2 PROJECT DESCRIPTION

2.1 INTRODUCTION

This Chapter provides a description of the *Sasol Pipeline and FSO Project* and associated Project phases. This description is preliminary and for information purposes only. Additional information will be made available in the Environmental Impact Report (EIR), once a more detailed project description becomes available.

2.2 BACKGROUND AND PROJECT NEED

Sasol has obtained approval from the Mozambique Council of Ministers for the Production Sharing Agreement's (PSA) Field Development Plan (FDP) that will see further hydrocarbon resources developed to support the economic growth of Mozambique. As discussed in *Chapter 1*, the PSA Development comprises various hydrocarbon reservoirs in the Temane, Pande and Inhassoro areas. In order for Sasol to accommodate the increased requirement for processing, the Temane Central Processing Facility (CPF) will be expanded to process additional gas, condensate and stabilised light oil. Sasol has an approved EIR for the PSA Development and LPG Production Projects.

The PSA Development will be developed in phases. Phase 1 includes an integrated stabilised light oil and Liquid Petroleum Gas (LPG) project adjacent to Sasol and its partners' existing Petroleum Production Agreement (PPA) CPF Plant area.

Subject to the satisfactory outcomes of the initial PSA drilling campaign (in 2016 and 2017), the Liquids Processing Facility (LPF), adjacent to the existing Temane CPF, is expected to process 15 000 barrels of stabilised light oil per day. Sasol intends to export this stabilised light oil through a pipeline from the new LPF, adjacent to the existing Temane CPF, to an offshore Floating, Storage and Offloading unit (FSO) north of the Bazaruto Archipelago (*Figure 1.3)*. The FSO will have the capacity to store up to 500 000 bbl of stabilised light oil onboard and to offload 300 000 bbl within 24 hours.

2.3 PROJECT LOCATION

The Project is located in the southern region of Mozambique's Inhambane Province (*Figure 1.3)*, the capital of which is Inhambane town. The proposed onshore pipeline route from the new LPF to the shore crossing will be approximately 57 km long. The shore crossing is located approximately 20 km north of Inhassoro.

The proposed offshore pipeline route (located within a planned 700 m wide survey corridor) to the FSO extends approximately 50 km in a northeast direction from the shore crossing. The FSO will be installed at a fixed location within a 2 x 2 km block (*Table 2.1* and *Figure 2.1)*, approximately 50 km north east of the Bazaruto Archipelago National Park (BANP), inside the Exclusive Economic Zone (EEZ), at a water depth of approximately 50 m. A detailed survey (prior to construction) will confirm the preferred location of the FSO within the 2 x 2 km block.

Table 2.1 The Coordinates of the FSO Location Block

Latitude (South)	Longitude (East)
21°7'49.37"	35°33'39.94"
21°7'21.81"	35°34'42.82"
21°8'20.82"	35°35'11.98"
21°8'48.09"	35°34'9.41"

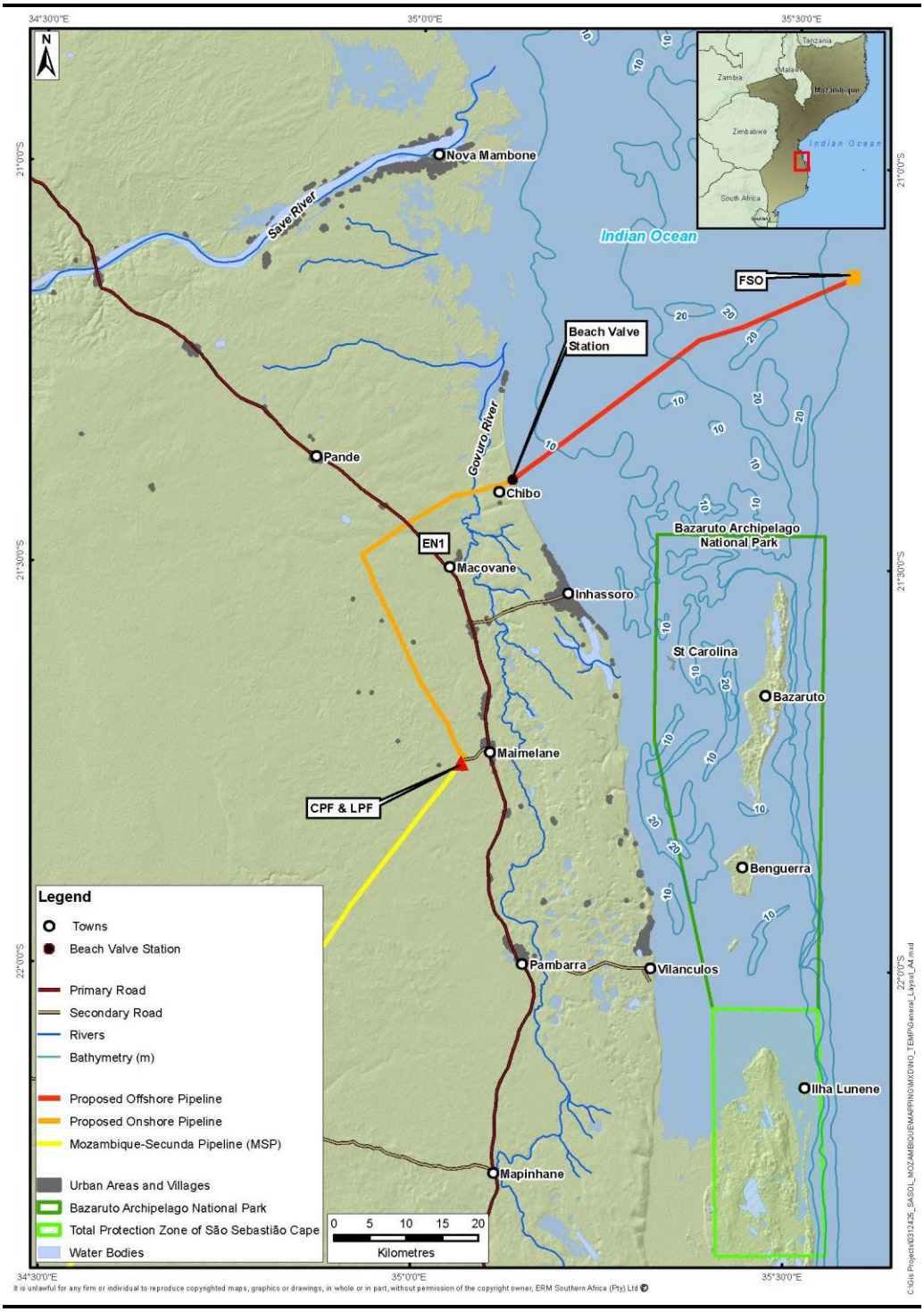
Four different alternatives for the FSO location were assessed during the Screening Phase (*Section 2.5*). A key reason for selection of the preferred FSO location was its greater distance from Bazaruto, the nearest island in the BANP, and the mainland.

2.4 PROJECT AREA

The Project Area comprises the various environmental and socio-economic receptors that may be affected both directly and indirectly by the Project activities described below. The Project Area can be separated into Areas of Direct Influence (ADI) and Areas of Indirect Influence (AII) depending on the source and causes of the impacts and these will vary in extent depending on the type of receptor affected.

The baseline environment of the Project Area is described using available data in *Chapter 5* (biophysical) and *Chapter 6* (socio-economic) as the basis for identifying potential impacts in *Chapter 7*. From the baseline information and identified impacts, a categorisation of ADI and AII for each receptor type is summarised in *Chapter 8* as the basis for defining the study areas for the specialist studies.

Figure 2.1 A Map of the Project Area



2.5 *ALTERNATIVES ASSESSED FOR THE PROJECT*

Following the completion of the feasibility study, the Pipeline and FSO concept was selected for further definition. The Engineering Team has assessed a number of potential location alternatives for the pipeline routes from the LPF to the FSO.

The options were assessed against the following criteria:

- Safety to operations (ie risks to existing infrastructure and potential third party interference);
- Construction and Operational Safety and Health and Environment (SHE);
- Environmental and Social considerations;
- Technical difficulty/ Constructability;
- Schedule; and
- Cost.

2.5.1 Onshore Pipeline Route Alternatives

A pipeline corridor assessment was completed in 2014 (Genesis, 2014) which evaluated a number of potential routes available for the pipeline from the LPF at Temane to the offshore FSO.

As detailed under *Figure 2.2* the following onshore pipeline route options were evaluated:

- Base Case Route: pipeline length of 57 km;
- Route Option A: pipeline length of 48 km;
- Route Option B: pipeline length of 45 km; and
- Route Option C: pipeline length of 146 km

The base case and Options A and B are all routed to the north of the Temane CPF towards a common landfall location which avoids environmentally sensitive wetland/ mangrove areas further north and populated areas around Inhassoro to the south. Route Option C is routed to the south of the CPF towards a landfall location far south of BANP.

The base case was considered to present the most favourable option when taking into account all of the above criteria, which can be summarised as:

- Limited habitat fragmentation by optimising use of existing pipeline corridor;

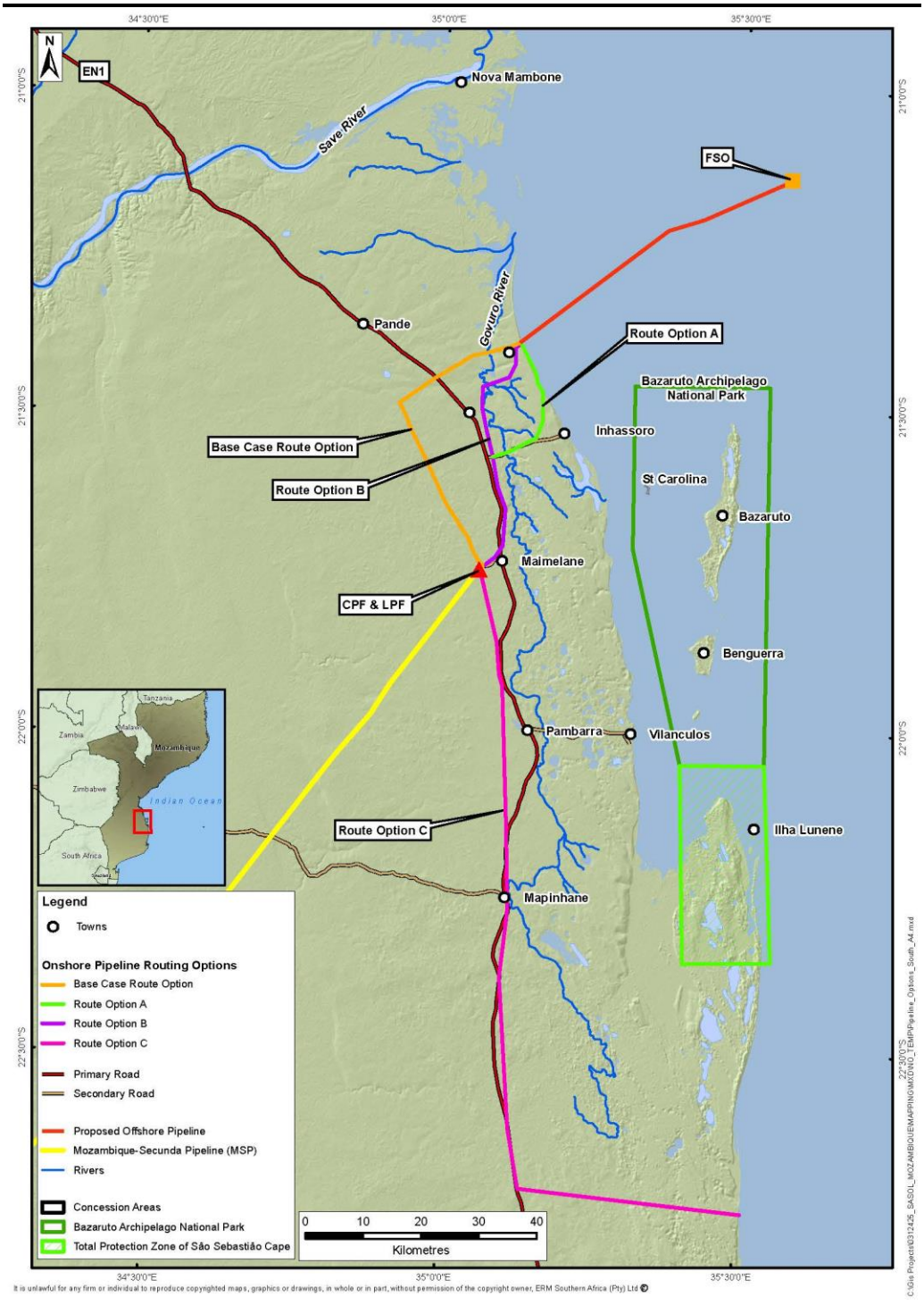
- Minimised routing through flood plain areas (deemed high value catchment area and sensitive environmental receptor);

- Minimising potential disturbance to tourism and recreational development by avoiding a pipeline route along the coastline;

- Reduced risk of third Party interference for section of route following existing Pande trunkline corridor ; and

- Reduced risk of road traffic and pedestrian accidents by avoiding transport construction along EN1 highway.

Figure 2.2 Alternatives Considered for the Onshore Pipeline Routes



2.5.2 *Offshore Pipeline Route and FSO Location Alternatives*

At the feasibility stage, four potential FSO locations were identified at a 50 m water depth contour with the following distances from Bazaruto Island (*Figure 2.3*):

- Location 1 - 52 km;
- Location 2 – 50 km;
- Location 3 – 31 km; and
- Location 4 – 19.5 km.

A 50 m water depth was selected in order to accommodate the riser and mooring system design for the anticipated metocean conditions and to provide sufficient water depth to allow safe shuttle tanker approach and departure.

Location 2 was selected as the preferred FSO location on the basis of:

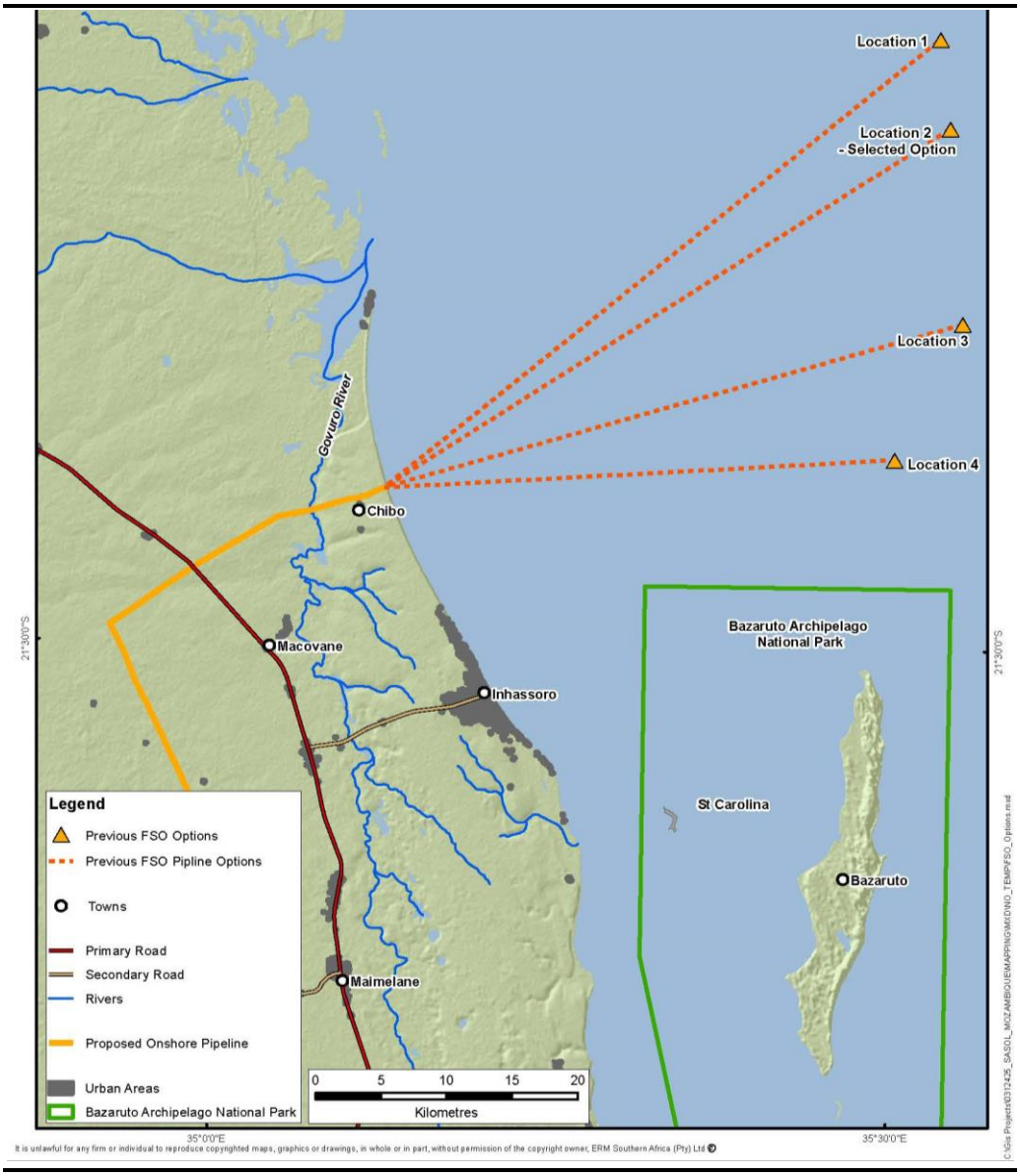
- FSO and shuttle tankers are expected to have no visual impact upon Bazaruto Island (depending on elevation above sea level);
- Provision of sufficient water depth to determine a clear manoeuvring area for the shuttle tanker approach and departure ;
- Minimisation of overall pipeline length compared to FSO location options further north of Bazaruto Island;

The main reason for the selection of the offshore pipeline route is the landfall and FSO location. The following criteria have been used to determine the offshore route:

- Minimum distance between shore crossing and FSO;
- Minimised pipeline length in shallow water to optimise pipeline stability;
- Avoidance of shallow water areas marked on marine charts (eg potential coral outcrops);
- Minimised impacts upon seagrass beds (which are often associated with dugong presence) through selection of nearshore approach through seagrass beds at their narrowest point; and
- Avoidance of existing shipping channels.

A marine survey will be conducted before construction of the pipeline in order to collect information required to confirm the final FSO location and offshore pipeline route.

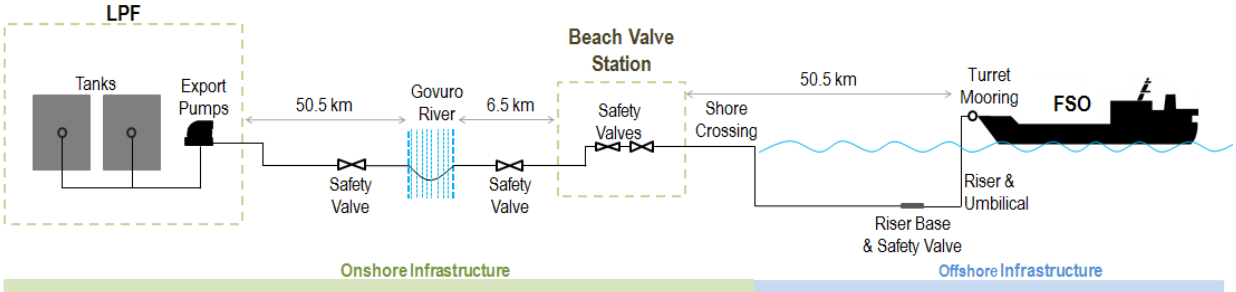
Figure 2.3 FSO Location Alternatives Assessed



2.6 PROJECT FACILITIES AND INFRASTRUCTURE

The Project includes the following facilities and infrastructure, depicted in *Figure 2.4* below. All Project infrastructure and equipment will have a design life of 15 years.

Figure 2.4 Sasol Pipeline and FSO Project Process Illustration



2.6.1 *Onshore Infrastructure*

Light Oil Export Facilities

The stabilised light oil export facilities (pumps and pipeline servicing infrastructure) will be located within the LPF (*Figure 1.3*), located adjacent to the existing Temane CPF. It will comprise a manifold, metering skid, export pumps and a temporary 'pig' (pipeline inspection gauge) launcher and receiver. The export pumps will pump stabilised light oil from four tanks, located inside the LPF site, to the FSO.

- **Export Pump –** a pump that provides enough pressure to transport the light oil along the pipeline.
- **Manifold –**a wide and/or bigger pipe connector into which smaller pipes lead.
- **Metering skid**- a special platform on which various devices and instruments are installed.
- **Pig Launcher / Receiver–** a device installed on the pipeline to launch/ receive 'pigs' (pipeline inspection gauges). These pigs perform various operations (eg: cleaning, inspection) in a pipeline without stopping the flow of the product.

Onshore Pipeline

The onshore pipeline route will start at the LPF and will follow the northward route of the existing Pande trunkline corridor, for a distance of approximately 32 km north of Temane.

The terrain along the Pande trunkline is generally flat comprising a mixture of subsistence agriculture and woodland. This section of the pipeline is aligned along the east side of the existing trunkline Right of Way (ROW) for most of the north-south section of the route in order to minimise the additional bush-clearing required for construction.

The onshore pipeline turns north eastward towards the shore crossing, at a distance of approximately 33 km from the LPF. This section of the route corridor traverses relatively undisturbed habitat. It crosses the EN1 national road and utilities at approximately 8 km from the pipeline turn, and then approximately 10 km from the EN1 it crosses the Govuro River and its floodplain.

Approximately 6 km from the Govuro River the onshore pipeline terminates at the beach valve station approximately 20 km north of Inhassoro. This section of the route traverses an area of scattered rural settlement, subsistence cropping and secondary woodland. The entire onshore pipeline from the LPF to the beach valve station will be below ground.

Figure 2.5 Example of the Construction of a Pipeline and Associated Right of Way

Source: Golder, 2015

Remotely actuated mainline valves will be installed on either side of the Govuro River crossing, which can be closed from the LPF in the event of an emergency, preventing the continued flow of product into the river. The pipeline will be a 10 inch welded carbon steel pipeline that meets the American Petroleum Institute (API) 5L specification.

- **Mainline valve-** a valve that will create a safety barrier, at the Govuro River, in order to minimise the amount of light oil spilled into the river due to a pipeline leak or rupture.
- **API 5L –** is an American Petroleum Institute specification for the welded steel pipeline that is suitable for transporting oil, water and gas.

Two different methods of protection will be implemented to protect the pipeline from corrosion. The first layer of protection comprises a coating of three-layer polyethylene (3 LPE) bonded to the pipeline and the second layer will comprise the introduction of a small electric current onto the pipeline (known as cathodic protection).

Shore Crossing and Beach Valve Station

The shore crossing site, approximately 20 km north of Inhassoro, comprises an approximately 35 m high cliff, leading to a gentle sloping sandy beach *(Figure 2.6)*.

Figure 2.6 ***A Photograph of the Proposed Shore Crossing***

Source: ERM, 2015

The beach valve station (including pipeline servicing, testing, and safety and maintenance systems) will be inland from the top of the cliff and will have a footprint of approximately 30 m x 30 m. The beach valve station will include two connections for a temporary pig launcher/receiver to pig either the onshore or offshore pipeline. The function of the beach valve station is to isolate the onshore and offshore pipelines and provide a facility to aid pigging of either pipeline.

Pigging - refers to the practice of using an inspection gauge called a 'pig' which is inserted into a pipeline for the purposes of displacing or separating fluids, or cleaning or inspecting the pipeline to perform various maintenance operations on pipelines. These operations include but are not limited to cleaning and inspecting the pipeline.

The pipeline will be cleaned using "cleaning pigs" *(Figure 2.7)*; this activity is envisaged to be performed every two years for the duration of the operation. For the purposes of pipeline inspection, maintenance and monitoring, "intelligent pigs" may be used. Intelligent pigs are sophisticated instruments that include electronics and sensors to collect various data measurements along the pipeline to identify and monitor integrity issues.

Figure 2.7 ***Example of a Typical Cleaning Pig***

Source: www.rosen-group.com

Manually actuated isolation valves will also be installed on both the offshore and onshore pipeline at the beach valve station, providing a safety barrier, isolating the onshore and offshore pipeline if and when required. A summary of the onshore pipeline and supporting infrastructure design specifications and safeguards are provided in *Table 2.2* and *Box 2.1.*

Isolation valve- - a valve that will create a safety barrier, at the beach valve station, in order to isolate either the onshore or offshore pipelines in the event of a leak or other emergency.

2.6.2 *Onshore Marine Supply Base in Beira*

The marine supply base will be located within the Port of Beira, on an existing brownfield site (previously developed land) and therefore it is not included in this EIA process. The supply base will provide all the supplies, support vessel and services for the FSO.

In order to support emergency response and operational logistics of the FSO a Marine Support Vessel (MSV) will be stationed permanently outside the FSO 500 m safety exclusion zone (refer to *Section 2.6.3*). This vessel will act as a guard vessel ensuring that other maritime users remain outside of the FSO 500 m safety exclusion zone and provide firefighting and spill response capability in the case of emergency. The MSV will have a core crew of 15 to 18 people. In addition to the MSV, a dual purpose vessel will perform crew changes and supply logistics including waste transfer to and from the Port of Beira.

This vessel will also perform the role as an anchor handler during offloading from the FSO. It is expected that the vessel will remain in the vicinity of the FSO location for approximately 26 days per month and will also be fitted with firefighting equipment on board. The core crew of this vessel will be approximately 10 people.

Anchor handler - a vessel that tows the shuttle tanker to its offloading location and anchors it.

The marine supply base will also receive all wastes from the construction of the onshore pipeline as well as the wastes from the FSO during both construction and operations phases. Licensed waste contractors will be appointed to sort and dispose of the wastes appropriately, in accordance with Mozambique legal requirements.

Table 2.2 Onshore Pipeline and Supporting Infrastructure Design Specifications

Characteristic	Description
Pipeline diameter	10 inches
Pipeline burial	The onshore pipeline will be trenched and buried from the LPF to the beach valve station.
Pipeline depth of cover	Minimum 1m to top of pipe
Pipeline depth below river	Trenchless crossing 3 m below Govuro River bed
Pipeline material and coating	Carbon steel (API 5L x 60) Three-layer polyethylene (3 LPE)
Pipeline corrosion protection (cathodic	Onshore – 3 LPE coating & impressed current

Characteristic	Description
Pipeline diameter	10 inches
protection)	cathodic protection Offshore – 3 LPE coating & cathodic protection
Pipeline permanent surface markers	Onshore pipeline, generally inter-visible along the centreline of the pipeline
Permanent fencing	Permanent fencing around all mainline valves ie above ground installations
Remotely actuated mainline valves	Installed on either side of the Govuro River crossing
Manually actuated isolation valves	Installed on both the offshore and onshore pipeline at the beach valve station
Onshore marine supply base	Located within the Port of Beira, on an existing brownfield site

Box 2.1 Main Design Safeguards for the Onshore Pipeline and the Onshore Supporting Infrastructure

- Entire onshore pipeline will be buried to prevent tampering with the pipeline by third parties;
- Pipeline routing will avoid, if possible, onshore environmental sensitivities;
- Trenchless crossings to minimize construction impacts at the Govuro River and shore crossing;
- Remotely actuated mainline valves located either side of the Govuro River to isolate the crossing in the event of a leak or other emergency;
- Manually actuated isolation valve at the beach valve station to isolate either the onshore or offshore pipeline in the event of a leak or other emergency; and
- Pipeline corrosion protection and leak detection systems.

2.6.3 Offshore Infrastructure

Offshore Pipeline

The offshore pipeline route extends from the beach valve station to approximately 50 km offshore. It is anticipated that the pipeline will be buried where water depths are less than 10 m in order to maintain pipeline stability at shallow water depths. Where possible, the final pipeline route will avoid sensitive areas such as seagrass beds, coral reefs and areas typically used by artisanal and semi-industrial (small-scale) fishermen.

The proposed offshore pipeline will also cross an existing buried subsea fibre optic cable (FOC). Concrete mattresses will be installed on the seabed above the FOC, which the pipeline will then be laid over, in order to spread the load and protect the FOC from damage. There are no requirements for offshore pipeline crossings of any other existing infrastructure. The offshore pipeline will be designed to allow easy inspection and cleaning. To achieve this, the pipeline will be equipped with temporary pig traps, one at the subsea riser base, and one at the beach valve station.

Riser Base, Subsea Isolation Valve, Riser and Umbilical

The riser base will be situated on the seabed, approximately 50 km offshore. The riser base will connect the pipeline to the FSO through a flexible pipeline called a riser together with an umbilical. The riser and umbilical will attach to the turret mooring on the FSO. The riser base includes a Subsea Isolation Valve (SSIV). The SSIV enables the import of stabilised light oil to the FSO to be isolated at the riser base in the event of an emergency. The SSIV is controlled and actuated remotely from the FSO through the umbilical. The SSIV is a fail-safe system ie should the FSO communication with the SSIV fail, it will automatically close.

- **Subsea Isolation Valve (SSIV) -** a valve that will create a safety barrier, at the riser base and FSO, in order to minimise the amount of light oil released into the sea due to leak or rupture on the offshore pipeline and/or riser.
- **Riser -** flexible pipeline which transfers the light oil from the riser base on the seabed to the surface.
- **Riser base -** a subsea support structure to tie in the pipeline and connect to the umbilical**.**
- **Umbilical -** flexible hose providing hydraulic power and controls to the FSO.

A summary of the offshore pipeline and associated infrastructure design specifications and safeguards are provided in *Table 2.3* and *Box 2.2* below.

Table 2.3 Offshore Pipeline and Associated Infrastructure Design Specifications

Characteristic	Description
Pipeline diameter	10 inches
Pipeline burial	Buried where water depths are less than 10 m
Planned survey corridor width	700 m
Safety Exclusion Zone	500 m during construction
FSO and subsea infrastructure	50 m water depth (to be confirmed by Offshore Survey)
Riser base	• Designed to minimise fishing equipment interaction • Subsea Isolation Valve (SSIV) • Retrievable pig trap

Box 2.2 Main Design Safeguards for the Offshore Pipeline and Associated Infrastructure

- Pipeline routing to avoid, where possible, offshore environmental sensitivities;
- 500 m safety exclusion zone during construction;
- Buried where water depths are less than 10 m to provide pipeline stability in shallow water;
- Pipeline designed to enable inline inspection and cleaning;
- Concrete mattresses placed over FOC prior to pipeline installation; and
- SSIV at the riser base to shut off the supply of light oil in the event of an emergency.

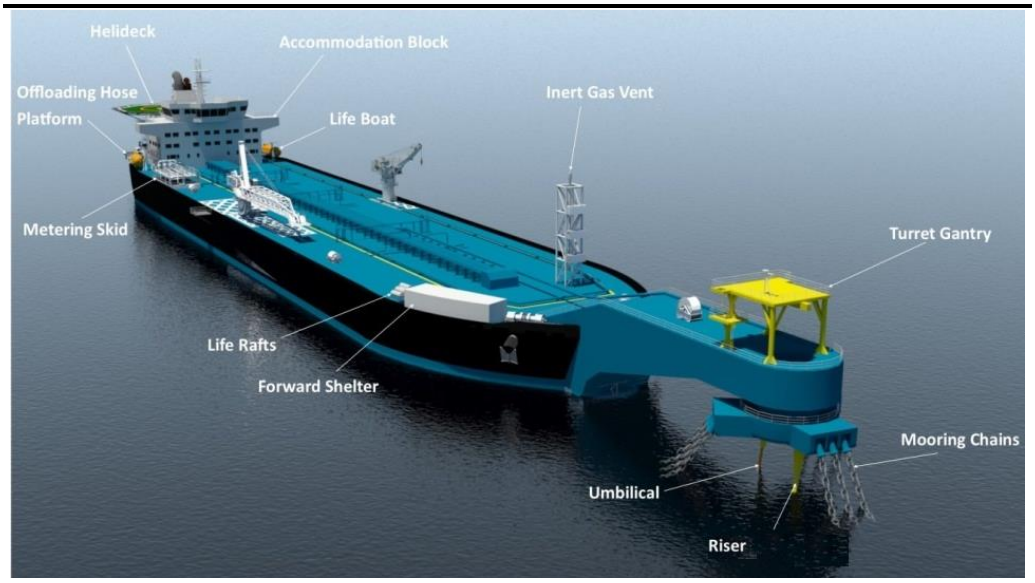
Floating Storage and Offloading Unit (FSO) and Turret Mooring

The FSO (*Figure 2.8*) will be located in the Mozambique Channel north of Bazaruto Island and as such shall be subject to compliance with the Government of Mozambique's rules and regulations as well as international treaties to which Mozambique is a signatory. The FSO is likely to be a converted medium-sized tanker (Aframax) of between 95 000 and 110 000 dead weight tonnes (DWT) that is that is less than ten years old at the time of conversion.

- **FSO -** is a permanently moored, floating vessel used for the storage and offloading of stabilised light oil.
- **Turret Mooring System -** consists of a turret swivel assembly that is integrated into a vessel and permanently fixed to the seabed by means of a mooring system. This system allows the vessel to rotate around the fixed part of the turret into the direction of oncoming seas when the FSO requires protection from high winds, waves and strong currents.

The FSO will measure approximately 234 m in length and 42 m in breadth with an operating draft of 7 to 15 m (below the water line). The hull of the FSO will be double-sided and double-bottomed to protect against any loss of stored hydrocarbons in the event of a collision or impact. The FSO will be designed for a continuous service life of 15 years without dry docking and for operation in 50 m water depth.

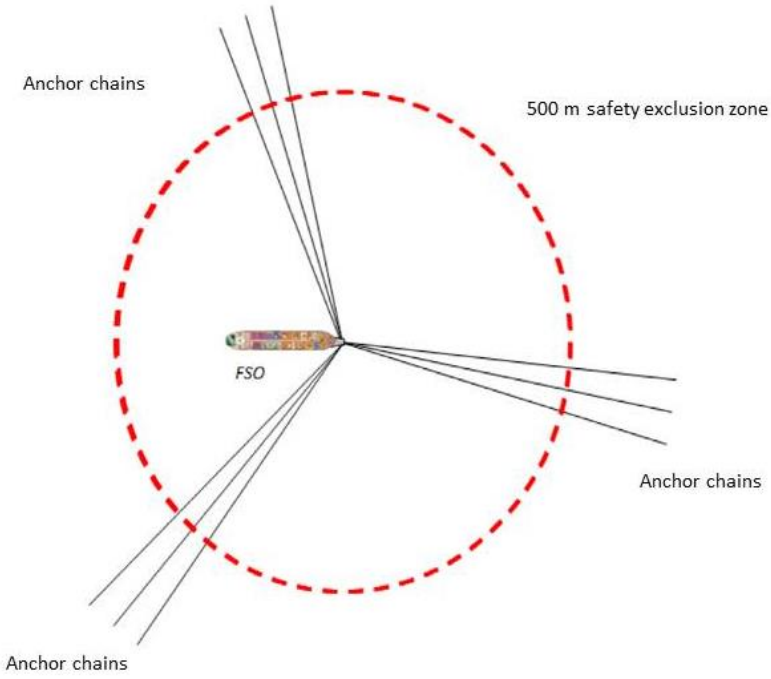
Figure 2.8 Floating Storage and Offloading Unit (FSO)



The FSO will have accommodation for 50 personnel to allow for sufficient crew onboard during high manning periods such as the initial hook-up and commissioning phase. Normal manning levels will require 35 to 38 personnel on board (POB) during operations. The living quarters will be located toward the aft (rear) of the FSO.

The FSO will be permanently moored, inside a 500 m safety exclusion zone (*Figure 2.9*), to the seabed using an external bow mounted Turret Mooring System (*Figure 2.10*), in accordance with the station-keeping requirements of ISO-19007-1. The mooring system will be installed at the forward part of the FSO.

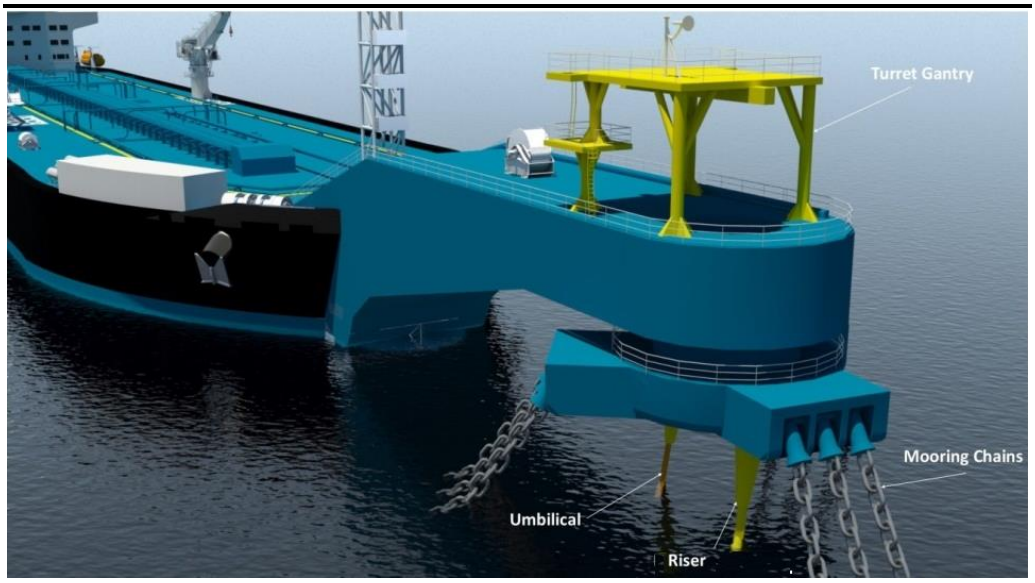
Figure 2.9 Schematic of the 500 m FSO Safety Exclusion Zone



Mooring lines will run from the turret to anchors on the seabed. The FSO turret mooring system will require nine anchor chains arranged in three bundles and nine anchors. The anchors will be located at a radius of approximately 900 m from the turret.

A Tandem Offloading System with an Offloading Hose will be installed at the rear of the FSO. The Offloading Hose will comprise a double carcass designed to contain potential spills from the main carcass should this fail.

Figure 2.10 Turret Mooring System (TMS)



The FSO, including the Turret Mooring System (TMS), will be classed, ie designed in accordance with the requirements of a member of the International Association of Classification Societies (IACS). A classification society is a non-governmental organization that establishes and maintains technical standards for the construction and operation of ships and offshore structures. The society will also validate that construction is according to these standards and carry out surveys every five years to ensure continued compliance.

The FSO will also have a Flag State Authority. The Flag State has the authority and responsibility to enforce regulations over vessels registered under its flag, including those relating to inspection, certification, and safety and pollution prevention. The FSO will comply with all applicable national and international maritime conventions, acts, codes, rules and regulations, including:

- International Convention for the Safety of Life at Sea (SOLAS);
- International Convention on Load Lines;
- International Convention on Tonnage Measurement of Ships;
- International Convention for the Prevention of Pollution from Ships (MARPOL73/78);
- Regulations for Prevention of Collisions at Sea; and
- Regulations for Communications.

Table 2.4 FSO Design Specifications

Characteristic	Description
FSO dimensions	234 m length 42 m breadth Operating draft (7 to 15 m)
Water depth at FSO location	50 m
Hull construction	Double Hull Construction with Double Sided Fuel tanks
Mooring type	Permanent external turret mooring , 9 anchors and chains
Storage Capacity	500 000 barrels
Loading rate	15 000 barrels of stabilised light oil per day
Offloading rate	300 000 barrels over 24 hours
Safety Exclusion Zone	500 m
Persons on Board (POB)	50 (maximum) 35 to 38 (normal operations)
Minimum Age of vessel:	Less than 10 years old at the time of conversion
Service Life	15 Years

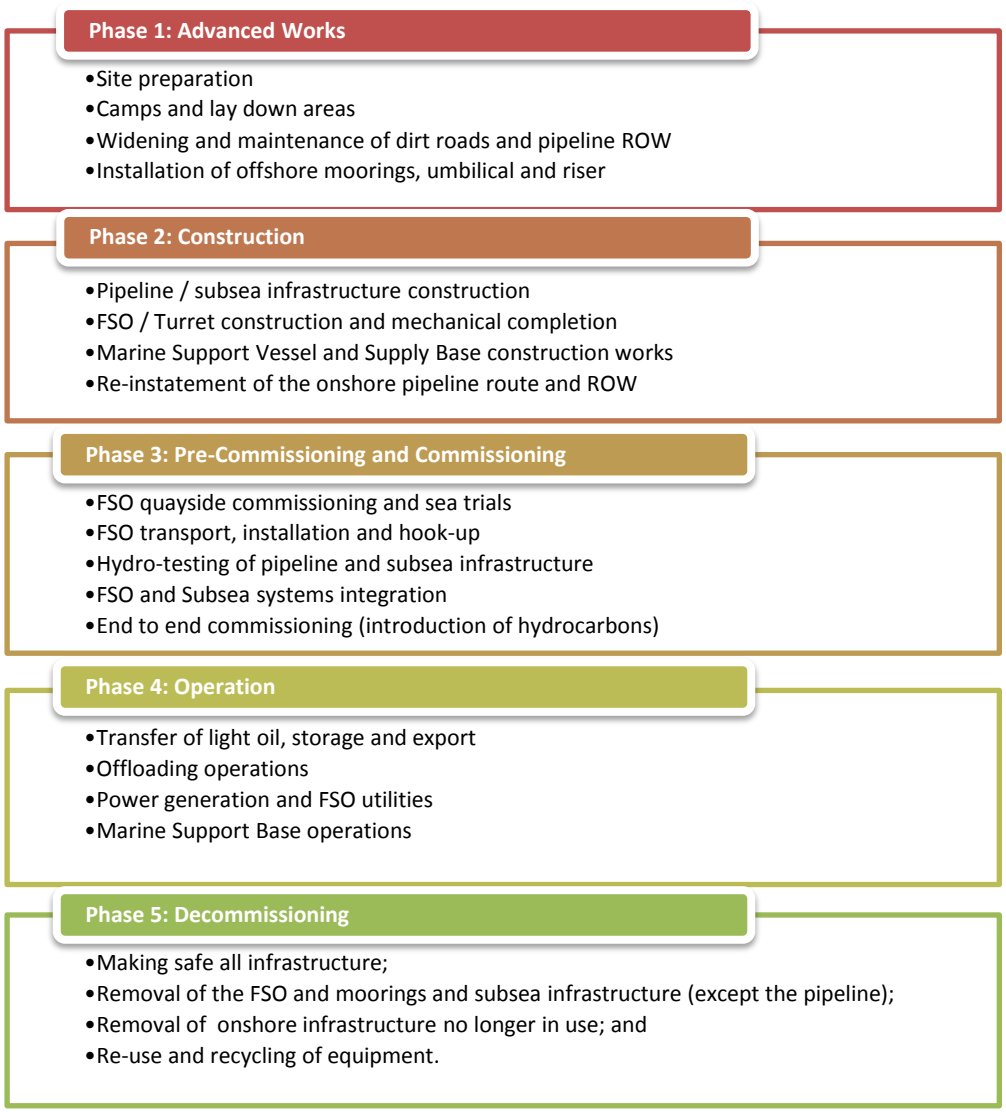
Box 2.3 Main Design Safeguards for the FSO

- Double hull construction to protect against hydrocarbon leaks in the event of an impact or collision;
- Stabilised light oil stored within 12 individual cargo tanks in order to minimise inventory loss in the event of an impact or collision;
- FSO located to minimise its visibility from the mainland and Bazaruto;
- Turret mooring system minimizes seabed footprint;
- A 500 m safety exclusion zone around the FSO and Mooring;
- Turret mooring system allows the FSO to rotate (or weather vane) according to sea state and wind direction and is designed to operate safely in extreme cyclonic weather conditions; and
- Cargo handling system spill prevention measures.

2.7 PROJECT PHASING

The planned activities over the lifespan of the Project are summarised in *Figure 2.11* and described in the text below.

Figure 2.11 Project Phases and Associated Activities



2.7.1 *Phase 1: Advanced Works*

Site Preparation

Site preparation onshore includes demining, vegetation clearance and topsoil removal and storage along the onshore pipeline corridor. There may be some clearing of the coastal vegetation in the vicinity of the beach valve station. This vegetation will be re-instated in line with an amended version of the Infrastructure Construction EMP (Golder, 2014a) for the PSA and LPG Project activities.

For the offshore pipeline route a debris survey will be undertaken prior to the installation of the offshore pipeline, subsea infrastructure and FSO, where any debris and fishing gear found along the offshore pipeline corridor and at the FSO site will be removed or avoided.

Camps and Lay Down Areas

For the duration of construction activities, camps and lay-down areas will be established in the vicinity of the CPF, along the pipeline corridor alignment and near the shore. Sasol intends to use existing camps and lay-down areas in the area subject to their availability during construction. These camps will support the workforce involved in construction activities and provide support services, including offices, clinic, workshops, warehouses, accommodation, kitchens and ablutions and utilities.

Widening and Maintenance of Dirt Roads and Pipeline Right of Way

The existing dirt road from Inhassoro heading north along the coast will be used to provide construction vehicles access to the shore crossing and beach valve station site, and may require additional widening and grading. An access track to and along the pipeline ROW will be established that will be maintained for the life of the operation. There is also a possibility that a temporary bridge across the Govuro River will be installed to minimise the impact of construction traffic on local transport infrastructure. The temporary bridge would be installed at a suitable location in close proximity to the pipeline crossing to enable vehicles to drive on the pipeline ROW and restrict increased road traffic.

Installation of Offshore Moorings, Riser and Umbilical

The turret mooring, anchors and anchor chains, riser and umbilical will be installed offshore using an Anchor Handling Tug and support vessels prior to the arrival of the FSO at its mooring location. The installation techniques will be confirmed and discussed in the EIR.

2.7.2 *Phase 2: Construction Activities*

Pipeline Construction

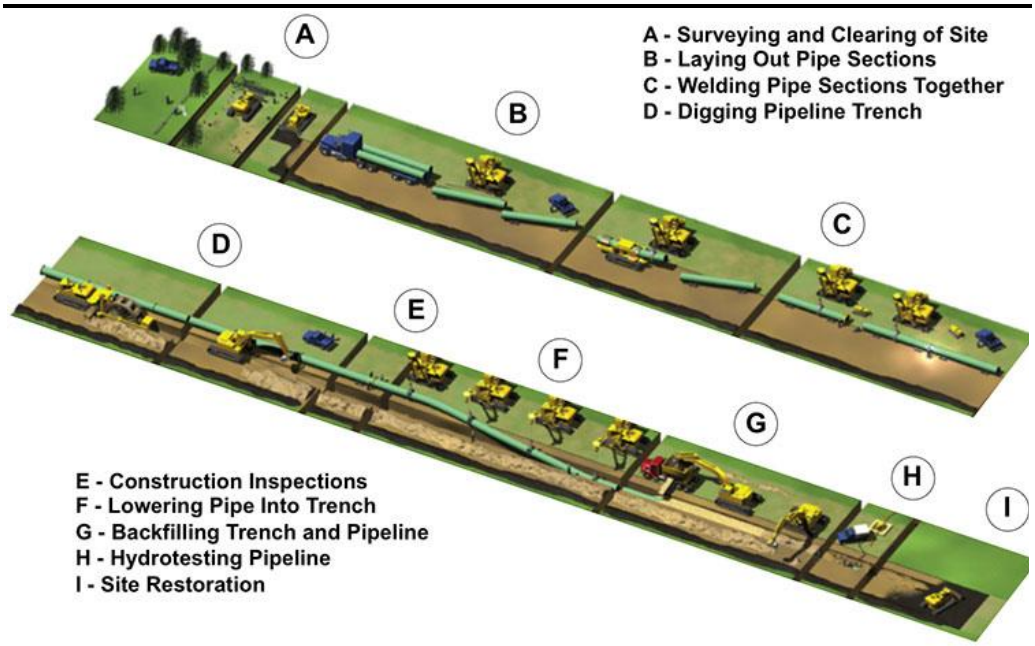
The preferred methodology for the construction of the onshore pipeline from the LPF to the beach valve station is to use standard construction techniques and for the pipeline to be trenched and buried (*Figure 2.12*).

The Pipeline Servitude / Partial Protection Zone (PPZ) is planned to be 50 m or less. The Servitude / PPZ is the land where the pipeline will be located, it requires any other entity wanting to conduct any activity or erect any infrastructure within the pipeline servitude / PPZ to seek prior permission from the certificate holder (Sasol).

In addition to the Pipeline Servitude / PPZ a Safety Zone is planned, this is an additional 50 m on either side of the pipeline servitude; this could be optimised if required. The Safety Zone is an area which housing or other infrastructure development is restricted. The topsoil will be stockpiled along the pipeline route in the pipeline ROW, and then re-instated following the completion of pipeline construction activities.

Auger boring is the preferred construction methodology for the EN1 road crossing and the Govuro River Crossing. The auger boring is expected to be completed within the 50 m wide construction ROW. The depth of the auger boring is determined by the geotechnical conditions encountered and capability of the contractor but will be approximately 3 m below the Govuro River bed. Following pipeline installation, the bore pits will be backfilled to match the original grade and rehabilitated.

Figure 2.12 Cross Section of Typical Trenching and Burial of an Onshore Pipeline



Source: Association of Oil Pipelines (AOPL)

Figure 2.13 Example of Auger Bore Technique for a Road Crossing

Source: US Department of Transportation (Federal Highways Administration)

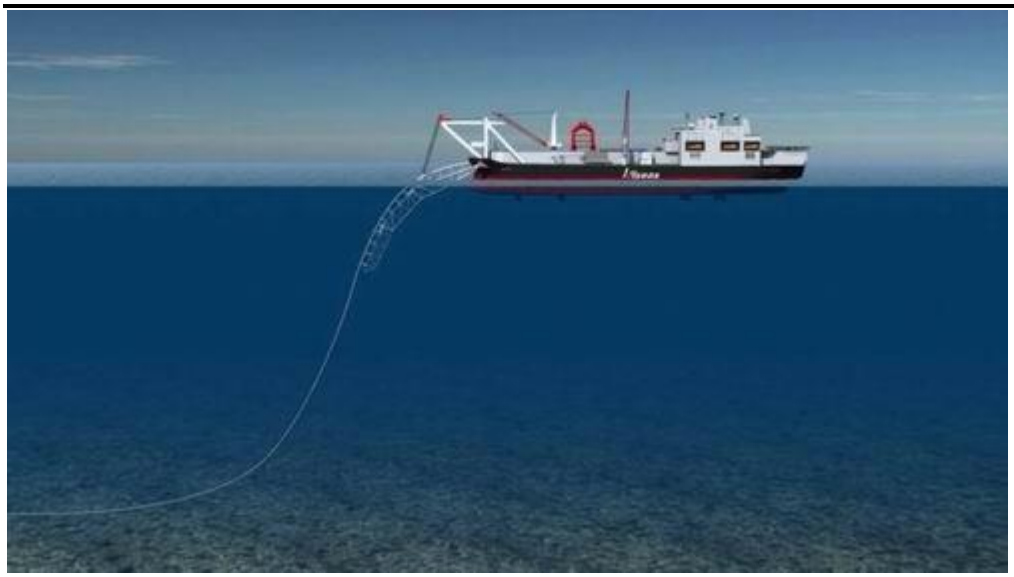
The preferred methodology (subject to nearshore geotechnical assessment) for the construction of the pipeline from the beach valve station to approximately 600 m offshore is using the Horizontal Directional Drilling (HDD) technique. HDD is a guided and trenchless method of installing underground infrastructure that will allow the pipeline to be installed beneath the beach and the immediate shoreline without surface exposure during construction.

The drilling mud and cuttings will be returned back through the hole to the beach valve station and the mud will be separated and reused and the cuttings disposed of in accordance with the Installation Construction EMP.

The rest of the offshore pipeline will be installed using a specialist pipelay barge. The most likely type of pipelay vessel is an anchored S-lay barge, as shown in *Figure 2.14*. Suitable barges are typically 120 to 150 m long, which includes a long support structure protruding from the vessel, called a stinger. The vessel will maintain correct position and speed using anchors. Pipeline sections are delivered to the pipelay barge in 12 m lengths by a separate barge.

The pipelay barge welds sections of pipe together and then applies a field joint coating over the bare steel as part of the corrosion protection system for the pipeline. As the pipeline gets longer the vessel, moves forward to progressively lay the pipe on the seabed. Following completion of the offshore pipelaying, the riser base will be installed at the pipeline spool tie in point. The installation techniques will be confirmed and discussed in the Project Description Chapter of the EIR.

Figure 2.14 Example of a Pipelay Barge for Offshore Pipeline Installation



Source: www.2b1stconsulting.com

FSO/ Turret Construction and Mechanical Completion

The construction and conversion of the FSO including hull fabrication, topsides fabrication, turret integration and shore based commissioning will be completed at a nominated Construction Yard.

The Turret will be fabricated separately at another facility and transported to a nominated yard for integration and commissioning. The Construction will ensure that completed works are tested and the required mechanical completion certification is in place before handing over the systems to the commissioning team.

Mechanical Completion (MC) requires that all construction and installation activities related, but not limited to equipment, piping, electrical services, instrumentation/control and utilities are physically complete and that inspection checks/tests have been performed to a level deemed satisfactory to Sasol. Additional construction works will take place in order to develop the marine supply base at the Port of Beira and the MSV.

Prevention of Access

For onshore construction activities the access to the existing construction camps will not change. However, access to the pipeline corridor during construction, notably at work fronts and open trenches, will be limited to ensure safety of the public. During construction, any impediment to access will be discussed with affected parties and alternative arrangements agreed upon with Sasol.

There will be a temporary 500 m safety exclusion zone around the installation and support vessels during installation of the offshore pipeline and subsea infrastructure including the moorings.

Ships, fishing vessels and other craft will not be allowed to access the safety exclusion zone during the advanced works and construction phases. This safety exclusion zone will be enforced by support vessels operating in the field.

2.7.3 Phase 3: Pre-Commissioning and Commissioning

FSO Quayside Commissioning and Sea Trials

The onshore (quayside) commissioning activities to be completed in the Conversion Yard prior to Sail away of the FSO will ensure that all systems required by Class are satisfactorily handed over to operations. Commissioning will also include a sea trial period for the FSO.

Once the systems are fully commissioned the FSO will be handed over to operations for the duration of the transportation to the installation location in Mozambique.

FSO Transport, Installation and Hook-Up

The FSO will depart from the tanker conversion facility (location to be confirmed) in full compliance with Class and Flag requirements (*Section 2.6.3*) and will be towed or be self-propelled to the FSO location.
Once the FSO arrives in the field, and a suitable weather window is available, a support vessel will pick up the pre-laid mooring lines from the seafloor and connect them to the TMS. After the last mooring line has been connected, the FSO will be classed as an installation. When fully installed, the FSO will be hooked-up to the subsea infrastructure, namely the umbilical and riser.

On completion of the FSO and subsea systems hook-up, both systems can be integrated and end to end commissioning, namely the introduction of hydrocarbons, can commence.

Pre-Commissioning and Commissioning of the Pipeline

Before normal pipeline operations can commence, the pipeline must be strength tested and prepared for the introduction of stabilised light oil. This will require the following steps:

- Initial pipeline cleaning;
- Filling the pipeline with water;
- Hydro-testing (strength testing the pipeline by pressurizing with water);
- Dewatering the pipeline; and
- Filling the pipeline with stabilised light oil (Commissioning).

The pipeline will be pigged to clean and check the pipeline quality is within acceptable limits. The pipeline will then be filled with water for hydro-testing. To fill the onshore section of pipeline, about 3 000 m^3 of freshwater will be required. Existing boreholes currently used by Sasol will be the preferred source and these may be supplemented with new wells if there is insufficient freshwater supply for the testing activities. Freshwater will be extracted at a low flowrate (approximately 0.03 m^3/s) before pumping into the pipeline. Approximately 3 000 m^3 of seawater will also be required for filling of the offshore pipeline, which will be drawn from the sea at the FSO location at a low flowrate and with the use of exclusion screens in order to minimise uptake of marine life. Once filled, the pipeline and subsea equipment will be hydro-tested in order to verify the pipeline's structural integrity and to check for leaks. The onshore and offshore sections of the pipeline will be hydro-tested separately.

The water used for testing the onshore and offshore pipeline sections will be filtered and treated with a package of chemicals designed to minimise corrosion of the pipeline.

The specific chemicals and additives to be used will be selected in accordance with internationally recognised classification systems with the intent to utilise those that are the least environmentally harmful.

Once the hydro-test has been completed for both sections of pipeline, the entire pipeline will be dewatered. Approximately 6 000m^3 of treated water will be discharged from the FSO over a period of around 24 hours. Dewatering will require pigging to displace the water from the pipeline, which will either be driven by compressed air or light oil (ie during pipeline commissioning).

Pipeline commissioning (hydrocarbon product filling) will not begin until the FSO is connected to the pipeline and the entire system is accepted as ready for

commissioning by Sasol. Pipeline commissioning will be performed by filling the pipeline with stabilised light oil from the LPF by displacing a pig first through the onshore pipeline and then the offshore pipeline to the FSO. The filling operation will be tracked by careful measurement of the volume of stabilised light oil introduced to the pipeline.

2.7.4 Phase 4: Operational Activities

Light Oil Storage and Export

The FSO will receive a continuous stream of incoming stabilised light oil from the onshore LPF. The FSO will be provided with an Inert Gas (IG) and venting system, the function of which is to maintain a non-explosive atmosphere at all times in the cargo storage, reception and slop tanks.

Tank venting on the FSO will occur during loading as the stabilised light oil cargo tanks are filled and the gas above the stabilised light oil is displaced. The composition of the vented gas will vary depending on the loading phase. At the beginning of tank filling, inert gas will be mostly vented, whilst a mixture of inert gas and hydrocarbon vapours (volatile organic compounds) will be vented as the tank fills. Most of the residual hydrocarbon vapours in the stabilised light oil will have already been removed via the stabilisation process at the onshore LPF.

A Volatile Organic Compounds (VOC) Management plan for the storage of stabilised light oil onboard the FSO will be developed in accordance with MARPOL Annex VI (Prevention of Air Pollution from Ships) with the objectives of minimising VOC emissions via effective control and maintenance procedures.

The cargo system onboard the FSO will be capable of independently isolating any tank for inspection, maintenance and repair without disrupting the use of any other tank for either loading or unloading.

Offloading Operations

Stabilised light oil stored on the FSO will be periodically offloaded through a double carcass offloading hose to a shuttle tanker positioned behind the FSO ie in tandem (*Figure 2.15*). Dual safety zones (*Figure 2.16*) will be applied during offloading operations with a 500 m safety exclusion zone enforced around both the FSO and the shuttle tanker.

Figure 2.15 Offloading from FSO to Shuttle Tanker

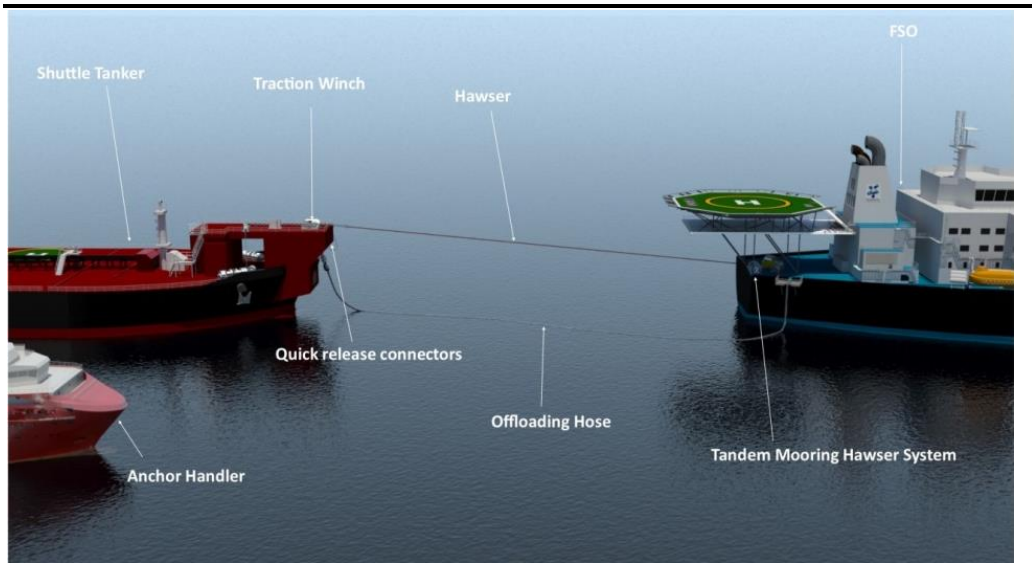
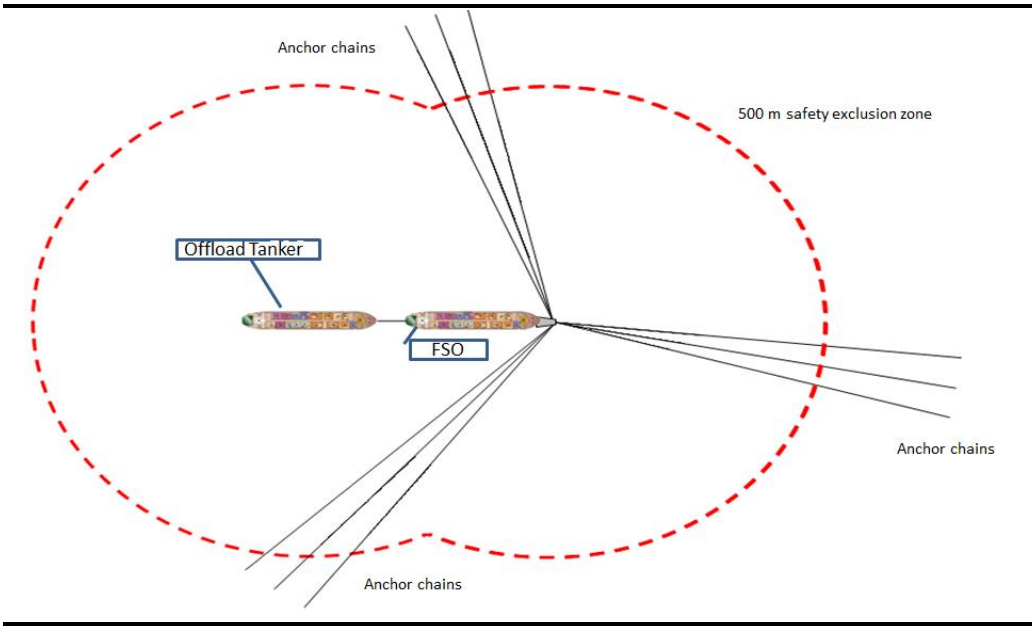


Figure 2.16 Schematic of the Dual Safety Exclusion Zone



Prior to contracts being awarded for export offloading, Sasol will undertake a full review of the suitability of the shuttle tankers for the safe transfer of light oil. Shuttle tankers will be required to conform with the Sasol Marine Assurance Plan (MAP) which will govern offloading requirements. Sasol will develop a MAP for offloading operations which will include the necessary provisions for crew training and competency, vessel maintenance and marine incident emergency response.

In order to be sure that personnel on board the FSO have the competence to carry out their duties, a Competency Assurance Management System (CMAS) will be developed by Sasol as part of the Operational Readiness and Assurance plan for the Project.

The capacity of the FSO export system will be designed to minimise the offloading time. Offloading of a complete cargo package of 300 000 bbls will typically be achieved within 24 hours, including connect and disconnect operations. Offloading of the FSO via shuttle tankers will be carried out every 20 to 28 days. The shuttle tankers mooring systems will be fitted with a Quick Release Hook (QRH).

The QRH assembly will be installed in accordance with Oil Companies International Marine Forum (OCIMF) guidelines, as part of the cargo handling system. The QRH will automatically disconnect if safe working loads are exceeded during cargo offloading.

The cargo system of the FSO will be designed and operated to minimize stabilised light oil spillages following any damage to the hull or cargo handling system. Pollution prevention measures include:

- FSO Double hull construction (ie with two complete layers of watertight hull surface in case the outer hull is damaged and leaks);
- Double carcass offloading hose fitted with a leak-proof, self-sealing breakaway coupling;
- Emergency shut off valve for the Cargo export system;
- Hose flushing into tanks onboard upon completion of offloading; and
- Hose maintenance and inspection procedures.

In addition, the support vessels and the FSO will have facilities for firefighting and spill response equipment, in line with class requirements, onboard in order to respond to operational spills resulting from minor leaks, dropped objects, transfer and storage of diesel fuel, and offloading activity incidents. There will also be an Emergency Shut Down (ESD) and Fire and Gas (F&G) detection system. The riser base will have an SSIV, which is a fail-safe system that enables the flow of stabilised light oil to the FSO to be stopped at the riser base by remote operation from the FSO

Power Generation and FSO Utilities

The main power generation on the FSO will be supplied by diesel generators fuelled by MGO (Marine Gas Oil). Precise specifications will be determined later during the detailed engineering design phase and further defined in the Project Description Chapter of the EIR.

The FSO will include the following marine and utility systems onboard:

- Air Systems (ie systems operated using compressed air);
- Heating, Ventilation and Air Conditioning (HVAC);

- Cooling water systems;
- Freshwater systems;
- Fuel systems;
- Ballast water treatment plant;
- Crude oil washing system for cleaning of cargo tanks;
- Drains systems equipped with oil discharge monitoring equipment; and
- Sewage treatment plant.

The utilities onboard the FSO will be dependent on the vessel that is selected and the capacity of the vessel to provide these utilities. More details about the utilities onboard will be provided in the EIR.

2.7.5 Phase 5: Decommissioning

Equipment and facilities will be decommissioned at the end of the economic life of the Project, which is expected to be 15 years from first stabilised light oil production.

Decommissioning offshore will involve making safe the FSO, offshore pipeline and associated facilities and the removal all the infrastructure except the pipeline. The subsea infrastructure design will allow for removal of subsea architecture in line with international best practice and national legislation, for subsequent possible re-use and recycling onshore. Umbilical and risers will be recovered and disposed of onshore using normal Sasol waste management procedures, prepared as part of the overall Decommissioning Plan, for potentially oil-contaminated equipment.

The FSO will be disconnected from the moorings which will be laid down on the seabed. The FSO will then be towed from its on-station position to a nominated yard. The mooring lines and anchors will be recovered, in much the same way as they were installed. The mooring lines and anchors will be disposed of onshore using normal Sasol waste management procedures. The overall decommissioning strategy for the FSO and Mooring is to ensure minimal permanent impact on the marine environment and other sea users.

Decommissioning onshore would involve making safe all the onshore facilities together with the removal of above ground infrastructure that will no longer be used. The restoration of the onshore pipeline route and ROW will be conducted in accordance with the license and the regulatory requirements.

The overall decommissioning strategy for the Project is to ensure minimal impact on the onshore and offshore environment and other users of the Project Area. Therefore, removal will be performed in such a way as to prevent any significant adverse effects. A framework Decommissioning and Rehabilitation Plan (DRP) will be developed during the EIA Phase and reviewed and updated two years prior to the end of the life of the Project. Decommissioning will be conducted to meet, as a minimum, the regulatory requirements in place at that time.

A DRP is a requirement of Mozambique National legislation (Petroleum Law 21/2014) and best international practice, and is intended to ensure that companies that operate large industrial facilities identify and make sufficient provision for the closure costs of the facility.

2.7.6 Emissions, Discharges and Wastes

Air Emissions

The emissions generated during the advanced works and construction phases will be mainly related to dust as a result of bush clearing and the emissions from the construction vehicles along the pipeline route. During the operational phase there will be no venting from the pipeline. The emissions during the operational phase will be limited to those associated with the export pumps, situated at the LPF, and the loading and offloading of the FSO. The latter emissions will be as a result of power generation, venting of inert gas from the FSO tanks and waste incineration.
These emissions will include carbon monoxide (CO), oxides of nitrogen (NOx) and sulphur (SOx), volatile organic compounds (VOCs) and particulate matter.

Noise

The Project's onshore construction activities and equipment will increase the noise in the local area during the advanced works, construction and operational phases. During commissioning and operation some noise will be produced by the export pumps located at the LPF.

The FSO, installation vessels, shuttle tankers and support vessels will introduce sound into the marine environment whilst they mobilise to site and while they are keeping on station using dynamic positioning. Vessel noise is primarily attributed to propeller cavitation and propulsion engines (ie noise transmitted through the vessel hull).

Dynamic positioning (DP) - is a computer-controlled system to automatically maintain a vessel's position and heading by using its own propellers and thrusters.

Increased Traffic

There will be increased construction vehicle activity onshore, due to material supply and delivery from Beira and Maputo. Approximately 200 truckloads will be required over a period of nine months. Traffic management measures will be developed and included in an amended Infrastructure Construction EMP.

The construction, installation, commissioning and support vessels will increase the offshore vessel traffic from the Port of Beira to the offshore pipeline corridor and FSO location.

Light

The FSO will be lit for safety and operational purposes at all times and will have similar lighting to that of a tanker. The FSO site has been selected in order to minimise the risk of lighting impacts on the nearest islands and mainland and that this will be verified during the EIA Process.

Disposal of Solid Waste

There will be both hazardous and non-hazardous solid wastes generated during all the phases of the Project, both onshore and offshore. All waste management will be carried out in accordance with the requirements of Mozambique legislation including the Regulations on Solid Waste Management (*Decree 13/2005*). Onshore and offshore construction wastes will be managed by the construction contractors. Onshore construction wastes will be managed in accordance with the existing Infrastructure Construction – EMP. During the EIA Phase a new offshore waste management section will be added to the existing Infrastructure Construction – EMP.
During the operational phase, most of the waste will be generated by the operation of the FSO. These wastes will either be incinerated or shipped back to the marine supply base where they will be reused or recycled, where possible, or disposed of by licensed local waste contractors. The types of wastes that will be generated and potential disposal methods are not yet confirmed.

However, typical waste types and potential disposal methods based on industrial good practice are provided in *Table 2.5*.

Table 2.5: Typical Waste Types and Potential Disposal Routes

Type	**Potential Disposal Method**
Hazardous	
Paints, adhesives, solvents	Incineration - typically partially used tins to be dried out and then incinerated. Metal tins may be recovered and recycled.
Empty drums containing hazardous residues	Other - typically drums are decontaminated at an approved facility, then sent for recycling
Lubricants, engine oil, hydraulic oil, crude oil	Recycling or Incineration
Transformers, capacitors, batteries, aerosols, contaminated filters, oily rags, refrigerants, absorbents	Recycling / incineration/ other -items such as batteries and capacitors should be sent to specialist recycling facilities.
Sludge's / Liquids / Tank Washings: Oil spills, heavy metals, tank washings, pig wax	Recycling or Incineration
Non-Hazardous	
Non-hazardous fluids	Landfill
Empty metal / plastic drums, dried paint cans	Recycling/ landfill
Scrap metal, wire rope, uncontaminated pipe, electric cable	Recycling/ landfill
Aluminium cans, cardboard, paper, wood, rubber, plastics, glass, fluorescent tubes, cooking oil	Recycling/ landfill
Galley waste, accommodation waste, compactor waste	Incineration/ landfill
Non-hazardous tank washings	Incineration

Source: extracted from LMC, 2016

Disposal of Waste Water Onshore

Portable toilets and existing camp facilities will be used to provide ablution facilities for the onshore construction activities. Storm water will be managed at the existing camps in-line with their existing management plans.

Disposal of Waste Water Offshore

The operation of the installation, construction and support vessels will result in routine discharges to sea (ie, sewage, grey water, food waste, bilge water, ballast water and deck drainage).

One-off discharges to sea includes the estimated 6 000 m^3 of hydro-test water from the onshore and offshore pipeline; potentially containing dye, oxygen scavenger and corrosion inhibitor. When pipelines and risers are dewatered (ie flushed) after pressure testing and treatment, these fluids will be pumped through the pipeline to the FSO for overboard discharge.

Routine Project discharges will typically include the following: sewage, grey water, food waste, deck drainage, bilge water, ballast water, brine, and cooling water. Anticipated discharge volumes and treatment methods will be assessed during the EIA process. Discharge streams would be treated to required national and international standards (eg MARPOL 73/78) prior to discharge.

2.7.7 Fresh Water Use

The water for construction personnel and construction activities is likely to be provided by using the existing Sasol groundwater wells near the CPF and the PSA Development well pads, if possible. Prior to construction, Sasol will verify the volume of water required and potential availability from existing boreholes, aquifers and additional sources that may be required.

Bottled drinking water will be provided to the crew on the FSO and all other vessels. All other water required for the supply vessels will be provided by a local water source to be confirmed in the EIR.

2.7.8 Labour, Equipment and Service Supply

Qualified personnel will be required to support both onshore and offshore activities including but not limited to:

- Advanced works and construction activities;
- Marine supply base;
- Camps;
- Logistics operations (eg. land transportation, aviation, marine/quayside operations, material handling, loading and transport);
- FSO operations;
- Installation vessel operations; and
- Support vessels

Personnel requirements will be met via a combination of direct staff employment, third party contractors and consultants as well as third party service providers.

Where qualified Mozambican personnel are available for employment to support Sasol's operations, whether staffed directly or via third party, Sasol will ensure opportunities are provided for their employment as far as reasonably possible.

Direct (Sasol employees) and indirect (contracted services) employment requirements will change with each phase of the Project through to production operations.

Attracting, developing and retaining qualified, high-performing professionals will be a key objective. Sasol will continue to promote local labour employment opportunities via the existing Community Liaison Forum (CLF) in Inhassoro and Govuro (Pande). The CLF comprises Sasol, the local governments of Inhassoro and Govuro, and Community Leaders representing around 32 individual communities across both areas.

2.7.9 Project Activities and Schedule

The Project is planned to start in the third quarter of 2019, and be ready for operation in the third quarter of 2021 (*Figure 2.17)*.

Figure 2.17: The Preliminary Project Schedule

2.8 *EMERGENCY RESPONSE PROCEDURES*

Sasol has an existing Emergency Response Plan for all activities in Temane, which will be reviewed and updated during the EIA Phase to include this Project's activities.

The objectives of the emergency response plan are to ensure that all emergencies consider:

- The safety of all SPT and service provider personnel;
- The safety of the CPF;
- The protection of the environment ; and
- The rapid assessment and containment of the emergency.

Sasol has also developed a Tactical Response Plan (TRP), together with the Oil Spill Contingency Plan (OSCP), for the producing assets of the Temane, Pande and Inhassoro fields. These plans will also be reviewed and updated to include this Project's activities.

2.9 *COMPENSATION PROCEDURES*

Sasol has adopted and implemented World Bank Group policies and procedures for compensation and has an existing compensation procedure for both onshore and offshore activities in the region which will be updated to include this Project. Within the framework provided by the policy, procedure and directive, Sasol adopted the following objectives:

- Avoidance of impacts to people and their assets wherever feasible through integrated and iterative planning;

- Where impacts to people and their assets are unavoidable:
  - To minimize the scope and magnitude of the impacts;
  - To treat all affected parties with respect, dignity and fairness;
  - To pay affected parties fair and equitable compensation to the extent that they are affected by project activities;
  - To assist affected parties to adapt to their new environment; and
  - To monitor the effects of project impacts for a period after project completion and to take the necessary actions to address issues that may arise.

Sasol has a comprehensive socio-economic development programme which is centrally managed and operated in terms of which all Sasol's socio-economic development programmes are conducted and, therefore, it does not form part of the compensation procedure.

Sasol has undertaken to route the onshore pipeline so as to minimise the need for economic displacement and resettlement. Sasol will monitor damage to or loss of property or agriculture prior to, during and after key activities and map this against documented data and confirm trends.

Where a potential link is identified between Sasol's activities and damage to or loss of property or agriculture, then claims for compensation will be assessed.

Sasol will monitor fish catch via the Fisheries Development Institute (IDPPE) and map this against documented data and confirm trends. Where a potential link is identified between Sasol's activities and a drop in fish catch, claims for compensation will then be assessed.

Sasol will monitor tourism activities within the Project Area and map this against documented data and confirm trends. Where a potential link is identified between Sasol's activities and a drop in tourism activity, claims for compensation will then be assessed.