement structure.

Mitigation measures

- Slow moving abnormal loads should generate low dust level, but this should be monitored during the first trip;
- Ensure that at least two vehicles accompany every abnormal load; one vehicle in the front and one at the back. Position flag men at critical crossings of all major routes these include but are not limited to the Beach Landing/R241, EN1/R241 and the EN1/CTT access intersections;
- Communicate dates and times of vehicle movements to the communities, schools and businesses along the routes. Educate drivers on potential areas of high pedestrian and cyclist activity;
- Educate community on dangers of construction vehicles new to their area;
- Advertise the dates and times of the abnormal load movements, taking specific care to inform communities that do not have access to newspapers and other forms of media;

- Liaison with the traffic authorities about the movement of abnormal loads; and
- Upgrade roads and bridge crossing where necessary. The deterioration over time must be monitored and a maintenance plan must be negotiated with the ANE (National Road Administration) with specific mention of the Monitoring and Planning departments that should be consulted.

With the application of the mitigation measures above, it can be seen that the **SETA beach landing site** has the least impacts associated with the beach landing options and access/egress from the site. Furthermore, it can be seen that the **transportation route via the R241 and the EN1 to the CTT site** is the preferred route as it has the least impact on the receiving environment and communities.

Table 118: Abnormal Load Impacts

Route Type	Route Option	Generation of dust	Risk of vehicle collision	Risk of pedestrian accidents	Degradation of Public Roads	Costs of Additional Roads/ Improvements
Main Roads	Option 1A – From Seta	Low	Low	Low	Moderate	Moderate
	Option 2A – From Brisa Mar	Moderate	Moderate	Moderate	Moderate	Moderate
	Option 3A – From Maritima	Moderate	Moderate	Moderate	Moderate	Moderate
Back Routes	Option 1B – From Seta	High	Low	Moderate	High	High
	Option 2B-1 – From Brisa Mar (Dirt Roads)	High	Low	High	High	High
	Option 2B-2 – From Brisa Mar (Sand Tracks)	High	Low	High	High	High
	Option 3B – From Maritima	High	Low	Moderate	High	High

7.5.1.20 Socio-Economic Impacts – Tourism

The Beach landing activities could have a possible negative impact on Inhassoro town and the Bazaruto Island. The socio- and macro-economic results of the baseline were assessed against the potential impact of the temporary beach landing activities. A theoretical worst-case scenario was considered and modelled. The scenario shows the impacts before any mitigation took place.

The worst-case scenario (pre-mitigation) impact deviation percentage from the baseline for the Inhassoro beach was estimated at 5.63% and was identified as a low negative impact. This resulted in a theoretical loss of 58 direct and 33 indirect and induced jobs in Inhassoro (pre-mitigation). After mitigation measures are applied, this reduces to 26 direct and 15 indirect and induced job losses. This based exclusively on a reduction in GDP and translating that into potential job losses.

Less GDP will be channelled through the economy while the low-income household earners will also have less disposable income due to interruption of fishing activities, less regional tourists to accommodate and the effect of the dependant economic activities from the direct impacts. These job losses can be substantially reduced by additional mitigation measures such as agreeing that CTT contractors and visiting consultants make use of the accommodation facilities at Inhassoro (further discussed below).

The deviation percentage from the baseline is also estimated as 5.63% for the Bazaruto Island which is a low negative impact (pre-mitigation). The estimated projected loss in job opportunities is 47 direct and 35 indirect and induced (pre-mitigation) and this reduces to 27 direct and 20 indirect job losses after mitigation measures are applied. As with Inhassoro, less GDP will be channelled through the economy while the low-income household earners will also have less disposable income due to the job losses due to fewer international tourists to accommodate and the effect of the dependant economic activities will also reduce such as scuba diving trips.

The beach landing activities will only occur during a portion of the entire project construction phase i.e. only bringing in oversized and extremely heavy power plant components over approximately 8 months, with infrequent activities. The anchoring and barge transport will only last for approximately 1-2 days at a time. The Proponent has indicated that there is flexibility in scheduling delivery of components as they are expected to arrive every 3 or 4 months so scheduling these activities outside of peak tourist periods should be relatively easily achieved, thereby reducing the impact.

No beach landing activities will take place during the CTT operational phase, as all temporary jetty infrastructure will be dismantled, and the area rehabilitated.

Mitigation Measures

Two possible mitigation measures are identified that will minimise the impact on the Inhassoro beach:

- Maintain the practice of operating outside of peak tourist seasons (November-January and outside Easter Holidays);
- Restrict the offloading to the daytime periods and use local Inhassoro facilities to accommodate the staff involved in the beach landing and offloading project during the construction and operational period, and
- Only use the local Inhassoro facilities to accommodate the involved staff associated with beach landing activities and the CTT plant construction.

For the mitigation measures, the "Out of Season" proposed activity will have the best effect on reducing the negative impact. The utilisation of local resources (accommodation) and the daytime option for offloading activities has a further positive effect as mitigation, specifically on the Inhassoro Beach.

It should be borne in mind that the construction and operation of the CTT project will contribute to the long-term economic growth of Mozambique, which is also necessary to impact positively on the alleviation of poverty in the country.

In terms of the local tourism industry, it is concluded that in theory, it may be temporarily negatively impacted for an 18 to 24-month period, with a recovery over the medium term, however there is the distinct possibility that additional bed-nights will be occupied during the CTT construction phase which will have positive effects on the accommodation facilities in Inhassoro.

Table 119: Socio-Economic impact during construction

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Tourism Socio-economic impacts (Loss of revenue and jobs)	-	-	-	-	**Low**	-	-	-	-	**Low**

7.6 Socio-Economic and Cultural Environment

7.6.1 Operational Phase

7.6.1.1 Change in environmental setting and demographic change (Cultural)

There are no direct impacts anticipated on tangible cultural heritage sites during the operational phase. Impacts upon intangible cultural heritage, in particular through demographic changes (influx), are anticipated to be limited due to the small number of jobs associated with the operational phase and the likelihood that these will be primarily sourced from the local population. The CHMP should provide mitigation for this and will provide measures for the maintenance of community access to sacred sites and facilitate respect for local intangible cultural heritage, tradition and taboos through continued community liaison. It is suggested that the presence of culturally significant places are highlighted to contractors and sub-contractors during the site induction process as project cultural awareness training.

Once constructed, the environmental setting of burials and cemeteries along the electricity transmission route (BU-105 – BU-109, and CE-104 and CE-105) could be impacted by noise and visual effects as result of the overhead powerlines. Pre-mitigation, this could result in a moderate severity, long term, local impact at high value sites. It is proposed that the noise impact would be mitigated by re-aligning the route to avoid these burials (which is already proposed during the construction phase).

Table 120: Environmental setting and demographic change – Operation phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Impact of change in environmental setting	6	4	2	4	**Mod 48**	4	4	2	4	**Low 40**
Impact of demographic change	4	4	2	4	**Low 40**	2	4	2	2	**Low 16**

7.6.1.2 Visual intrusion of Key Infrastructure

- The level of visibility of the power plant within the overall study area can be described as "mottled" or spotty, with many individual locations from which potential views of the power plant are expected to be partially obscured by the existing vegetation (see viewshed in Figure 142). The screening effect of the vegetation can clearly be seen, with the level of visibility decreasing significantly as the viewer moves away from the respective sites. The influence of the topography on the level of visibility of the infrastructure is also evident, with the two roughly north-south orientated low-lying areas being largely screened from view. The power plant is therefore expected to be mostly screened throughout the largest part of the study area, although the stacks which represent its tallest component will be substantially more visible. The overall level to which the power plant will be visible within the study area is consequently estimated as being less a quarter within the study area and is therefore rated as low;

- As previously indicated, the majority of resident as well as transient receptors will be located more than two kilometres away from the power plant, and therefore the level of visual exposure of this impact is scored as being low;

- The power plant once constructed and operational will essentially be a continuation of the visual impact created by the existing Sasol CPF albeit to a greater extent. The existing visual baseline is therefore already partially compromised by the presence of this infrastructure and to a lesser extent the sprawling low density settlements. Nevertheless, the expansive and highly geometric shapes of the power plant infrastructure will likely be perceived as visually intrusive by most viewers and will dominate short-range views and is therefore rated as moderately intrusive (Figure 141):

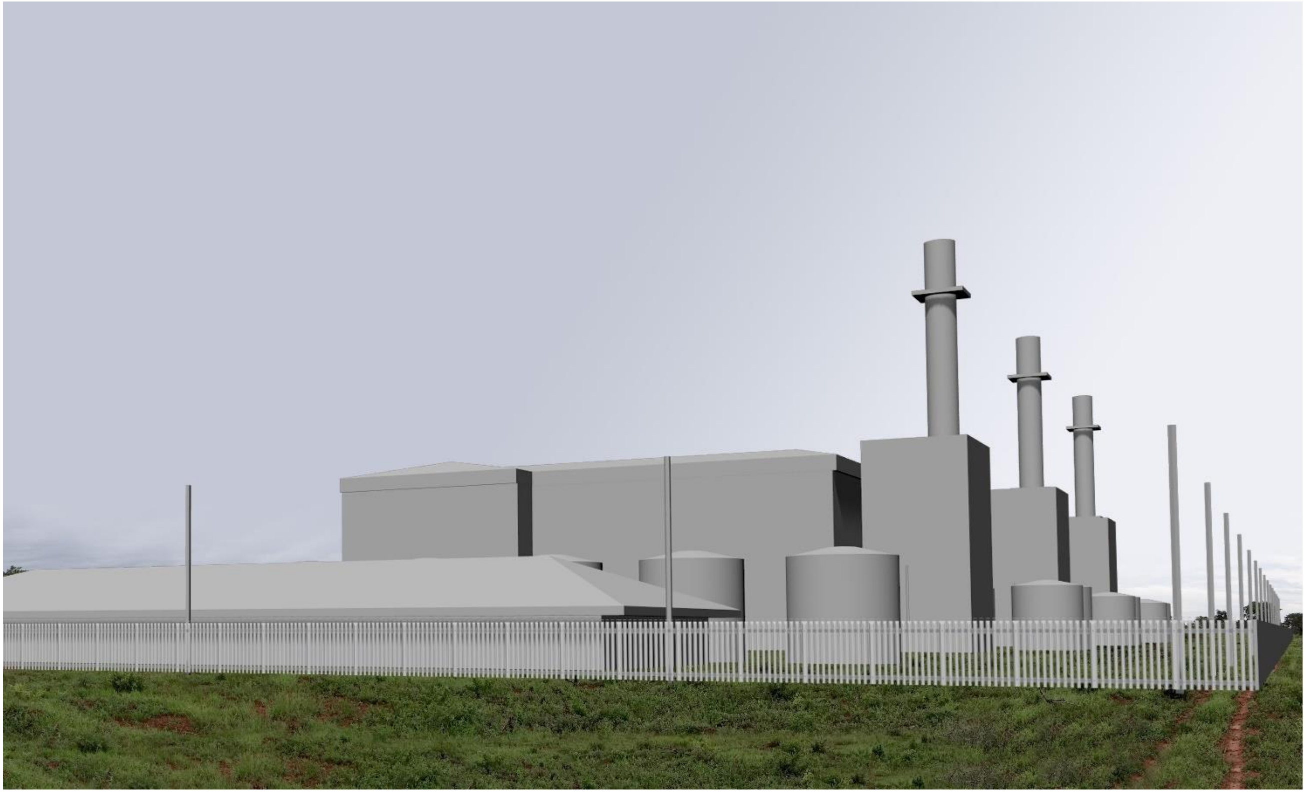


Figure 141: Visual scale of power plant within the existing landscape (short-range view)

- The effective level of visibility of the transmission lines is somewhat higher within the 5 km radius study area than that of the power plant in the same radius, as the pylons will only be spaced a few hundred meters apart and it is therefore likely that several pylons may be visible from any given location. The compounding screening effect of the vegetation over distance can however still be seen, even if to a lesser degree than is the case with the power plant. As previously mentioned, the study area for the transmission lines was limited to a 5 km radius around the infrastructure, as the pylon structures are visually more opaque than the solid shapes of the plant infrastructure. The visual prominence of the pylons will therefore diminish over distance more rapidly than the power plant over the same distance. However, the level of visibility of the transmission line pylons is far greater within their defined study area than the power plant and is therefore rated as moderate;
- As majority of resident as well as transient receptors will also be located more than two kilometres away from the transmission lines, and therefore the level of visual exposure of this impact is scored as being low; and
- The transmission line pylons will be similar in appearance to other existing pylons within the region, and as mentioned the frame construction is visually opaque and their visual impact therefore diminishes over time and therefore rated as only slightly intrusive.

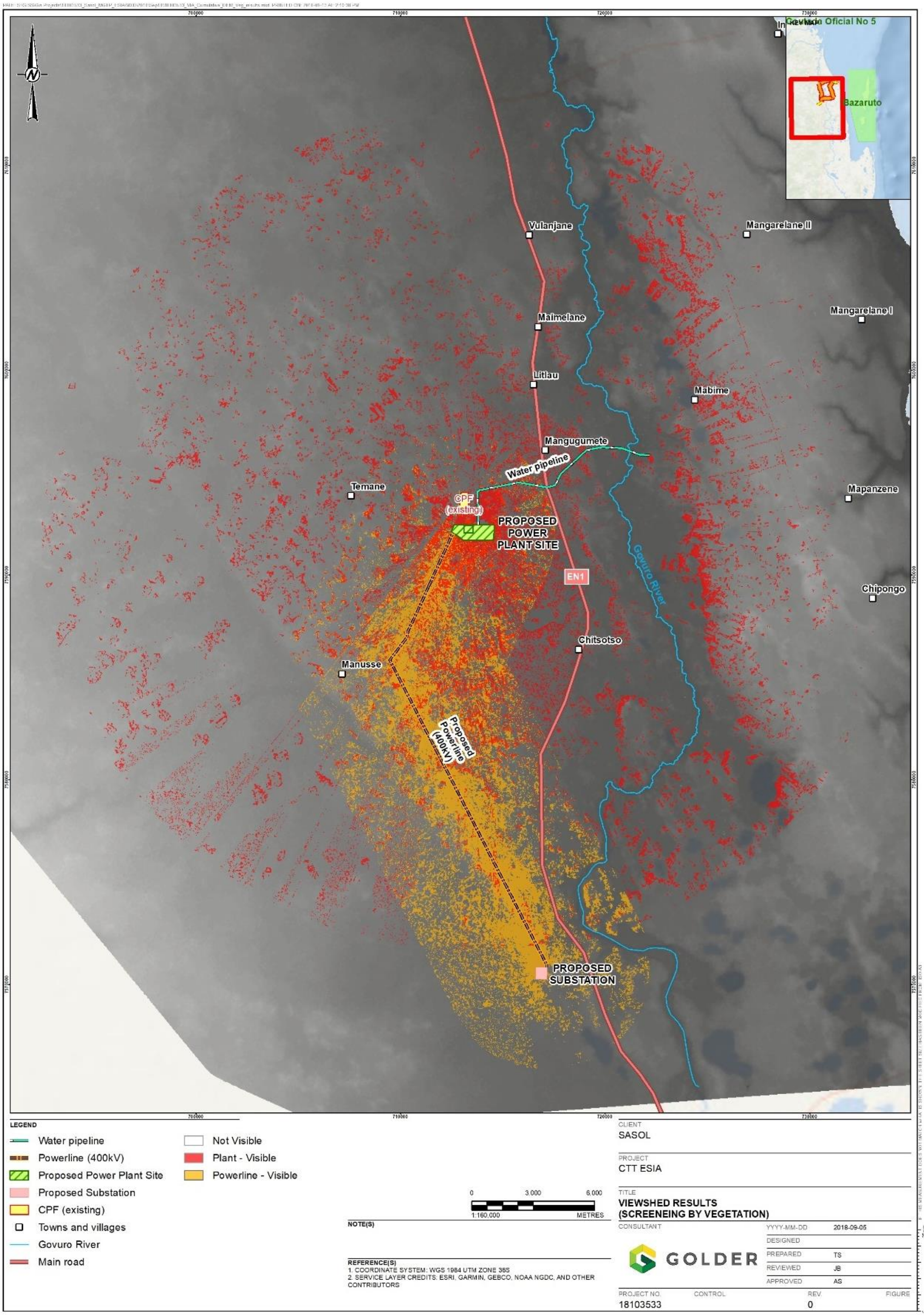


Figure 142: Combined viewshed/visibility analysis of power plant and transmission line

Mitigation Measures

- To reduce the visual intrusion of the buildings, where feasible roofing and cladding material should not be white, shiny (e.g. bare galvanized steel that causes glare) or brightly coloured;
- Buildings and workshops exteriors should also be painted in colours that are complementary to the surrounding landscape, such as olive green, light grey, blue-grey, or variations of tan and ochre;
- Retain existing trees wherever possible, as they already provide valuable screening; and
- Appropriate landscaping using indigenous vegetation should be introduced within the permanent camp facility as well as entrance areas to other facilities, in order to create a more welcoming overall appearance.

Despite the mitigation measures stipulated above the impact will remain a moderate significance.

Table 121: Visual Intrusion of Key Infrastructure - operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance*	Intensity	Duration	Geographic Extent	Probability	Significance*
Visually intrusive operational power plant infrastructure	4	4	2	5	**50**	4	4	2	5	**50 Mod**
Visually intrusive linear transmission lines and associated vegetation clearance	4	4	2	5	**50**	4	4	2	5	**50 Mod**

7.6.1.3 Light pollution at night from CTT power plant

The operational power plant will be situated close to the existing facility, which already contributes a measure of light pollution. The relatively sparsely settled residential areas to the north and east of the plant site likely also contribute some light pollution, and hence the power plant will be located in a visual setting that already has a measure of “background” light pollution. However, the extent to which the new power plant will be illuminated for security and safety reasons is expected to be more extensive than any of the existing structures within the study area (Figure 143 and Figure 144). For this reason, the combined level of visibility of the direct glare and indirect sky glow is rated as moderate, as this will likely be visible to some extent within a significant percentage of the study area. The level of visual exposure of the operational plant will be similar to that of the plant during construction and is therefore rated as low. As is the case for the construction phase, the visual intrusion of the illuminated plant is expected to be high.

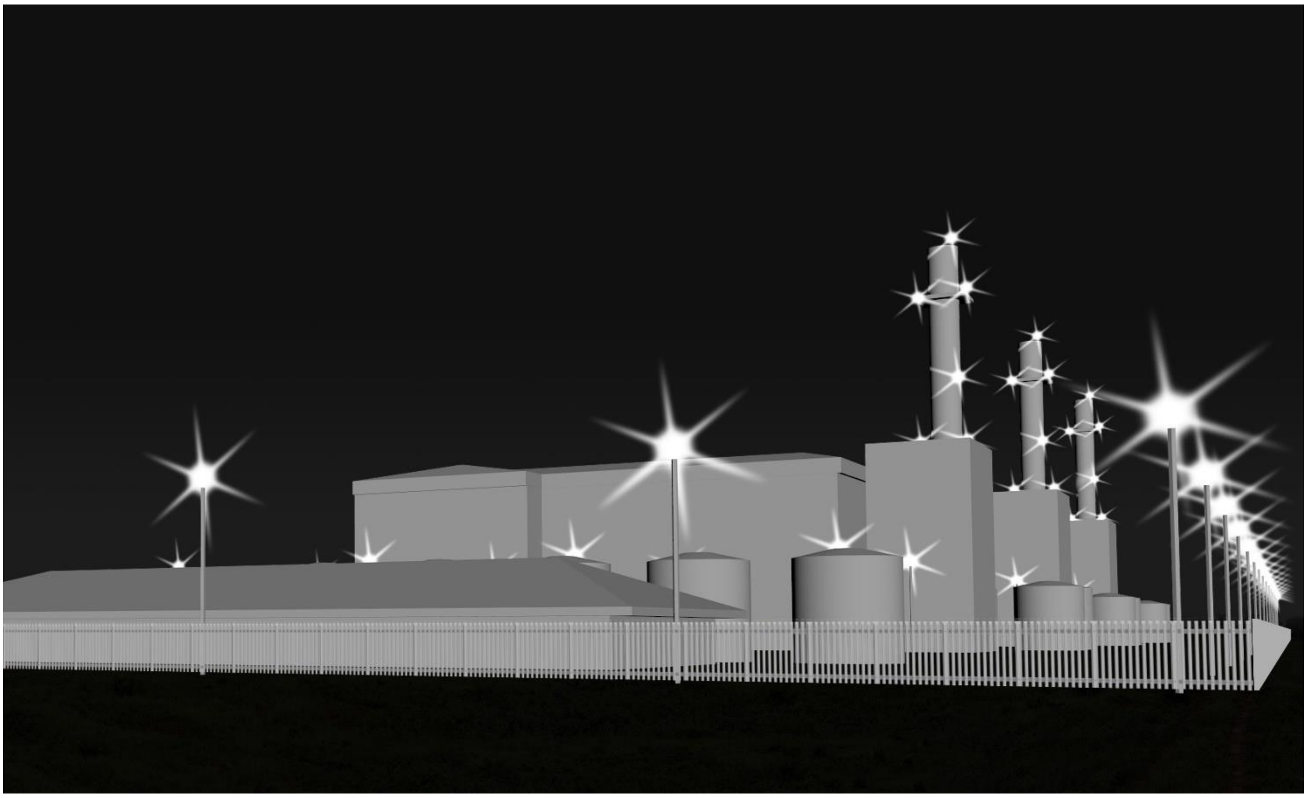


Figure 143: Light pollution at night from power plant (short-range view)

Figure 144: Light pollution at night from power plant (screened medium-range view)

Mitigation Measures

- Same as construction phase.

Table 122: Light pollution at CTT at night - operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance*	Intensity	Duration	Geographic Extent	Probability	Significance*
Light pollution at night at the CTT plant	6	4	2	5	**60**	4	4	2	5	**50 Mod**

7.6.1.4 Employment opportunities

During the operational phase, 70 vacancies will be available (the number will be the same for both power generation options). It is envisaged that the operational phase split between locals and expatriates will be a ratio of approximately 70% to 30% respectively. Although a target of expat employees below 10% should be considered and implemented. It may be required that there be an initial period of training and transfer of skills in the first 2 to 3 years before a hand over from an expat to a local employee, Although the number of available vacancies is not significant, the Nationals will receive the maximum advantage of employment opportunities during the operational phase. It is anticipated that employment during the operational phase will be over a long period. This will contribute positively to the income of the successful local job applicants as they will be able to support their dependants for an extended period. Similar to the construction phase, the operational phase of the proposed project could induce some indirect, informal employment opportunities such as the selling of consumables by the locals.

Mitigation Measures

- Directly affected communities should be given special consideration in terms of the benefits arising from the project. The local resident status of applicants should be verified in consultation with a community representative; and
- Where feasible, promote the creation of employment opportunities for women and youth throughout the project lifecycle.

7.6.1.5 Electricity supply

The proposed CTT project will ensure improved electricity supply in the country as Mozambique currently imports electricity from South Africa from time to time in order to meet its electrical energy demands (at times Mozambique also exports electricity to neighbouring countries). Consequently, the improved supply of electricity will:

- Increase the country's economic growth because most economic activities are dependent on a reliable and steady supply of electricity; and
- Improve local business environment due to a stable electricity supply.

Mitigation Measures

- All construction phase activities must be executed accordingly to ensure proper functionality during this phase; and
- Stakeholders must be engaged accordingly, and community relations maintained to avoid interruptions during the operation phase (e.g. social unrest).

7.6.1.6 Economic development

The client will pay tax for permit areas, and the employees' salaries will also be taxed monthly. A proportion of these funds could be used to stimulate economic growth. For example, the state might decide to invest the funds into infrastructure development, and appropriate infrastructure could have positive implications for economic growth. Additionally, the local businesses also have the potential to benefit financially as the client and its employees might also buy goods and services from them. The supply of electricity during the operation phase will contribute to economic development in the country.

Mitigation Measures

- The client will continue paying tax to the Mozambique government, including its employees. Additionally, local procurement of good and services should be employed by the client, where possible in line with their supply chain policy.

7.6.1.7 Community development

As per the CSR policy which was promulgated by the Mozambican government in 2014, the client will uplift project-affected communities through the implementation of sustainable and integrated community development initiatives. It is anticipated that the client will review community development initiatives which are on-going in the area (Sasol CPF) and consult with communities to identify and support necessary development gaps related to water supply, education, health and/or other identified needs. These development initiatives, especially if implemented in consultation with other community development role-players in the area, can contribute considerably towards education, health, socio-economic development, sustainable jobs and income stability within the project area.

Mitigation Measures

- Engage socio-economic development institutions and stakeholders in the area to gauge whether they can align or synergise with any of their efforts to collaborate in some of the development initiatives planned for the communities;
- The selection of project beneficiaries should be fair and directly affected parties should be given first preference; and
- A comprehensive community development plan will be development by the client (this will be in place before the construction phase commences).

Loss of employment

Although 70% of the locals and 30% of migrants (with a target to bring the expat figure below 10%) will be hired during the operational phase, the majority of the construction phase workforce will lose their jobs. Unfortunately, this will escalate various social consequences such as:

- Increased unemployment rate within the project area;
- Financial hardship and poverty;
- Family tensions and breakdown;
- Alienation, shame and stigma; and
- Crime.

Mitigation Measures

- Skills development programmes should be implemented to capacitate the locals with the skills necessary to secure other employment opportunities.

7.6.1.8 Sustained Gender based violence and sexual exploitation and abuse

Although the required workforce during the operational phase will be minimal, some gender-based violence and sexual exploitation may be experienced during the operational phase, if not successfully mitigated during the construction. The reasoning for this includes:

- After the construction phase, the construction workforce might decide to remain behind and reside closer to the CTT plant area in search for operational phase employment opportunities. During this period, they might continue to interact with locals within the area and engage in risky sexual behaviours *viz.,* unprotected sex and destructive behaviour *viz.,* alcohol abuse and domestic violence. The riskiest sexual and destructive behaviours may result in the formation of dysfunctional families; and
- During operation, the client will not construct a camp for the workforce considering that only 70 people will be employed. The workforce will decide where they want to reside, and most will likely reside in surrounding communities or Inhassoro town. Consequently, the interaction between the workforce and locals will not be controlled, resulting in people potentially engaging in risky sexual and destructive behaviour.

Mitigation Measures

- Women and youth should be empowered either by being employed to work on the project or be involved in the community development initiatives to minimise their financial vulnerability.

During the operational phase, many positive impacts can be realised with the implementation of the mitigation measures, and the significance of the negative impact of gender-based violence can be reduced to a low significance by implementing these measures.

Table 123: Social impacts associated with the operational phase

Indicator of potential impact	Pre-mitigation					Post mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Employment opportunities	4	4	2	4	+40	8	4	2	5	+70
Electricity supply (economic growth)	6	4	4	4	+56	6	4	4	5	+70
Community development	6	4	2	4	+48	8	4	2	4	+56
Loss of employment	8	5	2	5	75	6	5	2	4	52
Risk of sustained gender-based violence and sexual exploitation and abuse	8	4	2	5	70	4	1	2	3	21

7.6.1.9 Health Impacts associated with the proposed project

The Health Impact Assessment identified five (5) potentially affected communities (PAC) that may be influenced by the proposed project (Figure 145). These PACs are recognized as a “working model” that may evolve and change as the demographic structure in the communities change due to Project, and non-Project related influences, and thus the need for regular review and as required, adaptation.

The PACs considered for the Project are divided between construction and operations. Below are the PAC's for operations phase:

- Operations:
  - PAC1: Communities of Mangungumete, Maimelane and Litlau given their proximity to the current CPF and proposed Project and continued potential for cumulative impacts;
  - PAC2: Inhassoro due to indirect and cumulative impacts from the presence of the Project and it activities;
  - PAC3: The communities in the broader study area along the EN1 access route to Vilankulo;
  - PAC 4: The communities in the broader study area but not on the EN1 road; and
  - PAC5: Communities in the regional study area including those along the transport access road (EN1) and Vilankulo.

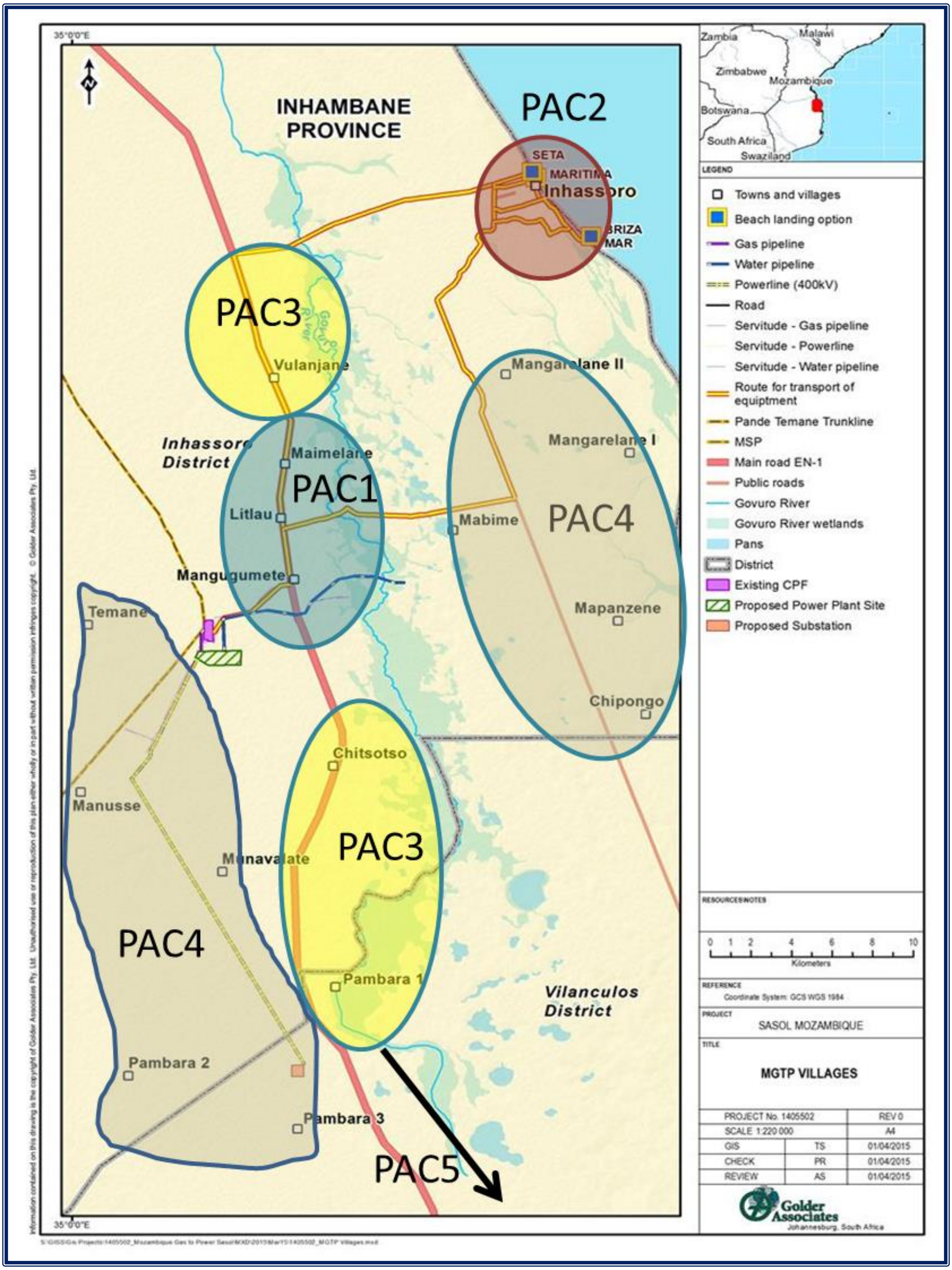


Figure 145: Potentially affected communities (PAC): operational phase

7.6.1.9.1 Communicable Diseases Linked to the Living Environment

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 124: Impact evaluation - Operations: EHA#1 Operations: Communicable disease linked to the living environment during the operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Communicable disease linked to the living environment in operations	8	4	2	2	**Low 28**	8	4	2	1	**Negligible 14**

7.6.1.9.2 Vector Related Diseases

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 125: Impact evaluation - Operations: EHA#2- Vector related diseases during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Vector related diseases in operations	6	4	2	3	**Low 36**	6	4	1	2	**Low 22**

7.6.1.9.3 Soil-, Water- and Waste-related Diseases

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 126: Impact evaluation - Operations: EHA#3- Soil, water and waste related diseases during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Soil, water and waste related diseases in operations	6	4	2	3	**Low 36**	6	4	1	2	**Low 22**

7.6.1.10 Sexually-transmitted Infections and High Risk Sexual Practices, including HIV/AIDS

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 127: Impact evaluation: Operations: EHA#4- Sexually-transmitted infections and high risk sexual practices, including HIV/AIDS during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Sexually-transmitted infections and high risk sexual practices in operations	10	4	3	4	**Mod 68**	8	4	3	2	**Low 30**

7.6.1.10.1 Food- and Nutrition-related Issues

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 128: Impact evaluation: Operations: EHA#5- Food and nutrition related issues during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Food and nutrition related issue in operations	8	3	2	3	**Low 39**	6	3	2	2	**Low 22**

7.6.1.10.2 Non-communicable Diseases (NCDs)

Same as that during the construction phase, however due to the larger impact on PAC's the significance can be determined as follows:

Table 129: Impact evaluation - Operations : EHA#6- Non-communicable disease during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Non-communicable diseases in operations	8	4	2	4	**Mod 56**	8	4	2	3	**Low 42**

7.6.1.10.3 Accidents and Injuries

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 130: Impact evaluation: Operations : EHA#7- Accidents and injuries during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Accidents and injuries in operations	10	4	3	4	**Mod 68**	10	4	3	2	**Low 34**

7.6.1.10.4 Veterinary Medicine and Zoonotic Diseases

Same as that during the construction phase, however due to the longer timeframe for the operational phase the significance can be determined as follows:

Table 131: Impact evaluation: Operations: EHA#8- Veterinary medicine and zoonotic diseases during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Veterinary medicine and zoonotic diseases in operations	10	4	2	2	Low 32	8	4	2	2	Low 28

7.6.1.10.5 Environmental Health Determinants – Hazardous Chemical Substances

Same as that during the construction phase, however due to the longer timeframe for the operational phase the significance can be determined as follows:

Table 132: Impact evaluation: Operations: EHA#9- Hazardous chemical substances during operations

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Environmental health determinant: hazardous chemical substances in construction, operations and decommissioning	8	3	2	4	**Mod 52**	8	3	2	2	**Low 26**

7.6.1.10.6 Social Determinants of Health

Same as that during the construction phase, however due to the longer timeframe for the operational phase the significance can be determined as follows:

Table 133: Impact evaluation: Operations: EHA#10- Local economic development and employment

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Local economic development and employment in construction and operations	Positive									
Social harmony, inequalities and Project expectations in construction and operations	8	3	2	4	**Mod 52**	Positive				

7.6.1.10.7 Cultural Health Issues and Health Seeking Behaviour

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 134: Impact evaluation: Operations: EHA#11- Cultural health issues and health seeking behaviour

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Cultural health issues and health seeking behaviour in construction and operations	6	3	2	3	**Low 33**	4	3	2	2	**Low 18**

7.6.1.10.8 Health Services, Infrastructure and Programmes

Same as that during the construction phase, however due to the smaller impact on PAC's the significance can be determined as follows:

Table 135: Impact evaluation: Operations: EHA#12- Health services, infrastructure and programmes during operation

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Health services, infrastructure and programmes in operations	6	3	2	4	**Low 44**	6	3	2	2	**Low 22**

7.6.1.11 Traffic impacts associated with the operational phase of the project

The impacts associated with traffic delays during the operational phase of the project is regarded as being **negligible** and therefore is not considered any further.

7.7 Socio-Economic and Cultural Environment

7.7.1 Decommissioning Phase

7.7.1.1 Change in Environmental Setting (Cultural)

There are no assets in close proximity to the proposed power plant site, and so no impacts from noise, air or visual disturbance are anticipated. There are also no impacts from a change in environmental setting anticipated at the burial and cemetery sites along the proposed electricity transmission line as a result of air emissions during decommissioning.

Cultural sites adjacent to the proposed transport route, are expected to experience noise, air and visual impacts as a result of decommissioning traffic. This will be limited to the decommissioning period and will only occur during delivery of equipment and materials. Potentially impacted sites comprise:

- Burials – BU-110 and BU-111 (high value);
- Cemeteries – CE-18, CE-19, CE-20, CE-21, CE-106 and CE-107 (high value);
- Churches – CH-102, CH-106, CH-107 and CH-108 (low - medium)
- Sacred Places – SF-01, F-02, ST-02, SP-01, SP-102 and SP-105 (high);
- Locations of Traditional Medical Practice (MP-101, MP-102 and MP-103).

In the worst-case (pre-mitigation), this could result in a moderate severity, short term, local, impact at high value sites (sacred places) (Table 135).

Mitigation

The CHMP should include plans to monitor changes to the environmental setting during the construction phase of those assets highlighted above. This may also include measures for the demarcation of sensitive areas (e.g. roadside sites) to prevent accidental damage via the laydown of materials etc. during construction and/or additional planting or screening to protect sites. The full requirements of the CHMP are summarised below. The CHMP should include:

- The preparation of a project-specific, 'site ready' Chance Find Procedure (CFP) to detail the requirements of the Mozambican Archaeological Heritage Protection Regulations (Decree 27/1994) which enforce the reporting of any archaeological assets to the local authority within 48 hours of discovery. The CFP will set out the course of action to be followed in the event that any cultural heritage artefacts are recovered. The CFP should be provided to all contractors and consultants on the project site during all construction activity and incorporated within the project's 'site induction' process. It will remain in place for the lifetime of the project;
- Demarcation of 'no go' sensitive areas e.g. sacred forests, sacred trees, sacred pools, medicinal bush, cemeteries (i.e. mitigation by avoidance). Although these sites may not be directly affected by construction activities there is a potential for disturbance of community access routes to cultural sites and to the environmental setting of the sites themselves;
- Enhancement or protection of environmental setting may be required and should be discussed in conjunction with local community e.g. through planting/screening;

- It may be necessary to demarcate of areas to be avoided (e.g. by noisy, dust-inductive) construction vehicles at certain times of the day/year so as to avoid disturbance of traditional ceremonial activities in close proximity of construction routes;
- Maintaining community access to sacred sites and facilitating respect for local intangible cultural heritage, tradition and taboo will ensure that the negative socio-cultural effects are effectively managed – regular platforms for community liaison are required in this regard. It is suggested that the presence of culturally significant places are highlighted to contractors at any early stage, e.g. during site induction; and
- Continued liaison between the Proponent and local cultural leaders to facilitate the identification of any cultural sites not yet shared by the community and potentially affected by the proposed project. The CHMP must set out plans for stakeholder identification and a programme for long term consultation in this regard.

Table 136: Change of environmental setting: Decommissioning phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Impact of change in environmental setting	6	2	2	4	**Low 40**	6	2	2	1	**Neg 10**

7.7.1.2 Visual Impacts associated with Decommissioning of the CTT and key infrastructure

The impacts associated with the decommissioning phase is expected to be similar to that of the construction phase, and therefore the same significance will apply. However, an additional impact that will occur:

- Airborne dust clouds similar to those during construction can be expected to be caused by demolition and rehabilitation-related earthworks activities and is expected to have a moderate level of visibility (2) within the study area;
- In terms of visual exposure, the majority of resident as well as transient receptors will be located more than two kilometres away from the demolition and rehabilitation activities on site and so this aspect is scored as being low (1); and
- Although the airborne dust clouds will be associated with a positive visual impact (i.e. progressive reinstatement of the pre-existing landscape aesthetic and character) the dust clouds themselves will still be as unsightly as during construction, and their visual intrusion is therefore rated as high (3).

7.7.1.3 Decommissioning, demolition and rehabilitation-related activity on site

- The decommissioning, demolition and rehabilitation activities will be somewhat similar in visual appearance as those that will have taken place during construction, however will largely take place I the reverse order. Accordingly, the level of visibility of the plant infrastructure will systematically decrease as it is progressively removed from site, and rehabilitation activities will commence thereafter. Nevertheless, this phase will be characterised by a large number of demolition machinery and vehicles as well as stockpiling of material and waste and the site is expected to be somewhat unsightly during this phase. This aspect was therefore rated as moderate (2);

- Similar to the construction sites themselves, the level of visual exposure of receptors to other demolition-related impacts is expected to increase to some extent during the decommissioning phase, due to increased traffic volumes and the increased activity footprint and was scored as moderate (2); and
- The level of visual intrusion of the power plant site during demolition works is again expected to be comparatively high, for similar reasons to those during construction. A conservative approach was therefore again adopted, and this criterion therefore rated as high (3).

7.7.1.4 Reinstatement of landscape visual character and sense of place after decommissioning (resultant impact)

- During the decommissioning phase the primary sources of visual impact will essentially be removed when the power plant and transmission lines are demolished, and the resultant footprint areas rehabilitated. It is therefore anticipated that the pre-existing visual character and sense of place can be largely reinstated, provided that effective rehabilitation is conducted.

Mitigation measures

- Water down any large bare areas associated with the construction and rehabilitation phases as frequently as is required to minimise airborne dust;
- Rehabilitate temporary bare areas as soon as feasible using appropriate vegetation species;
- Place a sufficiently deep layer of crushed rock or gravel over parking surfaces for vehicles and machinery;
- Apply chemical dust suppressants if wet dust suppression is insufficient; and
- Implement a dust bucket fallout monitoring system.

With the implementation of the mitigation measures as outlined above the impact significance can be reduced to a Low.

Table 137: Visual impacts - Decommissioning phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Airborne dust clouds and dust pollution during decommissioning activities	6	2	2	5	**50**	4	2	2	5	**40**
Decommissioning, demolition and rehabilitation-related activity on site	6	2	2	5	**50**	4	2	2	5	**40**

7.7.1.5 Loss of employment

During the decommissioning phase, operation phase workforce will lose their jobs. Unfortunately, this will escalate various social consequences such as:

- Increased unemployment rate within the project area;
- Financial hardship and poverty;
- Family tensions and breakdown;
- Alienation, shame and stigma; and
- Crime.

Mitigation Measures

- Timely and adequate consultation with employees who are dependent on the power plant for employment;
- Assisting employees in seeking alternative employment at other power plants or related facilities; and
- Training and education of employees to equip them with skills that could benefit them in other industries.

7.7.1.6 Reduced economic development

The electricity supply from the CTT will stop. There will be reduced local spending by the client and its employees, including tax payments. Consequently, local businesses and the country may be affected from a financial perspective.

Mitigation Measures

- Engage local and regional government with respect to the decommissioning phase.

7.7.1.7 Reduced community development

- All community development initiatives will be handed over to relevant parties by the client; thereafter, there will be a reduction in local community development investment from the client.

Mitigation Measures

- The client should develop exit strategies for all its community development initiatives.

7.7.1.8 Risk to family abandonment

Due to the loss of employment, it is anticipated that some women and children may be abandoned during this phase when migrant workers move on, leaving behind single and vulnerable female heads of households.

Mitigation Measures

- Local women and youth should be empowered either by being employed to work on the project or be involved in the community development initiatives to minimise their financial vulnerability.

While mitigation measures have been determined for the various social impacts associated with the decommissioning phase of the project, majority of the impacts will still have a moderate significance rating.

Table 138: Social impacts associated with the decommissioning phase

Indicator of potential impact	Pre-mitigation					Post mitigation				
	Severity	Duration	Extent	Probability	Significance	Severity	Duration	Extent	Probability	Significance
Loss of employment	8	5	2	5	75	6	5	2	4	52
Reduced economic development	6	5	2	5	65	4	5	2	5	55
Risk to family abandonment	8	5	2	4	60	4	5	2	4	44
Loss of employment	8	5	2	5	75	6	5	2	4	52

7.7.1.9 Health Impacts associated with the proposed project

The impact anticipated health impacts during the decommissioning phase will be similar to that predicted for the construction phase and therefore will have a similar significance rating.

7.7.1.10 Traffic impacts associated with the Decommissioning phase of the project

7.7.1.11 Impact on Existing Traffic in terms of Delay

In terms of the high-level impact of the decommissioning phase on the existing traffic in terms of delays experienced, it will similar to that of the construction phase, except there will be no abnormal vehicle trips. The significance rating given below (Table 139) has taken into consideration the mitigation measures stipulated below.

Table 139: Delay due to Decommissioning Phase Traffic

Route Type	Route Option	Impact of Construction Vehicles Trips on Existing Traffic (Delays)
Main Roads	Vehicles along EN-1	Low

Construction vehicle traffic impacts

If is estimated that the frequency of decommissioning vehicle trips to the site will peak between month 15 to 19 but will start slowly and will decrease toward the end of the decommissioning period. The impact of the vehicles will be more visible toward the access from the EN1 to the CTT access road and is discussed below and evaluated in Table 140:

- **Adequate turning lane lengths** are required to ensure enough queueing space for turning vehicles in order to prevent conflict with fast moving through traffic (assumed to have been implemented during construction phase);

- **Generation of dust** will be higher on routes that do not have a protective blacktop layer or that are not protected with a dust prevention layer or dust prevention treatment. For vehicles generation of dust will also be form the sand/materials that are transported;
- **Risk of vehicle collision** will be higher on roads with more background traffic and less on dirt road and tracks. However, the probability of a collision will be higher where fast travelling vehicles needs to pass slow moving construction vehicles;
- **Risk of pedestrian accidents** is lower in areas of less traffic movement. However, the risk increases significantly in areas that allow heavy vehicle traffic through residential areas, which should normally be shielded from frequent heavy vehicle traffic; and
- **Degradation of roads** increases significantly with an increase in vehicle load and is dependent on the type of pavement structure.

Table 140: Decommissioning Vehicle Traffic Impact

Route Option	Turning Lane Lengths	Generation of dust	Risk of vehicle collision	Risk of pedestrian accidents	Degradation of Public Roads
Decommissioning Vehicles on EN1 & CTT Access Road	Low, only inadequate in certain identified areas	Moderate	Moderate	Moderate	Moderate

Mitigation Measures

- EN1 / CTT Access northern approach: add minimum 30 m right turning lane with a 45 m taper to allow for safe queueing. EN1/CTT Access northern approach: add minimum 30 m left turning lane with 45 m taper (assumed to have been implemented during construction phase);
- Cover materials with tarpaulins where possible alternatively wet sand and/or provide other means of protection. Treatment of dirt/sand roads near communities would be advisable;
- Indicate areas where heavy vehicles will be expected with adequate signage;
- Clearly indicate pedestrian crossings;
- Educate drivers on potential areas of high pedestrian and cyclist activity;
- Educate community on dangers of construction vehicles new to their area; and
- Upgrade roads and maintain where necessary. The deterioration over time must be monitored and a maintenance plan must be negotiated with the ANE (National Road Administration) with specific mention of the Monitoring and Planning departments that should be consulted (assumed to have been implemented during construction phase).

8.0 UNPLANNED EVENTS

8.1 Background

In the context of the CTT project, there are certain ‘unplanned’ events that have the potential for highly significant environmental and social impact.

The above events have been assessed in a detailed risk assessment based on incidents that could result in undesirable consequences of fires and explosions resulting from hazardous chemical losses of containment. The scope included a risk assessment of the technology options under consideration (gas turbines and gas engines) located at the CTT gas power plant site. The scope of study considered the construction and operating phases only. On decommissioning the facility will be deinventorised/drained of all hazardous components as part of the decommissioning and closure plan and will cease to be a hazard to the public, as viewed from the QRA perspective.

The QRA process followed in this report is summarised with the following steps:

1) Identification of components that are flammable, toxic, reactive or corrosive and that have potential to result in a major incident from fires, explosions or toxic releases;

2) Development of accidental loss of containment (LOC) scenarios[1] for equipment containing hazardous components (including release rate, location and orientation of release);

3) For each incident developed in step 2, determination of consequences (such as thermal radiation, domino effects, toxic-cloud formation and so forth);

4) For scenarios with off-site consequences (greater than 1% fatality off-site), calculation of maximum individual risk (MIR), considering all generic failure rates, initiating events (such as ignition), meteorological conditions and lethality;

5) Using the population density near the facility, determination of societal risk posed by the facility (if required); and

6) Based on the outcomes of the first five steps an environmental impact assessment was conducted to access the environmental significance of the impacts identified.

In this section, the findings of this study are summarised, as a basis for a general assessment of the potential significance of fires and explosions resulting from hazardous chemical losses of containment, taking into consideration the sensitivity of any surrounding receptors.

The assessment of the impact of unplanned events includes ‘probability’ as an important element of impact significance. Recognised risk assessment methodologies assess the impact of unplanned events as a combination of probability and consequence.

8.2 Risk Associated with CTT plant on Surrounding Receptors

Continuous release of Flammable Gas

The continuous loss of containment of a flammable gas could result in consequences such as Jet Fire, explosion, or flash fire. Combustible and flammable gases such as natural gas, may within their flammable limits ignite and burn if exposed to an ignition source of sufficient energy. On process plants releases with ignition normally occur as a result of a leakage or spillage. Key operating parameters that will affect the impacts of a release of natural gas from pipelines include:

- The nature of the release (continuous or instantaneous), pipeline ruptures and leaks occur over time and are modelled as continuous releases;
- The location of the release;
- The orientation of the release, (vertical release for underground pipes and horizontal for aboveground pipes);
- The operating temperature and pressure of the gas; and

- The size of the release. The ignition frequency is determined by the size of release, continuous releases of the order of 10 kg/s and below are at the lower end of the process flowrates considered for a continuous release.

Various leak scenarios were simulated but were found to have fairly small consequences, typically less than 10 m, which did not satisfy the limits for inclusion in the QRA (1% fatality did not extend beyond the plant boundary).

Jet Fires

Combustible and flammable components within their flammable limits may ignite and burn if exposed to an ignition source of sufficient energy. Jet fires occur when a flammable a component is released with a high exit velocity ignites. The underground pipeline from the CPF to the CTT plant was simulated for Jet Fires and simulations of vertical jet fires indicate that for similar release conditions a vertical jet fire will have reduced effects compared with a horizontal.

The 10 kW/m^2 thermal radiation isopleths, representing the 1% fatality under high wind speed conditions has been used to compare the two different flow scenarios for the two the two technologies as shown in Figure 146 and they illustrate relatively similar footprints. The larger circles represent the cumulative consequences from all wind directions, whilst the smaller ones represent the consequence from a northerly wind condition.

While fatalities could be expected to occur within the1% fatality isopleth, the surrounding area is naturally vegetated bush or sparsely populated reducing the probability of fatalities.

LEGEND **SCENARIOS (1% Fatality, 10 kW/m^2)**

CCGT, Alternative 1 (200 mm, pipeline rupture)
OCGE Alternative 1 (200 mm, pipeline rupture)

Figure 146: 10 kW/m^2 Thermal radiation isopleths for releases from the CPF/CTT u/g pipeline scenarios

Various jet fires scenarios resulting from full bore ruptures of aboveground process pipes (horizontal release) were simulated at various points in the fuel supplies to the turbines/engines at the CTT itself was also simulated. The incoming feed line to the plant (high pressure) presents the largest effect zone in both cases extending slightly more than 100 m beyond the site boundary. The potential is created for fatalities that extend beyond the site boundaries and must be carried over to the risk assessment. Impingement of the flash fires onto the surface may also result in bush fires (domino effect).

Flash Fires

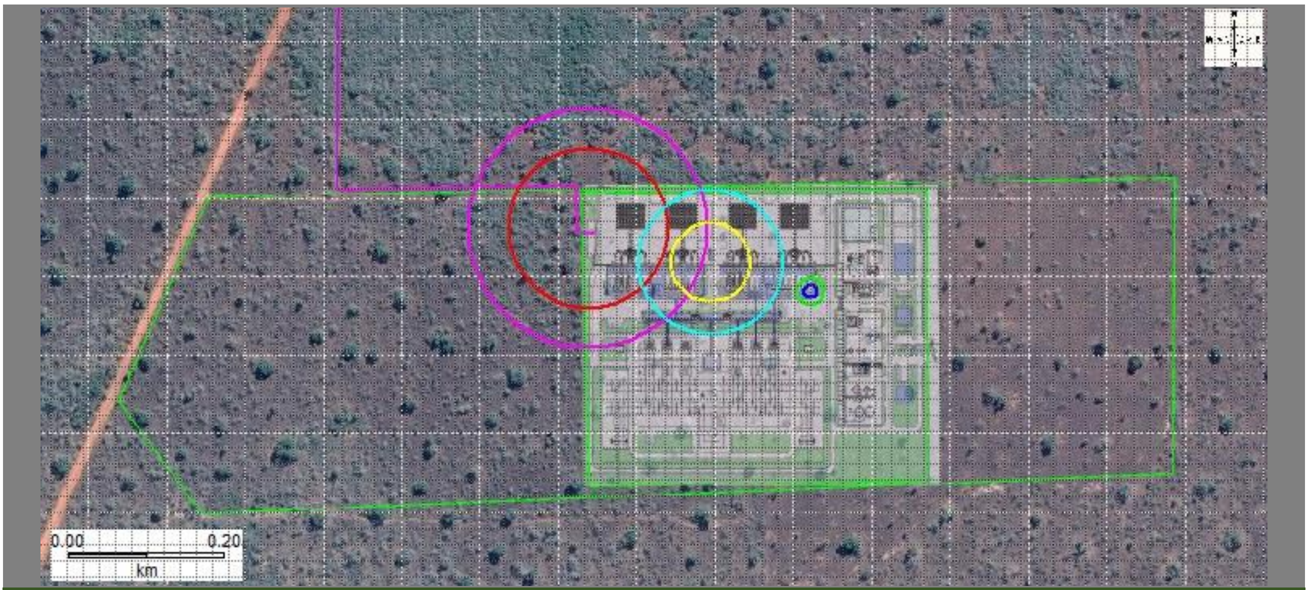
A loss of containment of a flammable component may mix with air, forming a flammable mixture. The flammable cloud would be defined by the lower flammable limit (LFL) and the upper flammable limit (UFL). An ignition within a flammable cloud can result in an explosion if the front is propagated by pressure. If the front is propagated by heat, then the fire moves across the flammable cloud at the flame velocity and is called a flash fire. Flash fires are characterised by low overpressure, and injuries are caused by thermal radiation.

No significant flash fires where generated at the receiver height of 1m above the ground for the underground Gas pipeline from the CPF to the CTT power plant.

Flash-fire scenarios were developed based on the scenarios developed for the jet fires for worst case high wind speed conditions (9 m-.s). Flash fire envelopes for all wind directions for both the LFL (lower flammable limit) and the ½ LFL concentration levels are presented for the two technology options Figure 147 (Gas Turbines) and Figure 148 (Gas Engines). The effects demonstrated by the two technology options are fairly similar. Potential offsite impacts for the LFL (flammable cloud) at the gas metering and reduction station require further investigation in the risk assessment.

LEGEND	SCENARIO (lash Fires)
Red	Metering and Pressure Reduction Station (LFL)
Yellow	Header feed to plant (LFL)
Blue	Individual Turbine Feed (LFL)
Magenta	Metering and Pressure Reduction Station (½ LFL)
Cyan	Header feed to plant (½ LFL)
Green	Individual Turbine Feed (½ LFL)

Figure 147: Flash fire limits due to a release of natural gas (Gas Turbines)



LEGEND **SCENARIO (Flash Fires)**

Metering and Pressure Reduction Station (LFL)
Header feed to plant (LFL)
Individual Turbine Feed (LFL)
Metering and Pressure Reduction Station (½ LFL)
Header feed to plant (½ LFL)
Individual Turbine Feed (½ LFL)

Figure 148: Flash fire limits due to a release of natural gas (Gas Engines)

Explosions

The concentration of a flammable component would decrease from the point of release to below the lower explosive limits (LEL), at which concentration the component can no longer ignite. The sudden detonation of an explosive mass would cause overpressures that could result in injury or damage to property. The release natural gas into the atmosphere could result in formation of a flash fire, as described above, or a vapour cloud explosion (VCE). In the case of a VCE, an ignited vapour cloud between the higher explosive limits (HEL) and the lower explosive limit (LEL) could form a fireball with overpressures that could result in injury or damage to property.

For the underground gas pipeline from the CPF to the CTT plant no VCE are expected. For the CTT plant itself, A loss of containment of natural gas with an ignition source could form a VCE. Figure 149 and Figure 150 indicate the blast overpressures of 0.1 bar from the release of flammable vapours from loss of containment scenarios under worst meteorological conditions. In each scenario, the vapours drifted to an ignition point before detonating. This is referred to as a *late explosion*. The 1% fatality does extend over the northern site boundary based on a release at the metering and pressure reduction station. Further analysis would be required. While fatalities could occur beyond the site boundaries, the surrounding area is largely undeveloped scrubby bush reducing the probability of fatalities.

LEGEND	SCENARIO
Red line	Metering and Pressure Reduction Station
Yellow line	Header feed to plant
Blue line	Individual Turbine Feed

Figure 149: 0.1 bar overpressures from VCEs due to flammable natural gas releases (Gas Turbines)

LEGEND	SCENARIO
Red line	Metering and Pressure Reduction Station
Yellow line	Header feed to plant
Blue line	Individual Engine Feed

Figure 150: 0.1 bar overpressures from VCEs from flammable natural gas release (Gas Engines)

Mitigation

Based on the simulations performed, the areas of highest risk for both power technology alternatives have been identified as the release of Natural Gas at the metering and pressure reduction station. Mitigation that may be considered to further reduce these risks are listed below:

- Ensuring that guidelines or equivalent international recognised codes of good design and practice are incorporated into the final designs can significantly reduce the incidence of both on and off-site safety impacts;
- A structured process hazard analysis (HAZOP, FMEA, etc.) should be completed for the proposed facility prior to construction to ensure that omissions in the process design are eliminated, operational hazards have been identified and effective mitigation has been put in place;
- Installation in a dedicated piping lane with carefully considered servitudes;
- Increasing the piping specification to one that is appropriate for underground specification; and
- Increasing the depth of pipeline soil cover.

Therefore, taking the above impacts into consideration with the stipulated mitigation measures the impacts have been rated as having a Low significance during operations phase (Table 141). Small quantities of hazardous materials such as diesel, gasoline, workshop gases, lubricants and paints and solvents will be stored on site during construction and decommissioning. The potential for impacts during these two phases to the public are likely to be negligible.

Table 141: Risk Assessment of the CTT plant on surrounding receptors: Impact Assessment - operational phase

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Magnitude	Duration	Geographic Extent	Probability	Significance	Magnitude	Duration	Geographic Extent	Probability	Significance
Impact of a loss of containment of natural gas during commissioning leading to dispersion, ignition and flash fire or explosive effects	8	1	2	1	**Negligible 11**	6	2	2	1	**Negligible 8**
Impact of an Explosion in a building. Failure to implement adequate engineering controls to prevent a confined space explosion	8	1	2	1	**Negligible 11**	6	2	2	1	**Negligible 8**
Impact of jet fires full bore rupture of incoming natural gas line with flammable vapour dispersion, ignition and flash fire or explosive effects	8	1	2	1	**Negligible 11**	6	2	2	1	**Negligible 8**

9.0 CUMULATIVE IMPACT ASSESSMENT

9.1 Introduction

This chapter addresses potential cumulative impacts that the construction and operation of the Central Térmica de Temane (CTT) Project (the Project) and other existing or planned developments could have on identified valued environmental and social components (VECs) in the regional cumulative impact assessment study area.

> *Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity, when added to other existing, planned, and/or reasonably anticipated future ones.*
>
> IFC (2013)

Multiple and successive environmental and social impacts from existing developments, combined with the potential incremental impacts resulting from proposed and/or anticipated future developments, may result in significant cumulative impacts that would not be expected in the case of a stand-alone development (IFC, 2013). Cumulative impacts may result in either:

- **An additive impact:** where it adds to the impact which is caused by other similar impacts; or
- **An interactive impact:** where a cumulative impact is caused by different impacts that combine to form a new kind of impact. Interactive impacts may be either:
  - countervailing (the net adverse cumulative impact is less than the sum of the individual impacts), or
  - synergistic (the net adverse cumulative impact is greater than the sum of the individual impacts).

The Cumulative Impact Assessment (CIA) process involves (a) the analysis of the potential impacts and risks of the Project in the context of the potential effects of other human activities and natural environmental and social external drivers on the chosen VECs over time, and (b) proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible (IFC, 2013).

This chapter presents a summary of the methodology used to prepare the CIA for the Project (Section 9.2), and the outcomes of the process (Section 9.3 – Section 9.6). The mitigation measures for the management of Cumulative Impacts within the CIA Study Area are provided in Section 9.7.

9.2 Approach and Methodology

A VEC-centred approach has been used for the CIA, conducted in the context of the CTT Project and other existing and future planned projects. The *Good Practice Handbook – Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets* (IFC, 2013) is the guideline and direct reference used for the completion of this study. Figure 151 defines the steps used in the determination, assessment and management of cumulative impacts in the current study.

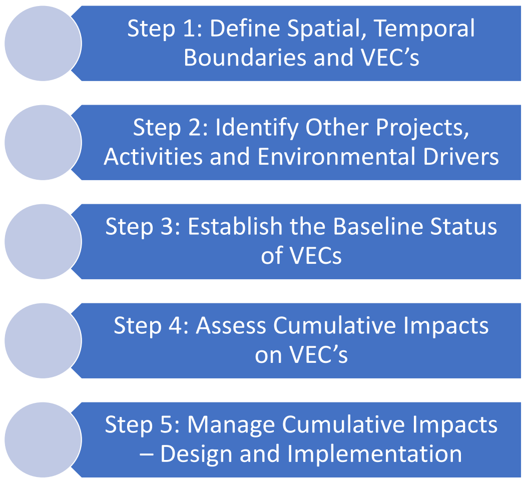


Figure 151: Steps in the Cumulative Impact Assessment Process

The approach deviates slightly from the steps outlined in the IFC guidance in that no attempt to quantify ecological, social and/or physical cumulative impact thresholds was made, in order to determine the *significance* of predicted cumulative impacts. Instead, this assessment identifies expected probable cumulative impacts that warrant additional mitigation and/or monitoring beyond that identified in the ESIA (such cumulative impacts are to be treated as 'significant' (IFC, 2013)) and proceeds directly to the provision of management measures that the Proponent can implement to strengthen mitigation and monitoring programs across their operations in order to consolidate their approach to environmental and social management on a regional basis.

9.2.1 Step 1: Define Spatial and Temporal Boundaries, and VECs

9.2.1.1 Spatial Boundaries

The spatial boundary for the CIA ('the CIA Study Area') was broadly defined as a combination of the Areas of Direct Influence (ADI) and Areas of Indirect Influence (AII) used in the main Environmental and Social Impact Assessment, and the Critical Habitat Areas of Analysis (ref. Chapter 6.2.4 Biological Environment), i.e. the predicted Project Area of Influence.

As required by Performance Standard 1 (IFC, 2012) the Project Area of Influence (the CIA Study Area) for cumulative impact assessment encompasses the following components:

vi) The primary project site(s) and related facilities that the client (including its contractors) develops or controls: *i.e.* the CTT site, and all associated infrastructure including the 25 km electricity transmission corridors, 2 km gas pipeline and servitude, access roads, construction camp and laydown areas, beach landing facility (temporary jetty and laydown area) and transhipment and barging and activities;

vii) Associated facilities that are not funded as part of the project (funding may be provided separately by the client or by third parties including the government), and whose viability and existence depend exclusively on the project and whose goods or services are essential for the successful operation of the project: i.e. the previously-authorised substation at Vilanculos and associated 400kV overhead transmission line as part of the Mozambique Regional Transmission Project – CESUL Transmission Project (*Projecto de Interligação da Rede Nacional de Energia Centro-Sul*) (MICOA Ref: 75/MICOA/12 of 22nd May 2012) is included on this basis;

viii) Areas potentially impacted by cumulative impacts from further planned development of the project, any existing project or condition, and other project-related developments that are realistically defined at the time the Social and Environmental Assessment is undertaken (see Table 144); and

ix) Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location: i.e. in-migration of opportunity seekers to the CIA Study Area.

9.2.1.2 Temporal Boundaries

The temporal boundary for the CIA was aligned with the time periods set for the complete lifecycle of the Project i.e. the construction, operation and decommissioning phases, as these are the time periods within which the Project could contribute to cumulative impacts in combination with other projects or activities.

9.2.1.3 VECs

In keeping with the IFC (2013) guidelines, the assessment of cumulative impacts identifies the degree to which the Project is affecting Valued Environmental and Social Components (VECs). The approach is VEC-centred, as opposed to project-centred, and focuses on the impact or stresses that multiple projects or developments may have on the future overall health or status of the VEC. Indicators were therefore chosen to reflect the resulting (future) condition of the VEC.

VECs within the CIA study area were initially identified in the Scope Definition Report and Terms of Reference for the Project (Golder Associates, 2015). These were refined based on the outcomes of the baseline studies, and with reference to the advice provided by the World Bank advisory team for the Project.

Within the CIA Study Area (Table 142), the resources and receptors (VECs) that may endure cumulative impacts as a result of the Project in combination with other existing, planned, and/or reasonably anticipated future projects and activities, include those occurring:

- Within Bazaruto Bay, extending north to the mouth of the Save River;

- Within the Govuro River floodplain;
- Along the powerline corridor, gas pipeline route, and upgraded roads in Inhassoro District; and
- Within Bazaruto Archipelago National Park.

9.2.2 Step 2: Identification of other Projects, Activities and Environmental Drivers

9.2.2.1 Identification of other relevant Projects/Activities with potential to generate cumulative impacts

Existing, planned, and/or reasonably anticipated future projects and activities ('developments') that have the potential to influence the current environmental baseline within the CIA Study Area were identified via a review of existing, proposed and/or permitted development applications submitted to MITADER, and other known developments that have not yet entered the planning process (ERM, 2017; Golder, 2017). All known existing/planned projects/activities, were mapped and described.

9.2.2.2 Identification of Environmental and Social Drivers with potential to generate cumulative impacts

Environmental and social drivers with potential to generate cumulative impacts (e.g. climate change, in-migration) were identified in the respective Physical, Biological and Social Environment baseline studies done for the Project ESIA (Chapter 6.0).

9.2.3 Step 3: Establish Baseline Status of VECs

The baseline status of VECs is established in the various relevant Physical, Biological and Social Environment chapters of the Project ESIA (ref. Chapter 6.0).

9.2.4 Step 4: Assess Cumulative Impacts on VECs

The CIA was based on the sensitive receptors/VECs identified during scoping phase of the EIA process; together with the outcomes of the stakeholder engagement process, and the Environmental and Social Impact Assessment undertaken for the Project.

The CIA is future-oriented. Therefore, as recommended by IFC (2013), cumulative impacts were assessed as the difference between the estimated future baseline condition of VECs in the context of the stresses imposed by all other sources (existing/proposed developments/activities within the CIA Study Area and natural environmental drivers); and the estimated VEC condition in the context of the <u>future baseline *plus* the Project</u>.

For this assessment, the expected potential environmental and social impacts and risks identified in Step 2 were initially assessed in the context of the predicted future baseline condition of the VECs, and subsequently in the context of any additional effects of the Project.

9.2.5 Step 5: Management of Cumulative Impacts – Design & Implementation

For *overall* significant cumulative impacts on VECs, management strategies to address these, consisting of collaborative/coordinated or adaptive management programmes must be proposed.

Therefore, the focus of this CIA was on mitigation actions that the Project can take to avoid contributing to the overall cumulative impacts on the future baseline of the identified VECs, building on those mitigation measures already implemented via the Project ESIA's mitigation hierarchy.

9.3 Defined VECS, Spatial and Temporal Boundaries

9.3.1 VECs

The VECs and associated indicators identified for the CIA, based on the outcomes of the Scope Definition and Terms of Reference Report (Golder Associates, 2015) and this ESIA, are outlined in Table 142.

Table 142: VECs for CIA

VEC Category	VEC	Indicators

Natural Habitats	Primary dunes and sandy beaches	▪ Regional representativeness (extent); and
		▪ Ecological integrity:
		  ▪ Ecosystem composition; and
		  ▪ Ecosystem configuration.

	Seagrass beds	
	Natural woodland/forest habitat	
Critical Habitat	Bazaruto Archipelago National Park/Important Bird Area	
	Govuro Floodplain Critical Habitat	
Species of Concern (marine)	Beach-nesting turtles	▪ Habitat quantity and quality; ▪ Habitat connectivity; ▪ Abundance and distribution; and ▪ Survival and reproduction.
	Dugong	
	Indian Ocean Humpback Dolphin	
	Endemic gastropods	
	Migratory bird species associated with Bazaruto Archipelago IBA	
Species of Concern (terrestrial fauna)	White-backed Vulture	
	Hooded Vulture	
	White-headed Vulture	
Social	Human Environment	Economy
		Community Health, Safety and Security
		Land and Resource Use
		Cultural Heritage
		Sense of Place
Physical	Physical Environment	Water quantity
		Water quality

9.3.2 Spatial Boundaries

The spatial boundaries for the CIA (the CIA Study Area) are illustrated on Figure 152. They include the Biophysical and Socio-Cultural Areas of Direct Influence (ADI) used in the main Environmental and Social Impact Assessment, and the Critical Habitat Areas of Analysis (Marine and Terrestrial). These incorporate the following areas that interact with the Project components, activities and induced effects:

- In the North: including Inhassoro and Govuro Districts, as far as the Save River;

- In the South: extending to the Districts of Vilanculos and Funhalouro;
- In the East: extending across Bazaruto Bay and northwards to the mouth of the Save River, and including Bazaruto Archipelago National Park/Important Bird Area; and
- In the West: extending to the Districts of Massinga and Mabote.

9.3.3 Temporal Boundaries

The temporal boundaries for the assessment were defined based on the timing and duration of Project activities and the nature of the interaction with the selected VECs (although it is recognised that the expected time frame of some of the potential Project impacts may extend beyond these temporal boundaries (i.e. the effects associated with population influx/in-migration)). The temporal boundaries were aligned with the defined phases of the Project, set conservatively at:

Table 143: Temporal boundaries for CIA

Timeframes	Gas Engine	Gas Turbine
Construction and commissioning period	18 months	24 months+
Operation	25 years (although plants are often re-furbished and life extended)	
Decommissioning	18 months	24 months+

The temporal extent of impacts from other past, present, and predictable future developments is considered within the same timeframe.

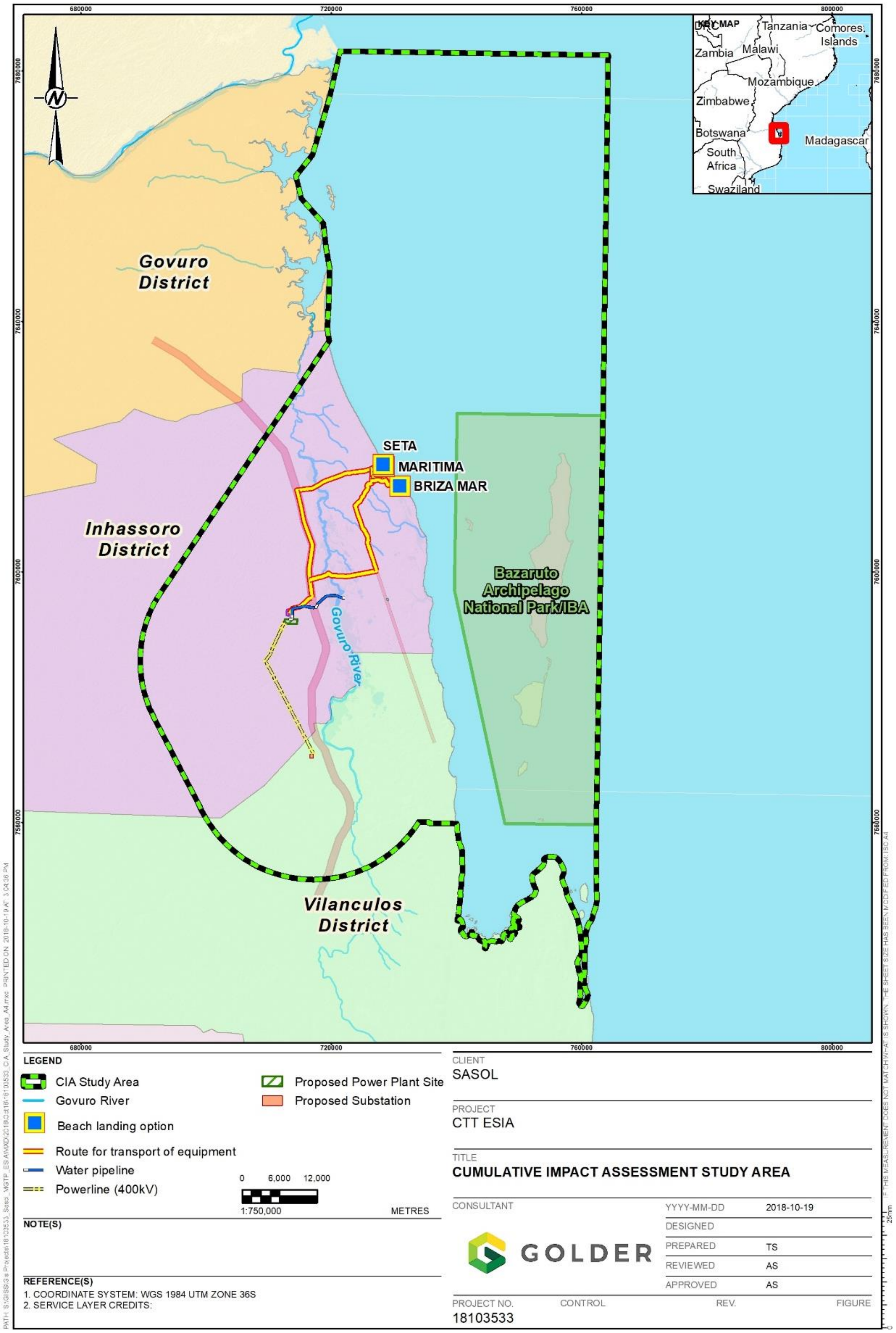


Figure 152: Cumulative Impact Assessment Study Area

9.4 Other Identified Projects, Activities and Environmental Drivers

9.4.1 Other Projects and Activities

A summary of the existing, planned, and/or reasonably anticipated future projects and activities that have the potential to influence the future environmental baseline within the CIA Study Area, and result in cumulative impacts on identified VECs, as a result of spatial and/or temporal crossover, are shown on Figure 153 set out in Table 144 overleaf.

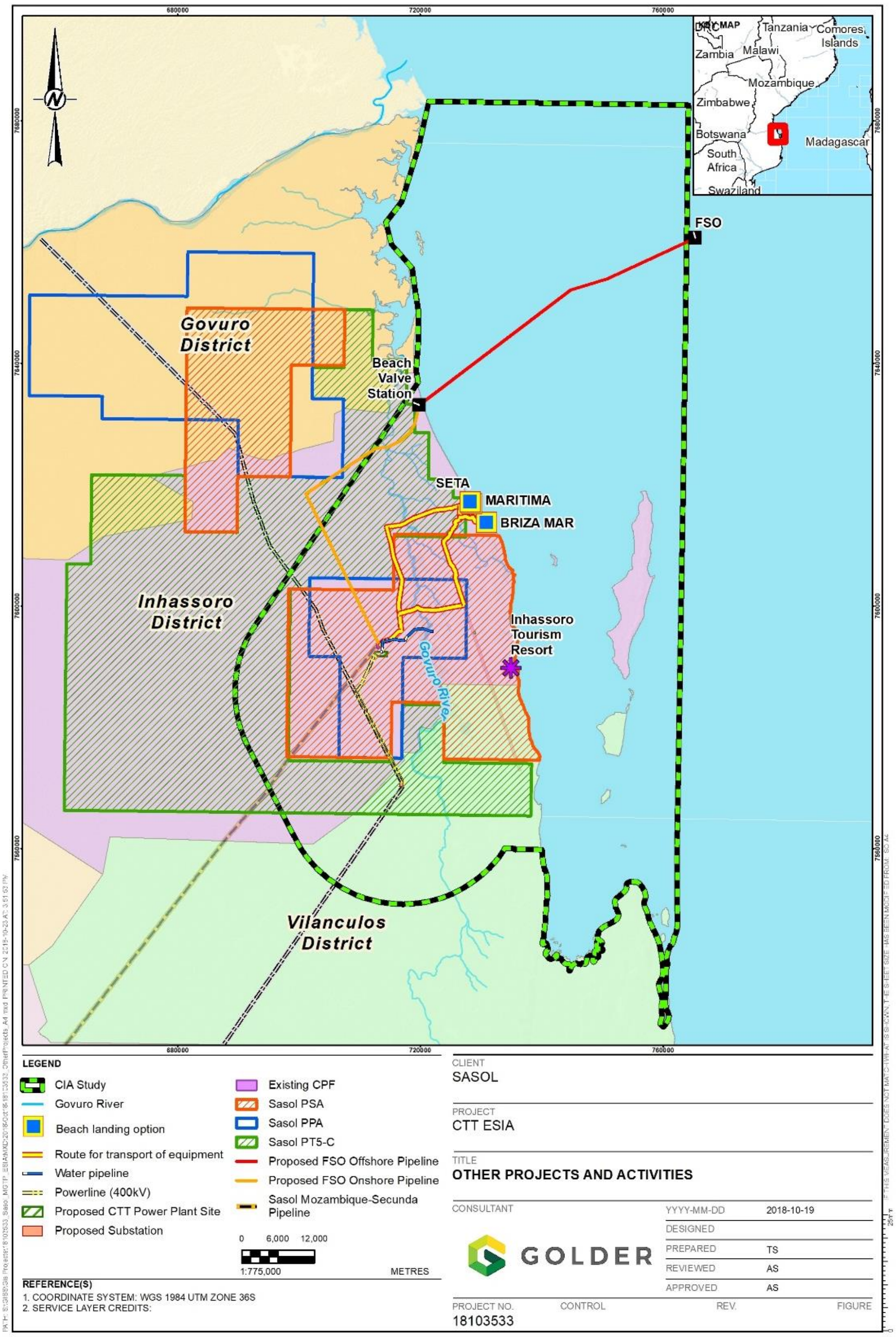


Figure 153: Known existing and proposed projects and activities in the CIA Study Area

Table 144: Other projects and activities in the Project Area of Influence

Project/Activity	Brief Description	Status or Likelihood	Proximity to the Project	Temporal Boundaries
CESUL Project – 400 kV Transmission Line and Vilanculos Substation (now called Temane Transmission Project, TTP)	Environmental authorisation for this 400kV transmission line and substation was obtained under the STE/CESUL project. (MICOA Ref: 75/MICOA/12 of 22nd May 2012). The key elements of the Project are: ■ New high voltage overhead transmission line (800 kV) between a new substation in Tete Province to the Maputo substation; ■ New high voltage overhead transmission line of (400 kV) between Songo or a new substation near Cataxa in Tete Province and Maputo substation; ■ The expansion of existing substations in Maputo, Matambo and possibly Songo; and The construction up to five new substations at places to be identified along the 400 kV line route	Authorised in 2012, currently lapsed and being re-submitted	STE/CESUL Transmission line adjacent to the CTT transmission line with substation 25 km from CTT plant	Permanent (construction likely in 2020)
Sasol PSA Development and LPG Project	The Production Sharing Agreement (PSA) development is an integrated oil, Liquefied Petroleum Gas (LPG) and gas project, involving the development of the Temane G8, Temane East, Inhassoro G6, Pande and Inhassoro G10 reservoirs.	Authorised, activities underway	Overlaps with the CIA study area. Within 0-20 km of the CTT Project.	Estimated 2018 to 2028
Sasol Pipeline and Floating, Storage and Offloading (FSO) Project	The proposed transport and export of stabilised crude oil from the new Liquids Processing Facility (LPF) in Temane to offshore Mozambican waters via an export pipeline to an offshore Floating, Storage and Offloading unit.	Awaiting authorisation by MITADER	The pipeline to the proposed FSO is located in the northern extent of Bazaruto bay, within the CIA study area.	Construction is planned to start in the third quarter of 2019, and is expected to be ready for operation in the third quarter of 2021

Project/Activity	Brief Description	Status or Likelihood	Proximity to the Project	Temporal Boundaries
Expansion of onshore exploration activities by Sasol	Sasol plans further exploration activities involving seismic surveys and drilling of wells over the next 10 years in its two existing licence areas (PSA and PPA) and in a third licence area (PT5-C), which is currently under negotiation with the Government of Mozambique. The total planned exploration area covers approximately 566 543 ha (Golder, 2017).	Awaiting authorisation by MITADER	The PTC-5 licence area overlaps with the CIA study area for this Project. The location of seismic activities and new wells in the PPA, PSA, and PT5-C is still to be determined.	2018 to 2028
Establishment of an industrial park near the Temane CPF	Sasol also plans to establish an “Industrial Park” (IP), which will consist of up to 70 ha of serviced plots and facilities, between the CPF and Mangungumete to accommodate its light industrial suppliers. In the medium and long term, if there is a demand for growth of this facility by industries that are not directly related to servicing the CPF, Sasol may negotiate a handover of responsibility for management of the whole IP to Government (Golder, 2017).	Awaiting authorisation by MITADER	Within 5 km of the CTT Project	Permanent
Potential offshore sub-sea cable	A few proposed subsea cables will be located along the east coast of Mozambique[17], which cross the marine extent of the CIA study area. Installation of the cables may increase marine traffic activities in the same vicinity.	In the planning stage	Overlaps with the CIA study area.	Permanent

[17] http://www.submarinecablemap.com/

Project/Activity	Brief Description	Status or Likelihood	Proximity to the Project	Temporal Boundaries
Increased marine traffic	Marine traffic through the Mozambique Channel and traversing the Project Area is expected to increase over time as the Port of Beira becomes a larger hub for cargo delivery and serves as a base for supplying industrial projects in the region. All such vessels will be subject to the international maritime and Mozambique's legal requirements for territorial waters.	Likely	Overlaps with the CIA study area.	Unknown
Inhassoro Tourism Resort Preliminary Master Plan/ Mozambique Tourism Anchor Investment program	The Mozambique Tourism Anchor Investment Program is a pilot Investment Generation program implemented by the World Bank Group's Investment Climate Services through IFC. The program responded to a request from the Tourism Ministry to assist the government of Mozambique in the development and implementation of a framework for tourism investment facilitation in the country. The proposed Inhassoro anchor site is 2,750 ha and was designated as a Tourism Anchor Zone by the Government of Mozambique. It has a 6 km seafront, is close to Bazaruto Islands and easily accessible through Vilanculos International Airport. The Resort includes a Golf and Sea Resort (including two 18-hole golf championship courses), an Eco-Resort, and Local Communities.	Likely	Overlaps with the CIA study area.	Unknown

9.4.2 Other Environmental and Social Drivers

9.4.2.1 Climate Change

Historic climate data trends for Mozambique (1961-2010) show that average temperatures have increased 1.5–2°C, and that southern Mozambique has experienced more persistent droughts, while coastal regions have experienced more episodic floods (USAID, 2018). Future projections indicate an average temperature increase of 1°C in the next 20 years, with more marked increases in southern and coastal areas, as well as increase in intensity of rainfall events and cyclones, and droughts for southern regions (USAID, 2018). In addition, a sea level rise of 13-56 cm by 2090 is predicted for the country as a result of climate change (USAID, 2018).

Mozambique is a signatory to the Paris Climate Agreement within the United Nations Framework Convention on Climate Change (UNFCCC). This is a recognition of the long-term and cumulative impacts that the emission of greenhouse gases will have on the world's climate. Such impacts are inherently cumulative and dispersed in nature. As a result, the climate change impacts from the Project will not necessarily be noticeable within the immediate surrounds of the project area, or indeed, globally, but the fact that Mozambique is a signatory places a responsibility and a monitoring and administrative burden on the Proponent. It is likely that local Mozambican officials will have to report greenhouse gas emissions for their local area as a part of a national climate report which must be submitted to the United Nations under the responsibilities of all signatories. This administrative burden is frequently passed on to the staff of the area's largest emitters which, in this case, is likely to be the Proponent.

From a positive point of view, the fact that Mozambique is a signatory to the Paris Agreement provides an opportunity to access climate change funding to help redress the potential climate change impacts that have already occurred in the area. With the development of the Project and the subsequent oil and gas projects still planned for the region, there is a good case for international climate change funding to be applied into the project region to offset the climate change impacts that have already and are still expected to occur.

9.4.2.2 Population Influx

During any development, it is anticipated that employment and business seekers will migrate to larger towns and communities. Based on the 2018 socio-economic baseline updated by Golder, an influx of work and opportunity seekers has been observed over the past years in Mangungumete and Maimelane because of Sasol's growing presence in the area (Figure 154 and Figure 155). Mangungumete and Maimelane community size have increased between 2005 and 2010, 72.46% and 58.45%, respectively. The percentage increase is high when compared to the general population increase in the Inhassoro District of about 15% over the six years from 2007 to 2014. The size of these communities is expected to increase if in-migration is not effectively managed, monitored and evaluated.

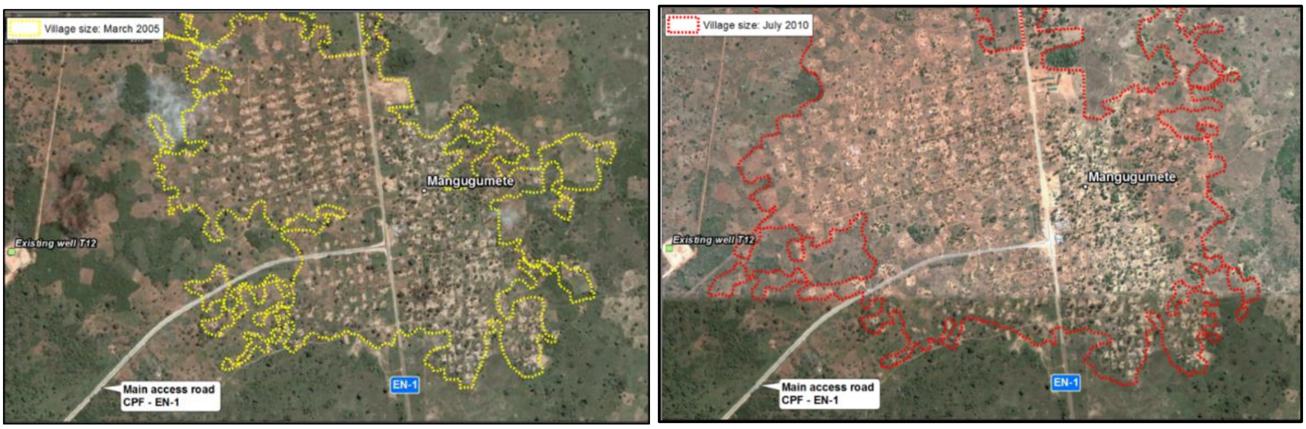


Figure 154: Mangungumete village in 2005 and 2010 (Google Earth imagery)

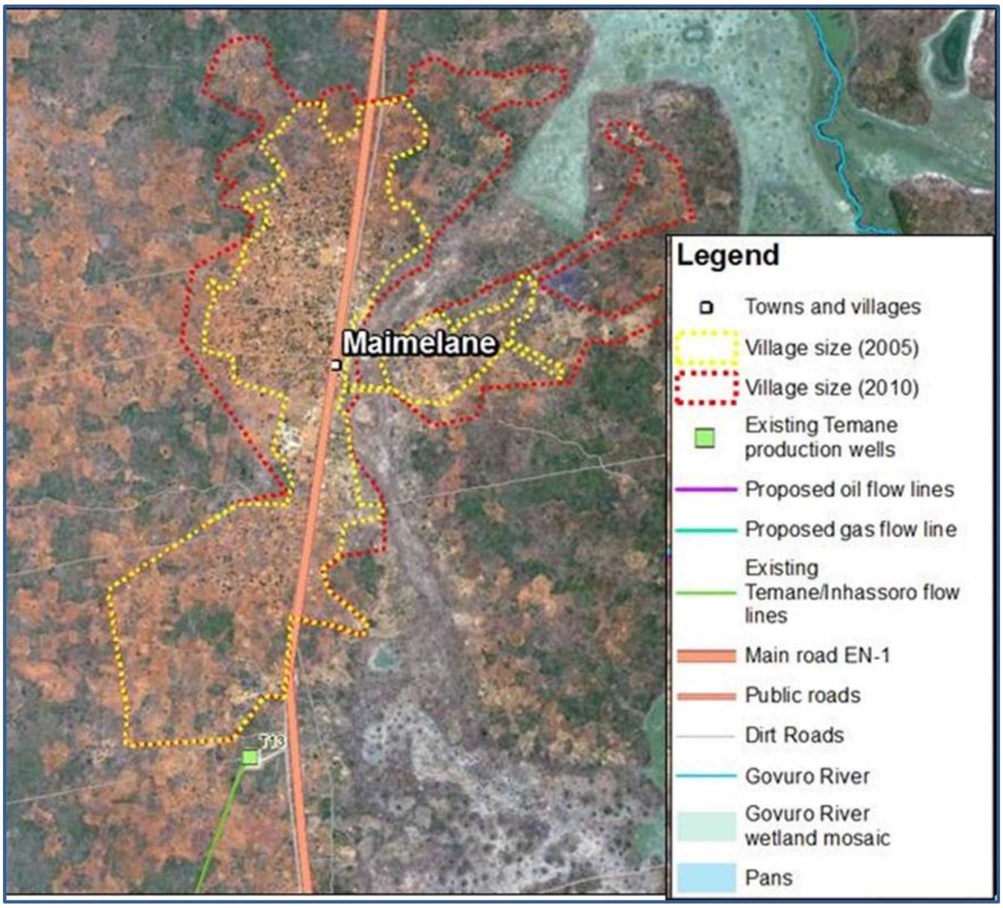


Figure 155: Maimelane community between 2005 and 2010 (Google Earth imagery)

9.5 Estimated Overall Cumulative Impact on VECs

Sasol's presence in the Inhambane Province is expected to increase substantially over the next 10 years. In addition to the CTT Project (where Sasol is a partner), planned projects include the construction and commissioning of the first phase of the PSA Development and LPG Project (activity underway), Early Appraisal and Development (EA&D) activities, and the construction of the Export Pipeline and FSO project.

This section focusses on the VEC's which are relevant in the context of cumulative impacts associated with the Project. The IFC stresses that: "*Scope creep should be prevented; expansion of the Cumulative Impact Assessment (CIA) scope beyond the impacts and risks related to a project is not good practice; focus on a small number of key Valued Ecosystem Components (VECs)*." This is the approach followed in this study.

For a cumulative environmental impact to occur, there must be an environmental effect caused by the project, which combines cumulatively with the environmental effects from other projects or activities and environmental and/or social drivers (Table 145.

Table 145: Estimated Cumulative Impacts on VECs

Project/Activity/ Driver of Change	Primary dunes and sandy beaches	Seagrass beds	Bazaruto Archipelago NP/IBA	Beach-nesting turtles	Dugong	Indian Ocean Humpback Dolphin	Endemic gastropods	Migratory seabirds	Govuro River Floodplain	Natural woodland/forest habitat	Vultures	Economy	Community Health and Safety	Land and resource use	Cultural Heritage	Sense of Place	Water Quantity	Water Quality
CTT Facility									x	x	x	x	x	x	x	x	x	x
Beach landing sites	x			x		x									x			
Anchorage points			x			x	x	x								x		
Barging activity		x			x	x												
Project-induced influx	x	x		x	x	x			x	x		x	x	x	x	x		x
CESUL Vilanculos Substation											x	x		x	x			
CESUL Powerline										x	x				x			
Sasol PSA Development and LPG Project									x	x	x	x		x	x		x	x
Sasol Pipeline and Floating, Storage and Offloading (FSO) Project	x	x	x	x	x	x	x	x							x			

Project/Activity/ Driver of Change	Primary dunes and sandy beaches	Seagrass beds	Bazaruto Archipelago NP/IBA	Beach-nesting turtles	Dugong	Indian Ocean Humpback Dolphin	Endemic gastropods	Migratory seabirds	Govuro River Floodplain	Natural woodland/forest habitat	Vultures	Economy	Community Health and Safety	Land and resource use	Cultural Heritage	Sense of Place	Water Quantity	Water Quality
Expansion of onshore exploration activities by Sasol									x	x	x	x		x	x			x
Establishment of an industrial park near the Temane CPF									x	x	x	x			x		x	x
Potential offshore sub-sea cables		x																
Increased marine traffic		x	x		x	x	x	x									x	
Inhassoro Tourism Resort Preliminary Master Plan/ Mozambique Tourism Anchor Investment program	x		x	x	x							x			x	x	x	x
Climate change	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x	x
Population Influx	x	x	x	x	x	x		x	x	x	x	x		x	x		x	x

9.5.1 Biological Effects

9.5.1.1 Primary dunes and sandy beaches

Other planned projects and activities that could directly impinge on the future condition of primary dunes and sandy beaches within the coastal region of the CIA Study Area include the proposed Sasol Pipeline and Floating, Storage and Offloading (FSO) Project and the Inhassoro Tourism Resort.

The FSO Project shore crossing will be located on the beach 20 km north of Inhassoro and will involve a certain amount of habitat loss and disturbance during construction and operation. The Inhassoro Tourism Resort is likely to have direct effects on the integrity of primary dunes and sandy beaches, including direct habitat loss caused by project development footprints, and habitat degradation arising from activities such as waste disposal, occasional accidental leakages and spills, use of herbicides and pesticides on golf courses, and discharge of sewerage.

The human in-migration associated with the future proposed oil and gas and tourism developments is likely to be accompanied by increased pressure on the integrity of this habitat within the CIA Study Area as new settlements develop and nearby dune systems become degraded (e.g. by creation of new beach access tracks which exacerbate erosion, use for sanitation, etc.). Increased cyclone frequency and rising sea levels are likely to affect dune formation and beach sedimentation processes into the future

The estimated residual significance of the direct Project impact on these habitats is low. The relative significance of the indirect contribution of the Project - largely driven by uncontrolled in-migration - is difficult to quantify but will probably be small; and will occur on a localised basis, and therefore is expected to contribute to overall cumulative impacts on this VEC within the CIA Study Area, in combination with the FSO Project and proposed Inhassoro Tourism Resort.

9.5.1.2 Seagrass beds

Cumulative impacts on the extent and ecological integrity of seagrass beds in Bazaruto Bay are expected as a factor of direct habitat loss and degradation due the barging activities associated with the Project, in combination with the pipeline being constructed as part of the FSO project, proposed sub-sea cables, and increased marine traffic in Bazaruto Bay which could disturb seagrass growth (beds typically occur in waters of less than 5 m depth); as well as the proposed Inhassoro Tourism Resort development, which could increase nutrient and sediment input to Bazaruto Bay, with concomitant effects on the extent and integrity of seagrass habitat. The Project contribution to potential impacts is expected to be very low, given that barging movements will be transient in nature, occurring over the course of several days on several disjunct occasions over the course of 18-24 months, and barging routes will be selected to avoid traversing any significant seagrass beds

Of greater concern are the impacts of future climate change on seagrass beds in the CIA Study Area. Recent marine heat waves in Western Australia (2010 - 2011) that raised water temperatures by 2-4 degrees resulted in the release of vast quantities (up to 9 million metric tonnes) of CO_2 resulting from the loss of seagrass meadows– roughly the equivalent of the annual CO_2 output of 800,000 homes (Arias-Ortiz *et al.*, 2018). The predicted rise in sea levels and sea water temperatures for Mozambique (USAID, 2018) are likely to have severe effects on the future baseline condition of seagrass meadows within the CIA Study Area. The relative significance of the direct and indirect impacts of the Project on the extent and ecological integrity of seagrass bed habitat compared with the potential effects of climate change is likely to be minor.

Nutrient enrichment/sedimentation from the proposed Inhassoro Tourism Resort, as well as other existing and proposed tourism facilities, is likely to contribute to eutrophication in Bazaruto bay, which is a known factor in the rapid loss and deterioration of seagrass ecosystems worldwide (Mvungi, 2011). Since the Project is not expected to result in nutrient enrichment and/or sedimentation-type impacts, no contribution to cumulative effects in this regard is predicted.

9.5.1.3 Bazaruto Archipelago National Park/Important Bird Area

The main footprint and activities of the CTT Project will have no direct impact on Bazaruto Archipelago National Park/Important Bird Area; however, two previously identified offshore anchorage points for transhipment of large machinery parts are located within the National Park boundary. If such anchorage points were to be selected, the Project could contribute to cumulative effects on the ecosystem composition and configuration of the protected area in combination with generally increasing marine traffic (fishing, transport, recreational vessels) in Bazaruto Bay and traffic generated by the proposed Inhassoro Tourism Resort development. The location of the anchorage points to locations outside the boundary of the National Park will remove any potential contribution of the Project to cumulative impacts on Bazaruto Archipelago National Park/Important Bird Area.

9.5.1.4 Beach-nesting turtles

The likelihood of loss of nest sites, or mortality or injury of nesting turtles or incubating eggs as a result of the construction of the beach landing sites for the Project is low, since the proposed landing sites are already being used for beach access for boats and are unlikely to be important turtle nest sites due to existing levels of disturbance. The Project contribution to cumulative impacts in this regard is therefore expected to be minimal-negligible.

However, the hunting of turtles for meat has been noted in the CIA Study Area. There is a potential that the Project-induced impact of construction workers or people attracted to the construction sites and beach landing sites (e.g. people seeking employment or opportunities) could increase hunting pressure on beach-nesting turtles within the Study Area, which would contribute to cumulative impacts, in combination with projected population influx to the region, as well as the loss of habitat that is likely to occur with the construction of the FSO Project shore crossing and influx surrounding the development of the Inhassoro Tourism Resort. As is the case for the primary dunes and sandy beaches VEC, the relative significance of the indirect contribution of the Project - largely driven by uncontrolled in-migration - is difficult to quantify but will probably be small; and will occur on a localised basis.

9.5.1.5 Dugong

The movements of the barges from the anchorage points to the beach landing points will cross Dugong habitat north of Bazaruto Archipelago National Park/Important Bird Area, with the potential to separate some of the largest feeding grounds of the north from other feeding grounds and/or preferred breeding habitats of the south as a result of acoustic and/or physical disturbances, creating barriers to movement for this species. Barge strikes are possible, as Dugong are very slow moving (average 10 kmph, typically 5 - 8 kmph, short bursts of up to 20 kmph) and are typically concentrated in shallow waters (<5 m depth) where seagrass beds occur.

The application of the required Project mitigation measures result in barge movements being expected to have a low residual impact on dugong; that is, no direct injury or mortality of individuals as a result of barge collisions are predicted; however some degradation of their preferred foraging habitat (seagrass beds) could occur. This low-level residual impact will contribute to cumulative impacts on dugong habitat quantity and quality, in combination with other activities in the CIA Study Area, notably, increased marine traffic, and the potential effects that discharges like treated sewerage and contaminated runoff from golf courses at the Inhassoro Tourist Resort, may have on seagrass habitat.

9.5.1.6 Indian Ocean Humpback Dolphin

Although barge strikes could also affect the *Endangered* Indian Ocean Humpback Dolphin, which is resident in the coastal waters of the CIA Study Area, the likelihood of actual strikes occurring is considered to be low, since Humpback dolphins do not ride the bow waves of boats and generally actively avoid moving vessels (Braulik *et al*., 2015).

However, they are highly susceptible to disturbance caused by inshore boat traffic and avoid heavily used areas (Braulik *et al*., 2015); therefore there is potential for the disturbance created by the barge and transhipment vessel movements (albeit transient in nature, and temporary) to contribute to cumulative impacts on the future abundance and distribution of this species in the CIA Study Area, in combination with generally increased marine traffic in Bazaruto Bay as tourism expands and fishing activity increases.

East African (Mozambique, Tanzania and Kenya) coastal populations of Indian Ocean Humpback Dolphin are estimated at approximately 100 individuals or less (Braulik *et al*., 2015); and since the species has a low reproductive rate it cannot withstand increased mortality rates as a result of human-generated impacts (Reilly and Barlow, 1986), with the removal of 2-3 animals per year considered sufficient to cause significant declines (Braulik *et al*., 2015). Mortality rates from fisheries bycatch exceed this by several orders of magnitude in most places that *S. plumbea* occurs (Braulik et al., 2015). Population influx to the CIA Study Area and the associated expected increase in fishing in Bazaruto Bay is therefore considered likely to negatively affect the abundance and distribution of this species as a result of accidental bycatch. The relative significance of the indirect contribution of the Project-generated influx - although small – will need to be addressed via appropriate population influx management planning by the Proponent for the lifetime of the Project.

9.5.1.7 Endemic gastropods from the Bazaruto Archipelago

The main footprint and activities of the CTT Project will have no direct impact on endemic gastropods associated with Bazaruto Archipelago National Park; however, the previously identified offshore anchorage points for transhipment of large machinery parts are located within the National Park boundary. If such sites were selected, the Project could contribute to cumulative effects on the abundance and distribution, survival and reproduction of endemic gastropod populations in combination with potential water quality declines as a result of generally increasing marine traffic (fishing, transport, recreational vessels) in Bazaruto Bay and additional seabed disturbance associated with the development of the FSO project and pipeline. The location of the anchorage points to locations outside the boundary of the National Park (proposed as mitigation in the marine ecology impact assessment – see Chapter 7.2.1.23) will remove any potential contribution of the Project to cumulative impacts on the endemic gastropods of Bazaruto Archipelago National Park.

9.5.1.8 Migratory bird species associated with Bazaruto Archipelago IBA

Again, the previously idenfitied offshore anchorage points for transhipment of large machinery parts are located within the National Park boundary. If such sites are selected, the transhipment vessels and anchorage points that will be in use during the construction phase of the CTT Project could contribute to cumulative effects on the future abundance and distribution of the migratory bird species that are characteristic of the IBA through contributing to sensory disturbance in the CIA Study Area, in combination with the Sasol Pipeline and FSO Project, and increased marine traffic in Bazaruto Bay. The location of the anchorage points to locations outside the boundary of the National Park (proposed as mitigation in the marine ecology impact assessment – see Chapter 7.2.1.23) will remove any potential contribution of the Project to cumulative impacts on the characteristic migratory bird species of Bazaruto Archipelago IBA.

9.5.1.9 Govuro River Floodplain

The Govuro River Floodplain has been defined as Critical Habitat (Golder, 2017), and is located within the CIA Study Area. It consists of an area of about 71 ha of the floodplain containing 47 colonies of approximately 550 critically endangered Govuro Cycads (*Encephalartos ferox* subsp. *emersus*) (Figure 156). This cycad is extremely habitat-specific. The populations on the floodplain are the only known recorded location of this cycad subspecies. The area therefore meets the Tier 1 Critical Habitat requirements as per GN74 in that 100% of the subspecies' known distribution are in this area and it is the only "discrete management unit (DMU)" for this species.

Figure 156: The critically endangered Govuro Cycad (Encephalartos ferox subsp. emersus)

The main footprint and activities of the CTT Project will have no direct impact on Govuro Cycad or the Govuro River Floodplain; however, Project-induced population in-migration to the CIA Study Area could contribute to increased pressure on the critical habitat as a whole as a result of habitat degradation due to expansion of settlements and conversion for agriculture, as well as taking of individual cycad specimens for sale in the illegal plant trade.

As is the case for all other instances of Project-induced population influx, the relative contribution of the Project is difficult to quantify yet will need to be addressed via appropriate population influx management planning by the Proponent for the operational lifetime of the Project, as well as regional biodiversity management planning (see Section 9.6).

9.5.1.10 Woodland and forest habitat

Woodland and forest habitats within the CIA Study Area have been assessed as being of moderate-high biodiversity value due to their support of tree species of conservation concern, and functioning in terms of provision of habitat for faunal species, and supply of ecosystem services to local beneficiaries (ref. Chapter 6.2.1). Some residual impacts of moderate significance on this VEC are predicted as a result of vegetation clearance during the construction of the access road from the main CPF to the Power Plant site, and the upgrade of the shortcut road linking the EN1 to the north-south road. In total, a loss of approx. 7.4 ha of these habitats is predicted for the Project.

Therefore, the Project will contribute to cumulative direct losses of these vegetation communities within the CIA Study Area, in combination with the various other proposed Sasol activities in the area (PSA and LPG project, expansion of onshore exploration activity, establishment of an industrial park near the Temane CPF) and the proposed CESUL 400 kv powerline, all of which will involve further vegetation clearance and loss of natural woodland and forest habitat. Although the Project contribution is minimal (approx. 7.4 ha), further management is required to address its impact in the cumulative context (ref. Section 9.6). The cumulative impact of the continuing expansion of the Sasol footprint on biodiversity receptors will be managed as part of Sasol's overall Biodiversity Offset Management Plan (ref. Section 9.6).

In addition, the impacts of future population influx to the region are likely to exacerbate the rate of degradation and loss of these habitats, further compromising their future baseline extent and condition within the CIA Study Area. The relative contribution of the Project-associated population influx is difficult to quantify but will probably be small; and will need to be addressed via appropriate population influx management planning by the Proponent for the operational lifetime of the Project.

9.5.1.11 Vultures

Three Endangered/Critically Endangered vulture species have been confirmed or are considered likely to occur within the Study Area; White-backed Vulture, Hooded Vulture and White-headed Vulture (refer to Chapter 6.2.6). The powerline infrastructure component of the Project and associated collision risk could result in impacts on the survival of these species in the CIA Study Area and contribute to cumulative impacts in combination with the proposed Vilanculos substation and CESUL 400 kV powerline.

Proposed impact mitigation measures including staggered insulators, raptor-protectors and/or perch deterrents are predicted to reduce the Project impact to one of low significance, however, there remains a residual moderate level of probability of mortality/injury of these species as a result of collisions. To mitigate this risk, in higher-risk areas for bird or fruit bat collisions, it is proposed to use self-supporting towers where possible and to avoid the use of Guyed ’V’ towers as far as is practical, because of the collision risk posed by guy wires to birds (also fruit bats), including species of conservation concern such as several globally threatened vulture species. Furthermore, bird flight diverters shall be installed along the transmission line to reduce limit collisions, prioritizing areas with a relatively high presence of vultures and other vulnerable species. To avoid electrocution the distance between conductors should be 3 meters.

The Project’s contribution to cumulative impacts on these species within the CIA Study Area will require further management to satisfy its obligations in terms of the requirements of IFC Performance Standard 6, which will be guided by the measures contained in Sasol’s overall Biodiversity Offset Management Plan for their activities in the region (see Section 9.6).

9.5.2 Social Effects

9.5.2.1 Human Environment

It is not possible to accurately predict the cumulative effects of the Sasol regional exploration and development activities and other identified activities and drivers in combination with the CTT Project on the community’s resident in the CIA Study Area. Nevertheless, there is a broad understanding of some of the possible outcomes that will result from these cumulative effects that will extend well beyond the direct and induced impacts of the CTT Project alone.

The most significant negative effects will be caused by the combined influence of development within the CIA Study Area on migration into the area, largely due to economic migration, with people pursuing the prospect of jobs or other opportunities in the various secondary industry developments (service providers and suppliers to Sasol and CTT) and/or tourism developments which are proposed in the wider CIA Study Area. The effects of population influx in the cumulative context are discussed under each of the human environment VEC headings in the sections that follow.

9.5.2.2 Economy

Employment

The study area is characterised by extreme poverty, subsistence living, strong dependence on local natural resources, few health and education facilities and access roads, and very limited employment opportunities. The lack of other industries and formal employers across the Districts translates, at present, into an inexperienced local workforce with limited capacity. Employment opportunities associated with the Project are typically limited to unskilled work during construction phases, with limited opportunities for employment in technical roles as the Project moves into its operational phase.

Even though the number of people directly employed by the Project may be small, it may make a significant contribution to reducing local poverty levels, with benefits from income generated flowing into other sectors of the economy, particularly when considered in combination with the full suite of other Sasol gas development projects that are ongoing and/or proposed for the CIA Study Area.

Indirectly, there may be unskilled or semi-skilled employment opportunities associated with general economic development as a result of the Project's ongoing presence in the License Areas, again in combination with Sasol's other activities in the CIA Study Area, could amount to a significant positive contribution to the future economic baseline.

In addition, Sasol's existing Corporate Social Investment Programme which includes financing of schools, clinics, boreholes, micro-businesses, capacity building initiatives, and health education and promotions initiatives for Project-affected communities will continue to be implemented in the CIA Study Area, further contributing to positive cumulative impacts on the economy of the Study Area.

However, population influx and increased economic activity in the CIA Study Area will increase demand for goods and services. Consequently, the increasing pressure on existing supplies may increase prices, resulting in inflation, with negative implications for local communities as the cost of living increases.

Fishing

Artisanal fisheries and aquaculture in the CIA Study Area involve a large number of fishermen living along the coast or inland along the Govuro rivers and the perennial and seasonal pans and lakes in Inhassoro and Vilankulo Districts. Artisanal fishing is carried out in both marine and inland freshwaters. Many households, especially those living in rural areas near the Govuro River and surrounding wetlands, and coastal areas of Govuro, Inhassoro and Vilankulo Districts, rely on fish to supplement their diet.

Artisanal marine aquaculture is practised in Vilankulo District with 79 cages operational in 2015, producing 17,7 tons of fish and employing 70 men and 50 women; and in Inhassoro district. Freshwater aquaculture is also practiced in the CIA Study Area, comprising two commercial aquaculture farms with earthen ponds and several household/artisanal aquaculture cages. Sasol has been involved in the financing of one of the commercial schemes. Inland (freshwater) artisanal fishing within the CIA Study Area is limited to the Govuro River and scattered non-perennial and seasonal lakes (depressions) in the Inhassoro and Vilankulo Districts; whilst marine artisanal fishing is practised by coastal communities throughout the CIA Study Area.

Although some of the Project activities (particularly road upgrades) occur in proximity to inland freshwaters where artisanal fishing and aquaculture is practised, no significant direct Project effects on inland fishing within the CIA Study Area are predicted, and the Project contribution to cumulative impacts in this regard will be minimal.

Barging of large equipment from the transhipment zones and transfer at the beach landing sites has the potential to cause limited disruption to the artisanal beach seine fishing activities, and artisanal fishing from boats, which could affect the ability of people who are reliant on fishing as a source of livelihood and food to harvest fish for household consumption and sale. However, given the limited footprint as well as infrequent and temporary nature of the proposed beach landing activities, no significant impacts on artisanal fishing are predicted as a result of the Project (refer to Chapter 7.5.1) and no contribution to cumulative impacts is expected.

Figure 157: Artisanal beach seine fishing at Inhassoro (Golder, 2015)

However, Project-induced population influx could contribute to increased demand for fish within the CIA Study Area, increasing pressure on the supply of this important source of food and livelihood – particularly for people who are reliant on artisanal fisheries. The future baseline condition of fisheries in the CIA Study Area is likely to be further compromised by the effects of climate change; for example, the drought conditions of 2017 resulted in many of the pans and lakes in Govuro, Inhassoro and Vilankulo Districts becoming dry or partially dry with consequent major reduction of fishing activity in the lakes; underlining the importance of management of the potential impacts of the CTT Project and its contribution to cumulative impacts on fisheries resources in the Study Area, in combination with other projects/activities and population influx.

Tourism

The coastal areas of Govuro, Inhassoro and Vilankulo Districts within the CIA Study Area include tourist lodges that promote sports and recreational fisheries, as well as diving and snorkelling activities, and wildlife interaction (e.g. whale watching) opportunities. Although the Project will involve the transhipment and barging of large components of the gas turbines/engines, the very short-term and transient nature of the presence of moored transhipment vessels and moving barges is not expected to affect the tourism value of the CIA Study Area. No significant Project impacts on the associated economic activities are predicted, and therefore no contribution to cumulative impacts is expected.

9.5.2.3 Community Health and Safety

Road Safety

The new and upgraded road infrastructure proposed as part of the Project, as well as increased traffic during the construction and operation phases of the Project, is predicted to have implications for community health and safety via increasing risk of both vehicle and pedestrian accidents with increasing volumes of traffic, particularly in areas where communities are *not* familiar with Sasol operations. Although the mitigated residual Project impacts are of low significance, the increased traffic volumes due to both the Project and are likely to contribute to overall cumulative impacts on the human environment in the CIA Study Area.

Air Quality (Particulate and Gaseous Emissions)

Air quality in the CIA Study Area is generally well within Mozambican and international standards for recognised reference periods. Slight deterioration in air quality along the EN-1 has been experienced due to vehicle traffic.

PM_{10} (fine airborne dust particles) is occasionally high in the region due to atmospheric dust, but in general, air quality is unaffected by human influences and is typical of rural environments.

Community health impacts, in particular respiratory health issues, may be caused by excessive inhaling of PM_{10} (fine airborne dust particles that cannot be seen by the naked eye) and/or gaseous emissions (SO_2 and NO_2) generated by Project construction works and traffic, and Project process emissions during operation respectively. The most recent baseline air quality data confirm that the air quality in the CIA Study Area is not currently degraded, with average recorded PM_{10} concentrations generally being well below the Sasol Temane standard and the most recent dust fall out rates being well below the SA NDCR limit of 1 200 mg/m^2/day for non-residential areas. The moderate PM_{10} concentrations measured during the most recent campaign are related to background sources as well as to emissions from the CPF facility. The existing Sasol operations have not resulted in any significant increase in background SO_2 and NO_2 concentrations to date (Airshed Planning Professionals, 2014).

The construction and decommissioning impacts for the proposed gas engines and gas turbines proposed as part of the current Project are predicted to be low (ref. Chapters 7.2, 7.4). Low-level impacts on PM_{10} and SO_2 are predicted for the operational phase of the gas engines option (ref. Chapter 0); however operational impacts on the levels of atmospheric NO_2 are predicted to be of moderate significance (hourly average NO_2 concentration exceeding 25% of the IFC guideline 200 µg/m^3), with the Orphanage being amongst the potentially affected receptors (others include the T-05 Well Pad, T-15 Well Pad, CTT, CPF, and Electricidade de Moçambique). Although baseline air quality in the CIA Study Area is currently within acceptable standards, there is a potential for the future baseline air quality to be affected by the cumulative effect of the Project emissions during its operational phase (if the gas engine technology is favoured over the gas turbines), in combination with existing emissions from the CPF in particular, additional proposed gas industry developments, and vehicular traffic on paved and gravel roads. The cumulative impact is likely to be localised around the CPF and CTT facilities and should be largely within the management control of the Proponent.

Noise and Vibrations (Nuisance and Structural Damage)

Noise and vibration during construction could result in the potential for general nuisance. High levels of noise could also result in difficulty in hearing speech or classroom instruction in noise-sensitive locations. Vibration may also cause concern and nervousness especially in those communities and isolated households not familiar with Sasol activities. Residents would be worried about structural damage to their houses and other infrastructure, especially since these structures in the CIA Study Area rarely comply with building regulations.

Potential Project impacts on residents are expected to be limited to the construction phase and would only come into effect at locations closer than 50 m from homes/communities or other sensitive receptors. Given the distances at which other potentially contributing projects and activities are located, the potential for spatial crossover of noise and/or vibration impacts is low, and no significant cumulative impacts on community health and safety within the CIA Study Area are predicted.

Improved Access

Villagers have repeatedly emphasised in EIA consultation meetings how important access is in their daily lives. While most villagers do not own vehicles, access roads make any form of travel and communication easier (walking, cycling, emergencies where a taxi may be called). Improved access also provides an opportunity to grow crops and harvest natural resources further afield. Land cleared for proposed new Project roads and along the powerline will provide improved access to natural resources and a variety of important social interactions, including markets, trade with nearby neighbours/villages, clinics and schools. Construction of the access road from the main CPF to the Power Plant site, and the upgrade of the shortcut road linking the EN1 to the north-south road as part of the CTT Project may improve local access for residents in the area, which in combination with bush clearing and civil (road) construction for other proposed Projects and activities may constitute a long-term, permanent, cumulative benefit for local communities.

Social Harmony, Social Pathologies

As indicated in Section 9.4.2.2, the CIA Study Area has already experienced a significant influx of people in search of work and business opportunities. It is likely that this existing impact will continue to increase as a result of both Project-induced influx, as well as ongoing regional in-migration of work and opportunity seekers. Increased and ongoing population influx has the potential to result in conflict with local communities, resulting in long term local impacts on community health and safety including:

- Increased social pathologies such as drug and alcohol abuse, prostitution, gender-based violence, increased incidence of sexually transmitted diseases and other communicable diseases;
- Rising crime, violence and tensions within and between local communities and outsiders, resulting in a breakdown of law and order;
- The breakdown of traditional household and community institutions, traditional leadership structures and cultural norms leading to a loss of community identity and resilience;
- Food scarcity through diminished communal and natural livelihood assets;
- Increased vulnerabilities associated with poverty, loss of livelihood assets and associated community status/perceived wealth and indebtedness, and domestic violence; and
- An overall decline in the well-being and welfare of the resident population by threatening their way of life and the basis of existing livelihoods.

The estimated residual significance of the Project impact on these aspects of community health and safety is generally low and may even result in positive community benefits in some circumstances (e.g. implementation of training and skills development programs and promotion of gender-based programs for local communities – ref. Chapter 7.6).

The relative significance of the residual Project impact contribution to overall cumulative impacts on this VEC within the CIA Study Area is therefore likely to be minor. Nevertheless, the Project residual impact will require ongoing management throughout the operational lifetime of the Project to cater for the potential cumulative effects that could arise in combination with the other proposed gas industry developments and the proposed Inhassoro Tourism Resort.

9.5.2.3.1 Land and resource use

During construction of the CTT Project infrastructure, access to portions of land currently used for subsistence and commercial agricultural purposes may be lost (ACER, 2018), and affected communities/individuals may require compensation. Several machambas (farms/plots of land) are located within the 100 m corridor of the transmission line and water pipeline components of the CTT Project. During the construction of the transmission line and water pipeline, it is likely that access to these machambas will be restricted. Furthermore, in the event of no agricultural activities being permitted within the 100 m corridor of the transmission line and water pipeline or in the event of access roads being constructed within these corridors, land or portions thereof may be lost on a permanent basis. In the event of the ‘southern transport route’ being chosen as the preferred option for the transport of equipment from the beach landing site to the project site, it is likely that there may be damage to machambas in areas where the access road will be widened.

For the most part, no significant resettlement of households has been required to date for most of Sasol’s exploration, appraisal or development activities since the start of the Natural Gas Project in Mozambique, with locations for infrastructure typically being situated far from identified social or environmental constraints at an early planning stage, as a principle of long-term risk management. For the few households affected by the Natural Gas Project, and in circumstances where compensation for the loss of land or fields has been required, the Proponent has a MITADER-approved *Onshore Compensation & Resettlement Plan* (see Box 1), which has been successfully used since 2002 with no lingering liabilities.

Box 1: Sasol's Onshore Compensation & Resettlement Plan

This Framework has adopted and implemented World Bank Group policies, procedures, directives and standards as contained within *Operational Policy 4.12: Involuntary Resettlement* (OP 4.12), *Bank Procedure 4.12: Involuntary Resettlement* (BP 4.12) and *Operational Directive 4.30: Involuntary Resettlement* (OD 4.30). Agreement has been reached that the principles, processes and actions taken thus far meet World Bank standards. It meets Mozambican regulatory requirements.

Provided that landowners affected by the CTT Project are correctly identified and compensated in accordance with a similar plan to that of Sasol's existing MITADER-approved *Onshore Compensation & Resettlement Plan*, no significant Project contribution to cumulative effects in the CIA Study Area is predicted.

9.5.2.3.2 Cultural Heritage

All *known* archaeological sites within the CIA Study Area are located sufficiently distant from the Project infrastructure to be unaffected, or are located adjacent to existing roads, which will not be widened.

There is potential, however, for *unknown* archaeological sites, which may exist beneath the surface or as undiscovered surface scatters, to be directly impacted during site preparation and construction works through changes to land surface.

A number of *known* cultural sites could potentially be directly impacted by changes to land surface. These include those located along the southern transport route option, which is to be widened and improved, and those along the proposed overhead electricity transmission line. There is also potential for accidental damage to *unknown* or undiscovered cultural sites (e.g. undiscovered burial or an undisclosed sacred site).

The mitigation measures provided in the Cultural Heritage Impact Assessment (see Chapter 7.5.1) will reduce all potential direct Project impacts to low or negligible significance once applied. The measures also ensure that community access to sacred sites is maintained, and respect for local intangible cultural heritage, tradition and taboos is facilitated through continued community liaison and ongoing employee, contractor and sub-contractor education as part of the standard site induction processes prior to commencing work. In the case of unknown archaeological and cultural sites, a chance find procedure has been developed that ensures that accidental cultural heritage discoveries are managed in a clear and sustainable fashion throughout the lifetime of the CTT Project and build upon the cultural heritage knowledge of the region through appropriate recording. No significant Project contribution to cumulative impacts on tangible and/or intangible cultural heritage value of the CIA Study Area are therefore predicted.

9.5.2.3.3 Sense of Place

Sense of place refers to the intrinsic character of a place, or the meaning people give to it, or frequently, a mixture of both. Loss of sense of place is a key concern for stakeholders involved in the tourism industry who believe that ongoing industrial development projects will damage the tourism potential in the area, as well as local residents whose sense of place may be affected by both visual intrusion as well as noise disturbance at sites of cultural importance in particular.

During construction, the Project impact on overall sense of place, as a consequence of the visual impact of dust generated from construction work, presence of construction vehicles, and light pollution at night, is predicted to be low with the application of the mitigation measures (ref. Chapter 7.5.1). Although the majority of resident (local inhabitants) as well as transient receptors (tourists, tourism enterprises) are located more than two kilometres away from the power plant and transmission line sites, and as such will experience a low level of visual exposure, moderate residual impacts on affected receptors are predicted as a consequence of the presence of visually intrusive power plant infrastructure, linear transmission lines, and site lighting at night during operation.

Visual impact assessment modelling conducted for the FSO and onshore pipeline project demonstrated that sensitive tourism receptors will not be affected; similar modelling conducted for the development of new permanent wells and implementation of flaring may however be visible by some sensitive receptors (locations unconfirmed pending confirmation of the location of new wells) and at considerable distances (ERM, 2016).

There are no cultural heritage assets in close proximity to the proposed CTT power plant site, and no impacts from a change in environmental setting (i.e. noise or air quality disturbance) arising from the Project are anticipated at the burial and cemetery sites along the proposed electricity transmission line, assuming the alignment of the powerline route is altered to avoid direct disturbance. Some cultural sites adjacent to the proposed transport route are expected to experience disturbance via noise, air and visual impacts as a result of construction traffic; and the environmental setting of burial grounds and cemeteries along the electricity transmission route could be impacted by noise and visual effects as result of the overhead powerlines during operation. However, the Project impact is expected to be minimal following mitigation, which centres on re-alignment of the powerline route to avoid important burial sites, and traffic management in sensitive areas.

In summary, cumulative impacts on both local residents' and tourists/tourism enterprises' sense of place are likely to arise in the CIA Study Area as a consequence of the presence of visually intrusive CTT Project infrastructure, linear transmission lines, and site lighting at night during operation, in combination with the CPF and well infrastructure of the Sasol PSA and LPG project, and the proposed CESUL powerline in particular.

9.5.3 Physical Effects

Since cumulative air quality, noise and vibration impacts are already discussed under impacts on Community Health and Safety, this section focusses on the Project contribution to cumulative impacts on the quality and quantity of surface and groundwater resources within the CIA Study Area.

9.5.3.1 Water Quantity

The Project water demand is estimated at 25.9 m^3/h for the Combined Cycle Gas Turbine (CCGT) Option, or 3.39 m^3/h for the Open Cycle Gas Engine (OCGE) Option. Raw bulk water supply required for cooling water, demineralised water and potable water aspects of the Project and will be sourced from from boreholes located on site at the CTT (borehole W5A) plant or from boreholes located east of the Govuro river (borehole T9) and treated accordingly. This water from borehole sources will be supplemented with rainwater during the rainy season. Stormwater will be captured and stored in a raw water tank and reused and recycled as far as possible. Borehole pumping will cease during periods when raw water source/fire water is supplemented by stormwater.

Abstraction of water from the sand aquifer at T9 in the Govuro River floodplain will reduce base flows river, since the surface water flow and the sand aquifer are directly connected. The abstraction from the karst aquifer at W5A could impact the groundwater levels and availability in local area, and potentially influence contribution to the baseflow of the Govuro River. However, the model simulations of the two aquifers suggest that there will be minimal drawdown at rate of 12 m^3/hr. The maximum drawdown at borehole T9, after 20 years of continuous pumping is 1.90 m, approximately 7% of the available drawdown, while for borehole W5A the maximum drawdown after 20 years of continuous pumping is 2.42 m, approximately 3% of the available drawdown. The effect of the additional abstraction from the groundwater resources on the contribution to the Govuro River baseflow is therefore likely to be minimal.

There are no recorded conflicts in usage of water between communities and Sasol's exploration, appraisal and development activities. Water use for these projects are generally short term and controlled to ensure that it does not conflict with community water supplies.

The water demand of the other more long-term projects and activities in the CIA Study Area - the Sasol PSA Development and LPG Project, the proposed industrial park near the Temane CPF, and the proposed Inhassoro Tourism Resort – is potentially significant; and there is likely to be spatial overlap of the Project impact (although minimal) with the PSA development and LPG Project, and the proposed industrial park in particular. Cumulative impacts on the future baseline water quantity within the CIA Study Area are therefore considered likely to occur over the operational lifetime of the Project.

9.5.3.2 Water Quality

Moderate residual Project impacts on the water quality of surface water and ground water systems are predicted during operation, primarily due to possible spills from the evaporation pond (which will serve as the local pollution control dam) which would have very high levels of salts, total suspended solids, oils as well as other contaminants (ref. Chapter 0). Such impacts would contribute to declining water quality in the CIA Study Area and could overlap spatially with similar residual impacts which may arise from the PSA development and LPG Project, resulting in overall cumulative impacts on water quality throughout the operational lifetime of the Project. In addition, future population influx to the region is likely to result in increased usage and contamination of surface water quality in the CIA Study Area, as well as pressure on ground water systems due to increased sanitary effluent entering the systems.

As long as careful management of Project risks are taken, the overall significance of the impact of the Project impact in the cumulative context will be low. The relative significance of the indirect contribution of the Project - largely driven by uncontrolled in-migration - is difficult to quantify, and although it will probably be small; it will contribute to overall cumulative impacts on water quality within the CIA Study Area.

9.6 Recommendations for Management of Cumulative Impacts

The measures for management of cumulative impacts focus on how the Proponent can contribute to the management of residual project impacts, and how this can be integrated with the overall regional management of cumulative effects across the various existing and proposed gas developments, as well as other projects and activities planned for the future.

Sasol's presence in the Inhambane Province is expected to increase substantially over the next 10 years and will result in a continuous presence of construction contractors and personnel within the CIA Study Area. There will be potential local benefits associated with jobs and multiplier effects but also social risks, particularly the induced impacts associated with in-migration. These impacts will need to be managed through integrated communication between the Proponent (CTT), Sasol and with local Government and community stakeholders and targeted interventions both at project level and CSI level. At present, this process could be improved at the Proponent level, so as to avoid individual projects being assessed and managed independently of broader company objectives.

In the context of the current CTT Project, the PSA and LPG projects, increasing EA&D activities and the other new projects potentially coming on stream, it is proposed that The Proponent prepares a Sustainable Development Plan covering a 10-year horizon, which is fully integrated with its CSI objectives to manage key social risks and benefits associated with the growing project.

Cumulative biological and social impacts in the CIA Study Area are predicted, particularly if the accelerating construction and development incentivises increased in-migration to the area. It is proposed that the Proponent pursues the investigation of biodiversity offsets as a means of mitigating its increasing footprint and the additional induced impacts on biodiversity resulting from all project activities. These measures will be outlined in a Biodiversity Management Plan (BMP). Furthermore, an Influx Management Plan that addresses residual impacts on the human environment associated with both Project-induced influx and external drivers of in-migration, across all proposed Sasol projects and activities within the CIA Study Area will need to be developed. The development and implementation of a Sustainable Development Plan covering all of the Proponent's activities in the CIA Study Area is also required (Golder 2017), as a basis for guiding future socio-economic and socio-cultural interventions to minimise the most pressing negative impacts and enhancing the project benefits.

9.7 Conclusion

The contribution of the CTT Project toward potentially significant cumulative impacts was found to be of low significance in most cases; however, some moderate residual impacts associated with the Project will result in the Project adding to cumulative impacts on VECs within the CIA Study Area. These include the predicted effects on natural (primary dunes and sandy beaches, woodland and forests) and critical (Govuro River Floodplain) habitats; most of which are driven by the Project contribution to human in-migration to the area and subsequent negative impacts on affected habitats. In addition, potentially significant cumulative impacts on critically endangered and endangered vulture species could occur as a result of the proliferation of high-voltage powerlines in the CIA Study Area, which are an intrinsic component of the CTT Project as well as other planned projects (CESUL Power Line and Vilanculos Substation) in the CIA Study Area.

The Project-induced human in-migration to the area, is also expected to contribute to cumulative impacts on the human environment, particularly on the local economy, and will also affect community health and safety. Increased vehicular traffic throughout the operational lifetime of the Project will contribute to cumulative impacts on road safety, in combination with the other various proposed gas developments in the CIA Study Area. Cumulative physical effects are predicted for water quality, again largely driven by the Project-specific contribution to human in-migration to the CIA Study Area, in combination with already-occurring and future-predicted levels of regional and local influx.

Currently proposed control/mitigation measures for direct potential Project impacts are largely adequate to mitigate the Project contribution to most identified potential cumulative impacts. Additional measures that should be implemented across the Proponent's operations within the CIA Study Area include the development of over-arching plans, such as:

- Biodiversity Management Plan;
- Population Influx Management Plan; and
- Sustainable Development Plan.

These plans should be developed with the objective of addressing the residual effects of the CTT Project and other planned projects in the CIA Study Area, as a basis for the further assessment, mitigation and monitoring of cumulative impacts, and will set The Proponent on a course towards a fully comprehensive systems approach to its environmental and social management across all of its activities and projects in the region.

10.0 CONCLUSION

The implementation of the CTT project will make a critical contribution to Mozambique's National Energy Strategy, the main goals of which are to promote universal access to electricity, reinforce Mozambique's position as an important regional power hub, to support social development and poverty alleviation, and to promote general economic growth.

A cumulative assessment was undertaken as part of the ESIA and considered the CTT project impacts as well as other proposed projects within the area and identified the various cumulative and residual impacts that may result. In this study, it was concluded that the CTT project will have a low impact in terms of its residual impacts contributing to cumulative impacts on the surrounding area.

The analysis carried out in the ESIA has identified a variety of impacts and mitigation measures that has facilitated the preparation of Environmental and Social Management Plans for the project to guide CTT and its contractors during construction, operations and decommissioning phases.

The ESMPs aim to outline measures to minimise any negative impacts incurred by the Project during the construction, operational and decommissioning phases. The ESMP's have been developed for each phase of the project and accompany the full ESIA as a separate Volume. Mitigation measures and monitoring programmes have been identified in all of the specialist investigations and were also drawn into the management plans for implementation.

Therefore, the implementation of the identified mitigation measures will reduce any negative environmental and social impacts of the CTT project to an acceptable level and will enhance the positive impacts to maximize their effect on the surrounding communities.

11.0 REFERENCES

- ACER (2018). Central Térmica de Temane project- Abbreviated Resettlement and Livelihoods Restoration Plan.
- Adamowicz, L and Nhatule, E J J, 2015. Cultural Heritage Survey Report, Govuro, Inhassoro and Vilankulos Districts 12 – 21 January 2015.
- Allen, K. (2013). Dugong distribution and fishing pressure in the Bazaruto Archipelago. Rapid Assessment Report, June-July 2013. Endangered Wildlife Trust/WWF. 22 pp.
- Airshed Planning Professionals. (2014). Environmental Impact Assessment for Sasol PSA And LPG Project - Air Quality Impact Assessment. Golder Associates Africa.
- Avis, T., Martin, T., Massingue, A. & Buque, L. (2015). Nhangonzo Coastal Stream Critical Habitat Biodiversity Assessment: Vegetation and Floristic Baseline Survey and Integrated Summary Report. Addendum to Golder Associates. 2014. Environmental Impact Assessment for the THE PROPONENT PSA Development and LPG Project, Inhambane Province, Mozambique.
- Aylesworth, L. (2014). Hippocampus kuda. The IUCN Red List of Threatened Species 2014: e.T10075A16664386.http://dx.doi.org/10.2305/IUCN.UK.2014-3.RLTS.T10075A16664386.en. Downloaded on 01 October 2018.
- Bandeira S, Muiocha D & Schleyer M (2008). Seagrass beds. In: Everett, B.I., R.P.van der Elst and M.H. Schleyer, A natural History of the Bazaruto Archipelago, Mozambique. Special publication, no 8. Pp 65-69.
- Bandeira S., Bento, C., Rafael, J. & Samussone, D. (2012). Zambezi River Delta EBSA – CBD Southern Indian Ocean Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas (EBSAs).
- BirdLife International (2018) Important Bird Areas factsheet: Bazaruto Archipelago. Downloaded from http://www.birdlife.org on 01/10/2018.
- Braulik, G.T., Findlay, K., Cerchio, S. and Baldwin, R. (2015). Assessment of the Conservation Status of the Indian Ocean Humpback Dolphin (Sousa plumbea) Using the IUCN Red List Criteria. In: Thomas A.

Jefferson and Barbara E. Curry, editors, Advances in Marine Biology, Vol. 72, Oxford: Academic Press, 2015, pp. 119-141.

- Chilvers, B.l., Dlean, S., Gales, N.J., Holley, D.K., Lawler, I.R., Marsh, H., Preen, A.R. (2004). Diving behaviour of dugongs Dugong dugon. Journal of Experimental Biology and Ecology, 304 pp. 203-224.
- Coffey. (2014). Mozambique Gas to Power Water Supply Feasibility Study. Coffey Mining South Africa (Pty) Ltd.
- Costa, A., H. Motta, M.A.M. Pereira, E.J.S. Videira, C.M.M. Louro & J. João. (2007). Marine turtles in Mozambique: towards an effective conservation and management program. Marine Turtle Newsletter 117: 1-3.
- CSIR (2001). The Proponent Natural Gas Project Mozambique to South Africa – EIS – Specialist Study 12: Impacts of an offshore buoy for transport of condensate. Prepared by CSIR for Mark Wood Consultants, South Africa, on behalf of The Proponent.
- DEA (2016), The Calculation of Country Specific Emission Factors for the Stationary Combustion of Fuels in the Electricity Generation Sector, Department of Environmental Affairs, Pretoria.
- De Castro, T. and Brits (2014) Botanical Biodiversity and Habitat - Specialist Report 10, in: EIA for the Sasol PSA and LPG Project. Golder Report No. 1302793-10712-20.
- Dutton, T.P. and R. Zolho (1990) Conservation Master Plan for sustainable development of the Bazaruto Archipelago, Republic of Moçambique. WWF/SANF Report, 75pp.
- EBRD (2010), Methodology for Assessment of Greenhouse Gas Emissions, www.ebrd.com [accessed on 29 August 2018].
- Equator Principles (2013), www.equator-principles.com [accessed on 29 August 2018].
- ERM. (2016). Environmental Baseline Report: Sasol Pipeline and FSO Project. Report No. MSDP1401-ERM-0000-11400-STU-00002.
- ERM. (2016). Marine Ecology Report: Sasol Pipeline and FSO Project. Report No. MSDP1401-ERM-0000-11400-STU-00001.
- ERM/Impacto. (2016). Cultural Heritage Study Report for the Environmental Impact Assessment for the The Proponent Pipeline and FSO Unit Project.
- Everett, B.I., van der Elst, R.P. & Scheyler, M.P. (eds) (2008). A Natural history of Bazaruto Archipelago, Mozambique. South African Association for Marine Biological Research.
- EWT (2015). Shapefiles of isopleths depicting sighting concentrations of dugong during research conducted 2012-2014. Endangered Wildlife Trust.
- Findlay, K., Guissamulo, A. & Bickerton, I. (2006). Seismic Operations - specialist study: Marine Ecology. Prepared by Findlay et al. for ERM on behalf of Sasol Petroleum Sofala Limitada (THE PROPONENT) and Enperesa Nacional de Hidrocarbonentos (ENH).
- Governo do Distrito de Inhassoro (GDI) (2010). Plano Estratégico de Desenvolvimento Distrital 2011-2015.
- Golder (2014) (update 2018). Surface Water Baseline Assessment – Mozambique Gas to Power (MGtP) Project.

- GOLDER ASSOCIADOS MOÇAMBIQUE LIMITADA, 2014. Aquatic Fauna Impact Assessment, Specialist Report 11. Report Number: 1302793-10712-12.
- GOLDER ASSOCIADOS MOÇAMBIQUE LIMITADA, 2015. Surface Water, Specialist Report. Report Number: 1405502-13410-9.
- Golder (2015a) Baseline Biodiversity Studies for the proposed Pande Wells Expansion Project and Associated Seismic Exploration Activities (Pande and Temane Blocks). Mindrand.
- Golder (2017) Volume 1: Final Environmental Impact Assessment Report - Future Exploration, Appraisal and Development Activities in the Sasol License Areas. Midrand.
- Golder (2018) Update of the Terrestrial Ecology Baseline Description for the Mozambique Gas to Power Project. Midrand.
- Golder (2014) (update 2018). Surface Water Baseline Assessment – Mozambique Gas to Power (MGtP) Project.
- Guissamulo, A. T. (2006). Dugong Survey. Environmental Impact Assessment for offshore exploration in blocks 16 & 19, Inhambane and Sofala Provinces, Mozambique. SASOL PETROLEUM SOFALA LIMITADA (THE PROPONENT) AND ENPERESA NACIONAL DE HYDROCARBONETOS, E.P. (ENH).
- Guissamulo, A. T. (2016). Dugong Specialist Study. Environmental Impact Assessment for the Proposed Pipeline from Temane Liquids Processing Facility to a Floating, Storage & Offloading Unit Offshore of the Inhambane Province, in Mozambique. SASOL PETROLEUM Mozambique, Impacto and ERM.
- Guissamulo, A. T. C. M. Bento & H. J. Curecure. (2016). Report of aerial surveys in the Greater Bazaruto Archipelago area (between Save River and São Sebastião peninsula), Inhambane Province, Mozambique, 26-28 April 2016. Environmental impact assessment for the pipeline from the Temane Liquids Processing Facility to a Floating, Storage & Offloading unit in Inhambane Province, Mozambique. Report Submitted to Impacto, Lda.
- Hughes, G. (1971). Preliminary report on the sea turtles and dugongs of Moçambique. Veterinária Moçambicana, 4: 43-84.
- IFC, 2012. Performance Standard 8, Cultural Heritage. (www.ifc.org)
- IFC. (2012). Performance Standards on Environmental and Social Sustainability. World Bank Group, International Finance Corporation.
- IFC GN6 (2012) Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, in: World Bank Group - International Finance Corporation.
- IFC PS6 (2012) Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. World Bank Group - International Finance Corporation.
- Index mundi (2018). Mozambique demographic profile. https://www.indexmundi.com/mozambique/demographics_profile.html
- Institute for Health Metrics and Evaluation (IHME). Burden of Disease Estimates 2016: Mozambique. 2016 [cited 2018 July]; Available from: http://www.healthdata.org/mozambique.
- IUCN (2017) The IUCN Red List of Threatened Species, Version 2017-4. DOI:http://dx.doi.org/10.2305/IUCN.UK.2016- 3.RLTS.T22719744A94642482.en.

- IUCN (2018) Red List of Threatened Species, International Union for the Conservation of Nature. Available from: http://www.iucnredlist.org [Accessed 20 August 2008].
- IUCN (2018). The IUCN Red List of Threatened Species. < http://www.iucnredlist.org/> Accessed 09 September 2018.
- Lutjeharms, J.R.E. 2006. The coastal oceans of south-eastern Africa. Submitted to The Sea, Volume 14.
- Mark Wood Consultants. 2001. Sasol Natural Gas Project – Mozambique to South Africa: Environmental Impact study of a proposed natural gas field at Temane and Pande in Mozambique.
- Marsh, H. 2008. Dugong dugon. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 16 March 2015.
- Mott MacDonald (2011) Mozambique Regional Transmission Backbone Project, ESIA.
- Musick, J.A., Grubbs, R.D., Baum, J. & Cortés, E. (2009). Carcharhinus obscurus. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 16 March 2015.
- Mvungi, E.F. (2011). Seagrasses and eutrophication - Interactions between seagrass photosynthesis, epiphytes, macroalgae and mussels. Printed in Sweden by Universitetservice, US-AB, Stockholm 2011. Distributor: Department of Botany, Stockholm University.
- Pereira, M. A. M. & E. J. S. Videira. (2009). Relatório de especialidade: ecologia marinha. In: Vaz, K., P. Norton, R. Avaloi, H. Chambal, P.S. Afonso, M.P. Falcão, M.A.M. Pereira & E.J.S. Videira (2009), Plano de maneio do Parque Nacional do Arquipélago do Bazaruto 2009-2013. Vol.2 Estudos de especialidade. MITUR/DNAC. Pp. 317.
- Pereira, M. A. M., C. Litulo, R. Santos, M. Leal, R. S. Fernandes, Y. Tibiriçá, J. Williams, B. Atanassov, F. Carreira, A. Massingue & I. Marques da Silva (2014). Mozambique marine ecosystems review. Final report submitted to Fondation Ensemble. 139 pp. Maputo, Biodinâmica/CTV.
- Project Seahorse (2003a). Hippocampus borboniensis. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 16 March 2015.
- Project Seahorse (2003b). Hippocampus camelopardalis. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 16 March 2015.
- Project Seahorse (2003c). Hippocampus fuscus. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 16 March 2015.
- Provancha, J. A. & E. D. Stolen. (2008). Dugong Aerial Survey Report. Bazaruto Archipelago National Park, Inhambane Province, Mozambique. WWF. Dynapac Corporation. 29 Pp.
- Reddy, S.J (1984). Earth and Water Series. General Climate of Mozambique. National Institute of Agronomic Investment. Communication 19a. Maputo, Mozambique.
- Reilly, S.B., Barlow, J., 1986. Rates of increase in dolphin population size. Fishery Bulletin 84, 527–533.
- Rrequal, Ancient & Golder Associados Moçambique Ltd, 2014, PSA Development and LPG Project - Cultural Heritage Report.
- Sætre, R. and AntóóJorge da Silva (1984) The circulation of the Mozambique Channel. Deep-Sea Research, 31(5), 485-508.
- Sætre, R. (1985) Surface currents in the Mozambique Channel. Deep-Sea Research, 31(12), 1457-1467.

- Samoilys, M., Pabari, M., Andrew, T., Maina, G. W., Church, J., Momanyi, A., Mibei, B., Monjane, M., Shah, A., Menomussanga, M., Mutta, D. (2015). Resiliance of coastal systems and their human partners in the western Indian Ocean. IUCN ESARO, WIOMSA, CORDIO and UNEP Nairobi Convention. Nairobi, Kenya. 88 pp.
- Sasol (2014). Mozambique Gas to Power (MGTP). Mozambique Gas to Power Plant Project Configuration Study Report.
- Sasol (2014). Mozambique Gas to Power Plant (MGTP). Conceptual Design Report. OCGE Conceptual Design Phase Report.
- Sasol (2014). Mozambique Gas to Power Plant (MGTP). Conceptual Design Report. CCGT Conceptual Design Phase Report.
- Schoeman, J.L. & Verster, E., 2014. Soils Report. In Sasol Petroleum Limited: Psa Development and LPG Project. Golder Africa.
- Simpson, E. S. W., 1974. Southeast Atlantic and Southwest Indian Oceans. Chart 125A, bathymetry.
- Smale, M.J. 2009. Dasyatis chrysonota. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 16 March 2015.
- Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdana, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A., & Robertson, J. (2007). Marine Ecoregions of the World: A Bioregionalisation of Coastal and Shelf Areas. Bioscience (57,7), pp 573-583.
- Tibiriçá, Y. (2013). Nudipleura of Mozambique. Proceedings of the World Congress of Malacology, Açoreana Revista de Estudos Açoreanos, Suplemento 8: 188.
- UNEP/CSIR. 2009. Guidelines for the Establishment of Environmental Quality Objectives and Targets in the Coastal Zone of the Western Indian Ocean (WIO) Region. (October).
- USAID (2017) Greenhouse Gas Emissions in Mozambique, www.climatelinks.org [accessed on 29 August 2018].
- USAID (2018). Climate Risk Profile Mozambique. USAID Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) Task Order No. AID-OAA-I-14-00013. Accessed 03 October 2018. <https://www.climatelinks.org/sites/default/files/asset/document/2018_USAID-ATLAS-Project_Climate-Risk-Profile-Mozambique.pdf>
- Videira, E. J. S., M. A. M. Pereira, C. M. M. Louro & D. A. Narane (eds.). (2008). Monitoring, tagging and conservation of marine turtles in Mozambique; Historical data and annual report 2007/08. 85 pp. Maputo, Grupo de Trabalho Tartarugas Marinhas de Moçambique (GTT).
- Wiswedel, S. 2012. Hippocampus histrix. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 16 March 2015.
- WWF & UNEP 2004. Towards a Western Indian Ocean Dugong Conservation Strategy: The Status of Dugongs in the Western Indian Ocean Region and Priority Conservation Actions. WWF, Dar es Salaam, Tanzania. 68 pp.
- WWF (2010). Marine Protection in Mozambique's Bazaruto Archipelago. < http://wwf.panda.org/who_we_are/wwf_offices/mozambique/wwf_mozambique__our_solutions/projects/index.cfm?uProjectID=MZ0010 > Downloaded on 16 March 2015.

- **Internet Sources:**

  - SANA 10103, (https://www.sabs.co.za/sectors-and-services/services/ems/ems_sp.asp). (South African National Standard (SANS) 10103**)**
  - (http://apps.who.int/iris/ bitstream/10665/69477/1/ WHO_SDE_PHE_OEH_06.02_eng.pdf)
  - (http://www.who.int/water_sanitation_health/dwq/fulltext.pdf).
  - (http://www.adc40.org/docs/schwela.pdf).
  - (https://www.epa.gov/iris/basic-information-about-integrated-risk-information-system)
  - www.industcards.com
  - www.wartsila.com

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