Environment and Social Impact Assessment Study (ESIAS)

Seychelles

Prepared by:

46 quai François mitterrand
13 600 La Ciotat – France
Phone : +33 4 42 71 33 33 Fax : +33 1 30 08 86 01

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Prepared by	Tony Agion
Signature	
Revised/Approved by	Eric Delort
Signature	

Submitted to :

Environment Assessment and Permits Section
Wildlife Enforcement and Permits Division
Department of Environment
Ministry of Environment, Natural Resources and Transport
P.O BOX 445,Victoria
Republic of Seychelles
Tel: + 248 670 567
Fax: + 248 610638

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1 - EXECUTIVE SUMMARY

1.1 - INTRODUCTION

This document is a summary of the Environmental and Social Impact Assessment (ESIA) study reports for Submarine Cable System.

1.2 - EIA APPROACH

A comprehensive EIA process was carried out for the Project. The EIA process and reports were structured to meet the requirements in the respective countries.

Three separate reports were prepared and submitted to support the Project's application for environmental authorization in Seychelles, Kenya and Tanzania.

1.3 - POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The cable will be installed in international waters as well as the national waters of Seychelles, Kenya and Tanzania. The Project will interact with both the marine and terrestrial environments. The Project would thus be subject to:

- Seychelles, Kenya and Tanzania administrative and legal requirements;
- International conventions and standards to which Seychelles, Kenya and Tanzania are signatory and with which the Project must therefore comply.

1.4 - PROJECT DESCRIPTION AND JUSTIFICATION

Project location

The submarine cable system would include installation of approximately 2 000 km of subsea cable running from Beau Vallon, Seychelles to shore crossing and landing sites in a east African country: Mombasa in Kenya or Dar es Salaam and Zanzibar in Tanzania (**Figure 1**).

The cable consists of an inner optical fibre, surrounded by a polyethylene or fibreglass core for strength and fibre separation.

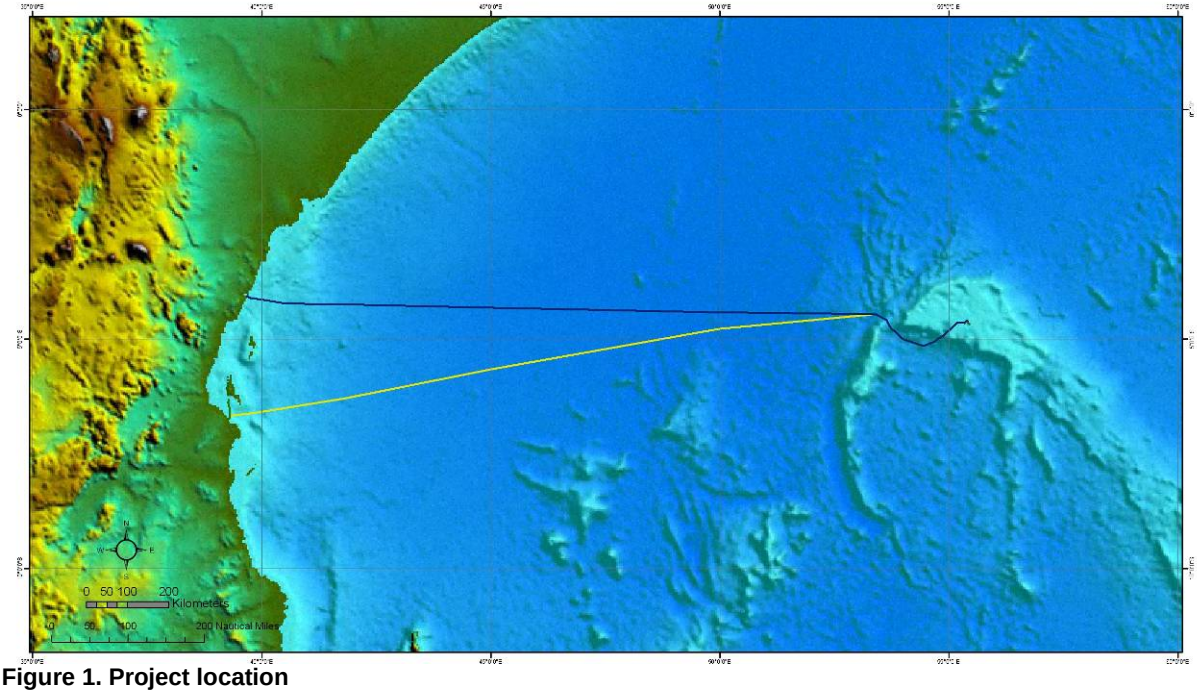


Figure 1. Project location

Seychelles landing site

The landing site in Seychelles is located at Beau Vallon (4°36.692' S, 55°25.793'E) (**Figure 1**).

View to west from the preferred landing site, Beau Vallon, Mahé

Kenya landing site

The GPS measured coordinates of the existing manhole at Fort Jésus are: 04º 03.715' S, 39º 40.814' E.

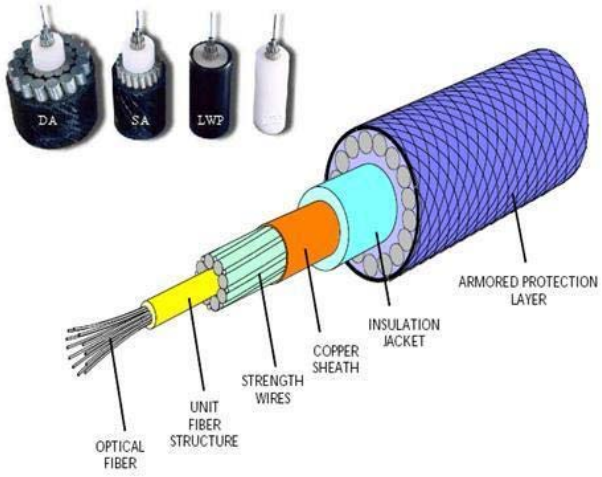
Tanzania landing site (Dar es salaam and Zanzibar)

The landing sites in Tanzania are located at (Figure 1): Dar es Salaam (Msasani Bay): 6°45.633' S, 39°15.689' E Zanzibar (Fumba): 6°19.118' S, 39°17.145' E

View to west from the preferred landing sites, Dar es Salaam (Msasani Bay) left and Zanzibar (Fumba) right

System components

The project comprises the laying of a subsea comminication between Seychelles and the East coast of Africa (Kenya or Tanzania). The Project will have direct benefits through the increase in available international transmission capacity and the lower cost for such access.



Installation

Prior to installation of the cable, a marine geophysical survey will be performed to investigate the safest route for the cable system. A detailed topographic survey will be performed to assess the conditions and feasibility of the landing. A limited seabed sampling program will also be conducted to supplement the side-scan sonar and subbottom profiler data in the areas where the cable will be buried.

For installation, a built ship will accurately place the cables on or under the seabed along the route determined by the pre-installation survey. Shallow water laying may be aided by scuba divers while deepwater laying is sometimes aided by remote operated vehicles. Due to the shallow water depth, cable burial at each of the shore ends may be undertaken by excavation of a trench using a single grab dredger and through the placing of the cable within the trench by divers. Offshore, cables would be buried in a narrow (<1 m wide) trench that would be cut by a water jet or plough while the cable is being laid.

Operations

Once in place and connected, the cable system requires no intervention. Cable repair and maintenance may be required as a result of damage…

Decommissioning

A full decommissioning plan will be developed near the end of the Project's expected 25-year lifetime. The plan will be based on best practices at the time and with consideration of environmental and safety issues.

Project justification

The proposed Submarine Cable System would include a new open-access fibre-optic submarine cable system which would expand International telecommunication services to Republic of Seychelles and countries on the East Indian coast of Africa. The network would facilitate transmission of data, voice, internet and television signals allowing for inter country transmission of information, thereby bridging the information gap between Seychelles, East Africa and the rest of the world.

Project benefits include:

The Project will have direct benefits through the increase in available international transmission capacity and the lower cost for such access. The project also expects to offer wholesale costs 75% lower than that of existing systems.

For existing businesses, increased capacity and lower cost will allow faster and more reliable transmission for data and voice call. This can results in an improvement of business performance as well as create opportunities for expansion. Lower entry costs will also facilitate the start-up of new businesses.

The project will also improve the connectivity between Seychelles and African countries on the system.

The operating company will have its headquarters at Victoria making the Project the first Seychelles-based submarine cable company. Hiring of staff for the operation would draw from the local skills pool and employees would be trained in telecommunications operations and international best practices. The experience would further enhance the local skills base.

In addition to the direct economic benefits of increased telecommunications access and reliability in Seychelles, many other indirect social and economic benefits would be associated with the proposed development, these include:

- improved educational opportunities through increase in access to information and education resources;
- development of a regional sense of community through greater equality of information sharing across geographical regions and across groups in society;
- economic benefits from the enhanced opportunities for new and small enterprises that may have previously been excluded from technologies by high costs;
- macroeconomic benefits of the potential expansion of technology-reliant industries, such as information technology services and software development businesses.

1.5 - DESCRIPTION OF THE PROJECT ENVIRONMENT

Geology and soils

Seychelles 115 granite and coral islands extend from between 4 and 10 degrees south of the equator and lie between 480km and 1,600km from the east coast of Africa in the western Indian Ocean. The coastal shorelands of Beau Vallon consist entirely of calcareous sands. The soil types in the mountainous areas behind the coastal plain comprise laterite and kaolinitc clays forming red earth giving a base of dense vegetation.

Oceanography characteristics

Meteorology

Average temperature is relatively stable during the year (between 26 and 28°C). Large influence of the monsoon, characterized by 2 seasons and 2 inter-season: North-east monsoon (November to March) and South-east monsoon (May to September). North-east monsoon: rainiest and norois winds (North-easterly); South-east monsoon: driest, windiest and suete winds (South-easterly). Calmest period is between April and November and dominant wind direction: South-eastern sector.

Oceanography and Sea temperature and salinity

Seasonal swell due to monsoon (norois: < 2m during 93% of the time, suete: > 2m during 40% of the time) and exceptional cyclonic swells (very low probability). Slow intensity of the current (maximum 1 to 2 knots); Longshore drift: oriented from North to South/South-west at the Beau vallon site. Foreshore area: Beau vallon: 450 m length.

Sea surface temperature is stable between November to May (at least 29°C) and lowest one during the South-east monsoon; Surface salinity is relatively stable and around 35.2 PPS.

Terrestrial habitats

There is a wetland at Beau Vallon.

Marine habitats

The ecological characteristics of the Beau Vallon coastal zone are numerous both spatially and in biodiversity, which include brackish water marshes, coastal vegetation, coral reefs and other marine fauna and flora. There are eight areas that can be considered as special ecosystems.

Area	In m^2	Description
Northern Fringing Reef	700,000	Coral Reef
Southern Fringing Reef	260,000	Coral Reef
Northern Fringing Reef Flat	250,000	Inter-tidal and Littoral Ecosystem
Southern Fringing Reef Flat	62,500	Inter-tidal and Littoral Ecosystem
Mare Anglaise River Estuary	5,500	Ecosystems of Estuaries and Enclosed Seas
Sullivan River Estuary	3,900	Ecosystems of Estuaries and Enclosed Seas
Mare Anglaise River Wetlands	46,800	River and Stream Ecosystems
Sullivan River Wetlands	15,600	River and Stream Ecosystems

Marine fauna

Seychelles is pa pristine sanctuary for diverse species of flora and fauna. Two orders of marine mammals (Sirenia and Cetacea) occur in Seychelles waters. Seychelles is not situated along any important migratory route, however many migratory species, especially waders, occur regularly.

Four species of sea turtles are found in Seychelles waters. However, only the Green turtle (*Cheloniamydas*) and the Hawksbill turtles (*Erethmochelys imbticata*) nests in the Seychelles. The Marine National Parks of Ste. Anne and Curieuse and the two Special Reserves of Cousin and Aride and the island of Cousine remain some of the most important hawksbill nesting sites in Seychelles

Protected area and Ramsar site

There are no protected areas in the vicinity of the proposed landfall. There are no RAMSAR site's in the vicinity of the proposed landfall.

Socio-economic and cultural environment

This is Mahé's most popular resort beach with both visitors and locals alike. This sweeping bay of white sand and clear waters on the north-western coast of Mahé offers a very safe swimming area.

With hotels stretched out along its sand, together with water sport and diving centres, this is the beach for those wishing to do something a little more energetic than soaking up the sun.

Beau Vallon is also very safe for children, as there are no strong currents, no rocks or corals underfoot and a lifeguard service is supplied. During the south-eastern trade winds, the sea is extremely calm and the beach is at its absolute best.

Beau Vallon is a very important zone for recreation not only for the tourists but also for the local community

1.6 - POTENTIAL IMPACTS ANDMITIGATION/ENHANCEMENT MEASURES

Positive impacts of the project

A number of positive benefits are predicted to be associated with the proposed development. Many of the positive aspects of the project relate to macro and micro-economic opportunities and benefits resulting from increased Information and communication technology connectivity, but many other secondary benefits including, social, employment and educational impacts will also be realized.

Negative impacts of the project

The different period of impacts were defined as:

- Marine survey (prior to cable installation (onshore, shallow water and offshore)
- Installation (onshore, shallow water and offshore)
- Operations/maintenance (onshore, shallow water and offshore)
- Decommissioning (onshore, shallow water and offshore)

The potentials impacts from the project are limited in scope and are mainly associated with the pre-installation and installation phases. Potential impacts during operations and decommissioning are negligible.This study indicates that there will be no impacts or negligible impacts on the following resources:

- Soils and geology
- Oceanography characteristics
- Hydrology
- Air quality
- Marine biology
- Protected areas
- Landscape and visual receptors
- Noise and vibration receptors
- Traffic
- Social and cultural structure
- Culture heritage

Detailed impact assessment was carried out for three potential impact areas:Habitats, fauna and flora, Water quality, Human activities (recreational, fisheries), health and safety

Table 1 below summarizes the potential negative or unexpected impacts from the global cable installation techniques.

Table 1; Summary of impacts without mitigation 0 : No impact, 1 : minimal impact, no need for specific mitigation ; 2: low to medium impact, need basic mitigation ; 3 medium to high, need specific mitigation measures and careful monitoring programme to ensure no adverse effects

Potential impact without mitigation			Project stage															
			Onshore				Shallow water						Offshore					
Area of impact	Description	Degree of impact	Construction (BMH)	Cable installation	Operation/Maintenance	Decommisioning	Marine Route Survey (e1cl. vessels)	Route Clearance (e1cl. Vessels)	Submarine cable installation	Vessels (All operations)	Operation/Repairs	Decommissionning	Marine Route Survey (e1cl. vessels)	Route Clearance (e1cl. Vessels)	Submarine cable installation	Vessels (All operations)	Operation/Repairs	Decommissionning
Environment																		
Geology and soils		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrology		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meteorology	Winds, rainfall…	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oceanography	Swell, currents…	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ecology	Terrestrial	Temporary, reversible,direct	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coral reef	Temporary, reversible,indirect	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
	Seagrass bed	Temporary, reversible,indirect	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
	Marine fauna/flora	Temporary, reversible,direct	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
	Marine habitats	Temporary, reversible,direct	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
Protected area/Ramsar		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water quality	Sediment disturbance causing turbidity discharges	Temporary, reversible,indirect	0	0	0	0	0	1	2	1	1	0	0	1	2	1	1	0
	Discharges	Temporary, reversible,indirect	1	1	0	0	0	1	2	1	1	0	0	1	2	1	1	0
	Accidents which cause spills	Temporary, reversible,indirect	0	0	0	0	0	1	2	1	1	0	0	1	2	1	1	0
Waste	Generation of wastes	Temporary, reversible,indirect	1	1	1	0	0	1	1	1	0	0	0	1	1	1	0	0
Air quality (Local)	Dust	Temporary, reversible,indirect	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gazeous emissions	Temporary, reversible,direct	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	0
	Odour	Temporary, reversible,direct	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat/radiation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social																		
Traffic	Impacts on traffic in area	Temporary, reversible,direct	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0
Noise		Temporary, reversible,direct	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Visual Pollution	creation of new building, landsacpe	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cultural and heritage	Impacts to sites of cultural or archeological interest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Human activities	Impacts on fisheries activities	Temporary, reversible,indirect	0	0	0	0	1	1	2	2	1	0	1	1	2	2	1	0
	On tourism - diving sites, recreational activities	Temporary, reversible,indirect	1	1	1	0	1	1	2	2	1	0	1	1	2	2	1	0
	Impact on shipping and anchorage	Temporary, reversible,indirect	0	0	0	0	1	1	2	2	1	0	1	1	2	2	1	0
	Impact on mining activities	Temporary, reversible,indirect	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0
	Impact on dredging/submarine cable/hydrocarbon activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Impact on employment	Positive																

1.7 - ANALYSIS OF ALTERNATIVES

The analysis of alternatives is a component of the ESIA process. Its purpose is to improve project design, construction and operation decisions based on feasible project alternatives. Early consideration of alternatives during the design phase of a project can result in the avoidance/minimization of impacts without the need for expensive or time consuming mitigation measures at a later stage.

The cable has a small diameter and is designed to be benign in the marine environment. Nevertheless some impacts are likely including:

- Impact to flora and fauna, ecosystems
- Disruption to recreational activities
- Disruption/loss of income to fishing communities
- Construction related nuisance (noise, dust, exclusion areas)
- Environmental and health risks

The impact of others, most notably exclusion areas where fishing and anchoring activity is prohibited, can be minimised if existing corridors (with existing exclusion areas) are used.

During the early stages of Project design an extensive desk top study (DTS) was undertaken to identify a preferred route. Throughout this study environmental issues were considered and potential impacts minimised through selection of the best route. The general philosophy included:

- Use of existing onshore facilities where possible;
- Avoidance of environmental sensitivities (protected areas, sensitive species...);
- Installation of pre fabricated facilities where exiting facilities were unavailable;
- Use of existing corridors (and existing exclusion areas)

For those potential impacts that remain following selection of an optimal route, appropriate mitigation measures are readily available. Where warranted, further consideration of route selection is provided in the country specific EIAs.

1.8 - CONCLUSION

Potential impacts were determined to be moderate or minor (localized short time scale...). Following application or mitigation measures the impacts for these areas was determinate to be negligible.

Environnemental management plan actions

Impact	Scope for Mitigation	Monitoring/ Implementation	Responsability
Environment			
Geology, soils, Hydrology, Meterology, Oceanography	not specific mitigation require		Contractors
Terrestrial	Limiting clearing and restoring areas of disturbance Controls to prevent incursion into adjacent areas Top soil will be segregated and laced on other back fill material to promote regeneration of vegetation. All soil that is disturbed during trench digging will be restored to approximate original depths as the trenches are backfilled	Hazardous materials management plan Construction site management plan	Contractors
Marine fauna/flora, Habitats	Marine vessels will be required to adhere to IMO regulations on bilge and ballast water discharge in order to avoid tentional introduction of non-native species to the marine environment Areas of habitat that are temporarily disturbed during cable installation will be restored upon the completion of the installation phase. Areas are disturbed during installation activities will be rehabilitated ASAP after the cable has been installed. The Project will ensure that measures are adopted to avoid incursion into areas adjacent to the work site or any secondary affects from pollution, sedimentation, or accidental spills The Project will also require that marine vessels have a similarly comprehensive plan for storage and handling of hazardous materials as well as a plan for containment and cleanup of accidental spills into the marine environment Contractors will implement a suitable system for spotting marine mammals and turtle whilst pre-installation and installation vessels are at sea. Should these species be observed in the vicinity of the work area, the vessels will execute measures to avoid collision or disturbance. Vessel operators will maintain a distance of 100 m or greater and will travel at 10 knots or less when safety permits until animals are more than 500 m away. Abrupt changes in direction will be avoided Vessel crews must report sightings of any injured or dead marine mammals and sea turtles immediately, regardless of whether the injury or death is caused by a Project vessel. The report should include the date and location latitude/longitude) of the animal/strike, the name of the vessel involved, and the species identification or a description of the animal. The report should be made to a designated ecology organisation Security lighting will be aimed on the area it is required at an adequate level of illumination only to avoid impacts on sensitive fauna. Spillage of illumination outside the direct work area will be avoided.	Construction site management plan Hazardous Materials Management Plan Marine Logistics Plan Waste Management Plan Marine Fauna Protection Procedure Daily fauna observation report Lighting plan	Contractors
Protected area/Ramsar	not specific mitigation require	Construction site management plan	
Water quality	Marine vessels will be required to comply fully with the requirements of the MARPOL Protocol (1978) at all times Marine vessel anchors will not be dragged along the seabed and they will be retrieved vertically to avoid unnecessary sediment disturbance The maximum speed of the cable laying will not exceed 5 knots per hour so that the amount of seabed sediment disturbed anddispersed during the cable laying process can be kept to a minimum	Marine logistic plan	
Waste	Waste management is required to avoid the risk of harm to the environment and human health.	Waste mangement plan	
Air quality (Local)	The Project should require that construction contractors operateonly well maintained engines Should considerable dust generation occur during construction, causing plumes of dust in the vicinity of the works and behind construction vehicles, a routine wetting program of all unpaved surfaces including roads and construction areas will be undertaken to ensure sufficient moisture content is maintained to suppress dust generation. Construction traffic speed control measures will be enforced on unpaved roads (reduced dust generation levels are often consistent with reduced traffic speeds). Operation in line with the requirements specified under MARPOL 73/78 Annex VI	Dust management measures Vehicle maintenance records Placement of traffic signs indicating the speed limit along the route used by construction vehicles Construction Site Management Plan	Contractors
Heat/radiation	not specific mitigation require		

Environmental and Social management plan actions

Social			
Traffic	Make contact with the other vessel to avoid collision or damage to equipment Vessels will increase watch when navigating in areas that are kwon to be used by fishermen and other vessels Make contact with the other vessel	Construction Site Management Plan	Contractors
Noise	Use equipment and vehicles in good working order, well maintained The Project will require contractors to use equipment and vehicles that are in good working order, well maintained, and that have all noise suppression equipment (mufflers, noise baffles) intact and in working order	Best driving practices Vehicle maintenance records	Contractors
Visual Pollution	Efforts will be made to minimize visual impacts; land disturbed by cable laying will be contoured to its original form as part of overall reinstatement		
Cultural and heritage	not specific mitigation require		
Human activities (fisheries activities, On tourism - diving sites, recreational activities…)	Contractors will be required to wear suitable Personal Protective Equipment including hard hats, high-visibility vests, safety boots and gloves and life vests as appropriate in accordance with theEHS plan All construction and cable repair workers will be sufficiently trained in the safe methods of working with fiber optic cables to avoid injury associated with laser lights and fibers All open trenches and excavated areas will be backfilled as soon as possible after the construction has been completed. Access to open trenches and excavated areas will be secured to prevent pedestrians or vehicles from falling in Vessels will increase watch when navigating in areas that are known to be used by fishermen and other vessels. If other vessels are observed within the near vicinity, the Project vessel will stop moving, make contact with the other vessel if possible, and wait until it has been confirmed that the course of both vessels will not result in collision or damage to equipment While a ship is laying cable its manoeuvrability is restricted, as such it will display the day signals and lights of a hampered vessel to avoid collision with other vessels at sea. Trenches and excavated areas will be backfilled ASAP Require to wear suitable personnel protective equipment Require day signals and lights of a hampered vessel to avoid collision with other vessels at sea	Environmental, Health and Safety Plan Health and safety training and training records Health and safety incident register Marine Logistics Plan	Contractors

Globally, project activities are expected to have no effect on the environmental or social environment. This is mainly a result of the benign nature of the Project and the associated activities as well as the result of the integration of preventative measures into the project design.

The environmental assessment does indicate some potential for limited environmental and social impacts to habitats and flora; fauna; water quality; and human health and safety. The potential is reduced through the implementation of standard mitigation measures and industry best practices, none of which are excessive in cost.

Given the low potential for negative impacts and the high potential for significant positive benefits (both direct and indirect), the Project would be deemed to have a high level of environmental and social acceptability.

2 - INTRODUCTION

iXSurvey Sas, as part of the AXIOM/IXSURVEY/Terabit Consulting consortium, have been commissioned by the Seychelles government to provide a Desktop Study showing the optimum submarine routing for the fibre optic cable system (**Figure 2**).

The Cable System Project is a fibre optic telecommunications cable network that will link Seychelles Island to Dar Es Salaam, Zanzibar (Tanzania) and Mombasa (Kenya). The system includes approximately 2 000 km of fibre-optic cable, almost all of which will be located in the Indian Ocean. The cable will rest off the continental shelf on the sea bed in deep water and will be buried to a target depth of 1.0 metre below the sea bed in shallower waters (0-1000m).

The system will have a terrestrial component in three countries:

- Seychelles
- Tanzania
- Kenya

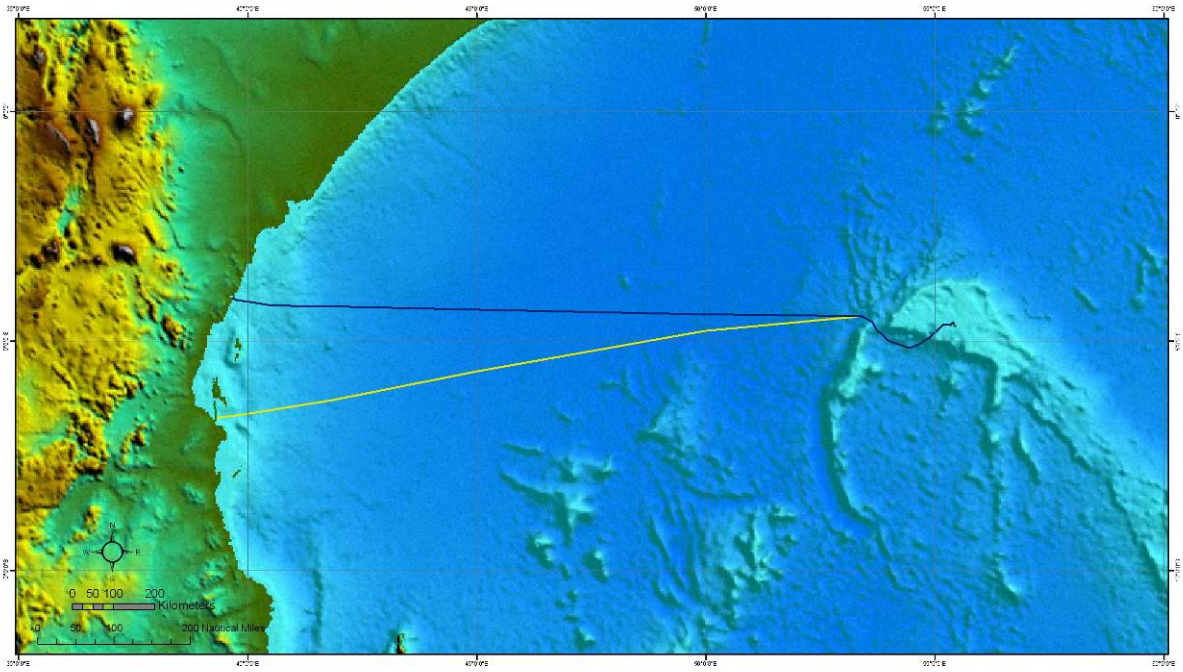


Figure 2. Map of the Fibre optic cable system (Fond ETOPO 2)

These terrestrial components provide the link between the marine component and the domestic telecommunications network in each of the three countries.

The tables 2 and 3 summarize the landing point location by country and local operators. All of the landfalls presented in the DTS have been visited.

Table 2. Cable landing site summary

Location	Country	Operator
Mahé	Seychelles	Unknown
Dar-Es-Salaam	Tanzania	Zanzibar Telecom Ltd (Zantel)
Zanzibar	Tanzania	Zanzibar Telecom Ltd (Zantel)
Mombasa	Kenya	Telkom Kenya Ltd

The cable lies within EEZ's of the country mentioned above and within international water.

Table 3. Summary of the cable DTS RPL

Option	Segment	RPL Version	Route Length (km)
Base Configuration	Mahé to Mombasa	Base Config_Mahe-Mombasa_Rev1	2000
Base Configuration	Mahé to Dar Es Salaam	Base Config_Mahe-Dar-Es-Salaam_Rev1	2000
Base Configuration	Dar-Es-Salaam to Zanzibar	Base Config_Dar-Es-Salaam-Zanzibar_Rev1	50

2.1 - THE SCOPE OF THE STUDY

This study comprises of two coastal states (Kenya and Tanzania) and one island state (Seychelles) (**Figure 3**).

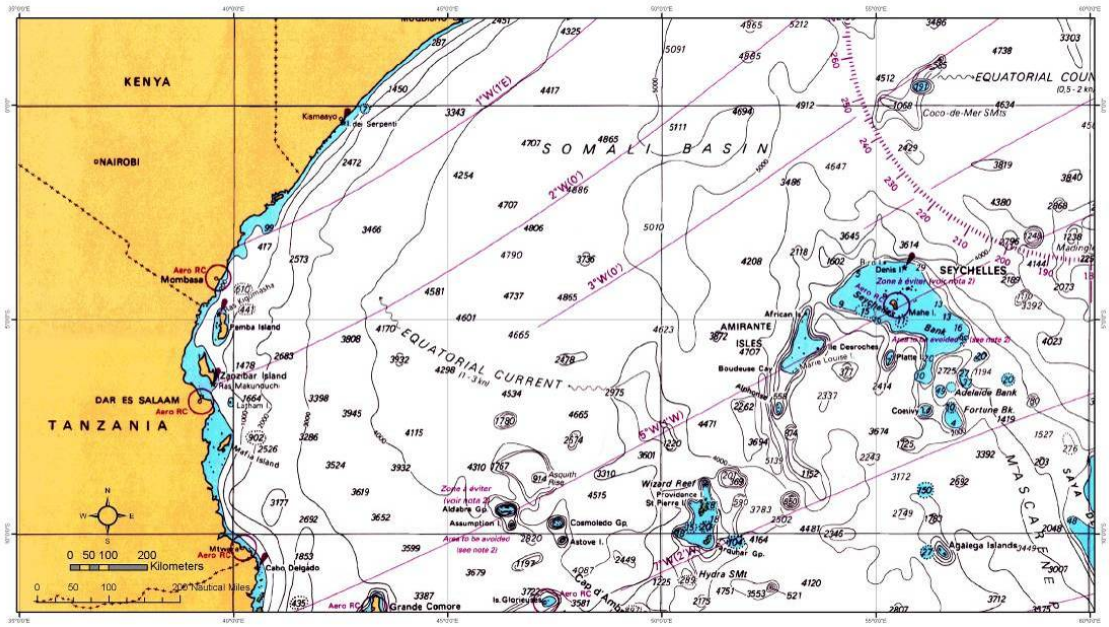


Figure 3. Scope of study – source SHOM chart n° 6684 Copyright license (in progress)

Further to the DTS findings, four areas will be exhaustively investigated and thoroughly analyzed when conducting the EASIAS:

- Cables installation and maintenance activities with environmental and social impacts
- Potential environmental and social impact assessment
- Identification of institutional arrangements for the management and monitoring of environmental and social impact
- Program for consultation with stakeholders and the public

2.2 - METHODOLOGY

A comprehensive ESIAS process was carried out for the Project. The ESIAS process and reports were structured to meet the requirements in the respective countries

The primary preparer of this ESIAS is IXSURVEY, an international environmental consulting company (www.ixsurvey.com). The ESIAS uses various data generated for the environmental approval documents prepared in the various landing countries. These documents have prepared with consultations of local administrations in each country, in cooperation with IXSURVEY.

2.3 - REPORTING

In accordance with the national guidelines for ESIAS reporting, the first five chapters present an overview of the project, location, proposed activities and the policy and legislative framework for the proposed project. The sixth chapter provide the socio-cultural biophysical environmental setting and chapter seven, the heart of this report, identifies and details all the impacts.

Chapter eight presents an analysis of alternatives. Chapter nine and ten are a managerial section presenting the monitoring and environmental and social management plan. In addition to the a number of appendices are included in this report.

3 - LEGAL REGULATORY AND INSTITUTIONAL FRAMEWORK

The project will be conceived and implemented strictly within the legal, institutional and regulatory framework ruling in the republic of Seychelles. Reference is specifically made to the following.

3.1 - THE ENVIRONMENT PROTECTION ACT

The implementation of the project requires administrative clearance from the Ministry of environment and Natural Resources, in conformity with the provisions of the environment protection Act No. 9 of 1994. In terms of section 6 of the EPA, the Minister may prescribe standards for:

- Quality of air, water or soil for various areas and purposes;
- Effluent limitations for existing and new point sources;
- Emissions of air pollutants from mobile and stationary sources;
- Noise emissions from various sources including construction sites, plants, machinery, motor vehicles, aircraft, industrial and commercial activities;
- Odours as are required to preserve and maintain public health and the environment; and
- Pesticide residues in the environment.Emission standards have been published under the EPA for noise, the Environment Protection (Noise Emission Standards) Regulations, SI 49 of 1999, and effluent quality, the Environment Protection (Miscellaneous) Regulations, SI 84 of 1995 (see Table 12.4). No other emissions are monitored or regulated.

Sustainable development is a major aim of the country and several policy frameworks have been elaborated for its integration into the country's development. For the Environmental sector the country is at present implementing its second, ten year Environment Management Plan (EMPS 2000-2010).

The primary goal of the EMPS 2000-2010 is the promotion, coordination and integration of sustainable development through its programs across all sectors. According to the EMPS these shall be integrated into the ten chosen thematic areas which are as follows:

- Society, Population and Health (including Gender)
- Land Use, Coastal Zones and Urbanisation
- Biodiversity, Forestry and Agriculture
- Energy and Transport
- Fisheries and Marine Resources/Processes
- Water, Sanitation and Waste
- Tourism and Aesthetics
- Environmental Economics and Mainstreaming, and Sustainable Financing
- Regulatory, Policy and Institutional Mechanisms
- Commerce, Industry and Production

These guidelines are used by the authorities in screening applications and drafting Term of reference) ToRs, and should be referred to by developers and their consultants to ensure that all key issues are addressed in the Environmental Impact assessment (EIA).

The general legislative framework on environmental protection in the Seychelles is the Environment Protection Act (EPA) 1994. The EPA 1994 provides for the protection, preservation and improvement of the environment and for the control of hazards to human beings, other living creatures, plants and property. The Act also provides for the coordination, implementation and enforcement of policies pursuant to the national objectives on environment protection. This Act is administered by the Department of Environment in the Ministry of Environment and Natural Resources, which has been designated as the Authority under the Act. The Act makes provisions for the Authority to co-ordinate the activities of other agencies concerned with the protection of the Environment. The Act provides for the prevention, control and abatement of environmental pollution.

The Environment Protection Act 9 of 1994. The aim of the EPA is stated as being:

"… to provide for the protection, improvement and preservation of the

environment and for the prevention, control and abatement of

environmental pollution."

The Environment Protection Act, 1994 came into effect on 1st March 1995. It is an umbrella legislation providing a general policy framework for environmental protection enabling the introduction of detailed regulations by policy-makers. It has the flexibility and scope to deal with wide range of issues, and at the same time, has a provision for dealing with specific issues such as pollution control, waste management, environment impact assessments etc. The section of EAI of the EPA 1994 are described below:

S.15 *Environment Impact Assessment* - control of development and activities in a protected or ecologically sensitive area, set-up of the environmental appraisal committee (EAC), contents of the EIA, responsibilities of the developer, provision for public inspection, claims and appeals, and monitoring of development or activity for compliance with EIA recommendations. It also makes provision for the promulgation of regulations for EIA

Where a project is deemed to have a potentially significant impact on the environment, a Class 1 EIA will be required and the Ministry of Environment will provide the Terms of Reference for the EIA.

Part IV of the EPA and the Environment Protection (Impact Assessment) Regulations (EP) (EIA) Regulations)55 deals with Environment Impact Assessment (EIA). The legislation requires that an EIA study be carried out and that an environmental authorisation is obtained if any person commences, proceeds with, carries out, executes or conducts or causes to commence, proceed with, carry out execute or conduct any prescribed project or activity in a protected or ecologically sensitive area. The criteria, which establishes the necessity of an EIA is found in the EP (EIA) Regulations which lists categories of projects or activities requiring environmental authorisation. Schedule 1 of the EIA Regulations lists the prescribed projects and activities which necessitate an authorisation and these include the following activities: mining, agricultural production, forestry, fish and associated farming products, chemical industries, industry (construction), food and agro-industries, energy production and distribution, water reservoirs and distribution, sewage and wastewater treatment systems, solid waste management systems, the hotel industry (hotels, restaurants and tourism activities), transport (harbours, air transport infrastructure, roads and coastal defences); land reclamation, and housing development. Schedule 2 of the EIA Regulations lists the protected or ecologically sensitive areas. Furthermore, a set of thirteen Environment Assessment Guidelines exist for various sectors.

According to Section 6 of the EIA Regulations, the authority may undertake the EIA on behalf of the proponent or it may be done by the proponent. An Environmental Impact Assessment Study must contain a description of:

- The location, size and scope of the project or activity and description of the original state of the environment prior to implementation of the project or activity;
- The principle, concept and the purpose of the project or the activity;
- The technical aspects relating to the project or the activity;
- The direct or indirect effects that the activity is likely to have on the population, flora and fauna, soil, air, water, landscape, and other physical assets including historical, artistic and archaeological;
- Any actions or measures which may avoid, prevent, change, mitigate or remedy the likely effects of the activity or the project on the environment;
- The inevitable adverse effects that the project or the activity is likely to have on the environment if it is implemented in the manner proposed by the proponent;
- The irreversible and irretrievable impact on the commitment of resources which will be involved by the project or the activity;
- The actions or measures proposed for compensating physically or financially for any resulting loss or damage to the environment;

- A study of the feasible alternatives considered, including a summary of all the expected impacts;
- An environmental monitoring programme; and
- Such other information as may be necessary for a proper review of the potential environmental impact of the project or the activity.

Environmental Management Plans

The EPA does not make specific reference to EMPs, but requires that an EIA includes the following:

"…any actions or measures which may avoid, prevent, change, mitigate orremedy the likely effects of the activity or the project on the environment" (Section 15(3)(e)); and the actions or measures proposed for compensating physically or financially for any resulting loss or damage to the environment." (Section 15(3)(h)).

Notwithstanding the provisions of the EPA, the standard Terms of Reference prepared by MoE for EIA consultants usually require the inclusion of an environmental management plan (EMP), as well as environmental monitoring and reporting plans.

3.2 - OTHER REGULATORY REQUIREMENTS

Other regulatory requirements may be relevant to the cable project are:

Maritime Zones Act N°2 (1997)

Set the limits of the territorial seas and EEZ. Defines the rights of the Seychelles over the all resource and economic uses in these marine spaces

Maritime Zones (Maritime Pollution) regulation (1981)

Declare national jurisdiction over the territorial waters, the continental shelf and the exclusive economic EEZ zone of Seychelles. Discharge of oil to the marine environment. Prevention/ removal of marine pollution by oil.

Environment Protection Act (1994), Environment Protection (Standards) Regulations (1995)Environment Protection (Impact Assessment) Regulations (1996)

Regulates air and water quality. Protection and management of the coastal zone. Regulates noise disturbance. Regulation of hazardous substances. Regulates discharges into the marine environment. Legislation concerning marine protected areas.

Emission standards have been published under the EPA for noise, the Environment Protection (Noise Emission Standards) Regulations (Table 4)

Table 4. Noise Emission Standards

Description area	Time	Limits in Decibels (dB(A))
Residential	06h00 - 23h00	60 Leq
	23h00 - 06h00	55 Leq
Industrial	At all times	75 Leq (measured ath the boundary of the industrial site)
Audible intrusion in pristine acoustic environment	At all times	60 Leq

Environment Protection (Noise Emission Standards) Regulations, SI No. 49 of 1999

Regulates noise disturbance

Removal of Sand and Gravel Act of 1982 Removal of Sand and Gravel (Fees) Regulations, SI No. 40 of 1982

Dumping at Sea Act of 1974 (Overseas Territories) Order of 1975 (Chapter 67)

Control of waste disposal from ships

The Oil Pollution (Compulsory Insurance) Regulations, SI No. 8 of 1976

Prevention/removal of marine pollution by oil

Merchant shipping (Oil Pollution) Seychelles Order (1975)

Safety of vessels at sea

Beach Control Act (1978)

Control use of pleasure boat and motorised water sport

Harbour Act & Regulation 1933), Harbour (inner harbour) (control of traffic), regulation Harbour (fishing port) Regulation 1988,Ports (interim Provisions) Declaration Order 1975

Regulation of marine traffic, pollution prevention, regulates location for berthing and anchoring of ships. Control disposal of waste from ship Control exchange of ballast water by ship in port areas

Fisheries Act (1986) and Regulations 1987, Fisheries (Amendment) Act, No. 3 of 1997 Fisheries (Amendment) Act, No. 2 of 2001

Makes provision for the protection of several areas in Seychelles waters (shellreserves). Some of these areas are specifically designated to exclude certain types of fisheryOthers areas are specifically designated to prevent damage to the benthos (i.e.exclusion of certain gear types in specifiedareas). Provide for fishing agreements and licence conditions Management of fisheries stocks.

Land Reclamations Act (1961) Land Reclamation Delegation of statutory Functions order (1972) Land Reclamation (Amendment of schedule) (1975) Land Reclamation Amendment) Decree (1978) Land Reclamation (Retrospective Authority) order (1987) Land Reclamation (Amendment of schedule) rules (1988)

Sets out conditions under which reclamation is authorisedProvides mechanisms for objecting to any undertaking Makes provision for public notices to be issued for all land reclamation activities

3.3 - INTERNATIONAL TREATIES AND CONVENTIONS

Recognizing the value to humanity of international communications, cables are protected by international treaties:

- The International Convention for the Protection of Submarine Cables (1884)
- Geneva Convention on the High Seas (1958)
- United Nations Convention on the Law of the Sea (UNCLOS) (1982)

The International Convention for the Protection of Submarine Cables establishes that the breaking or injury of a submarine cable, done wilfully or through culpable negligence, and resulting in the total or partial interruption or embarrassment of telegraphic communications, shall be a punishable offence, but the punishment inflicted shall be no bar to a civil action for damages.

The Geneva Convention on the High Seas establishes the High Seas as being open to all nations; no State may validly purport to subject any part of them to its sovereignty. Freedom of the High Seas is exercised under the conditions laid down by the Articles of the Convention and by the other rules of international law. It comprises, inter alia, both for coastal and non-coastal States:

- Freedom of navigation;
- Freedom of fishing;
- Freedom to lay submarine cables and pipelines;
- Freedom to fly over the high seas.

Seychelles is signatory to the United nations Conventions on the Laws of the Sea (UNCLOS)(**Figure 4**). Under this Seychelles claims rights within a 12 nautical mile territorial water and a 200 nautical mile Exclusive Economic Zone (EEZ).

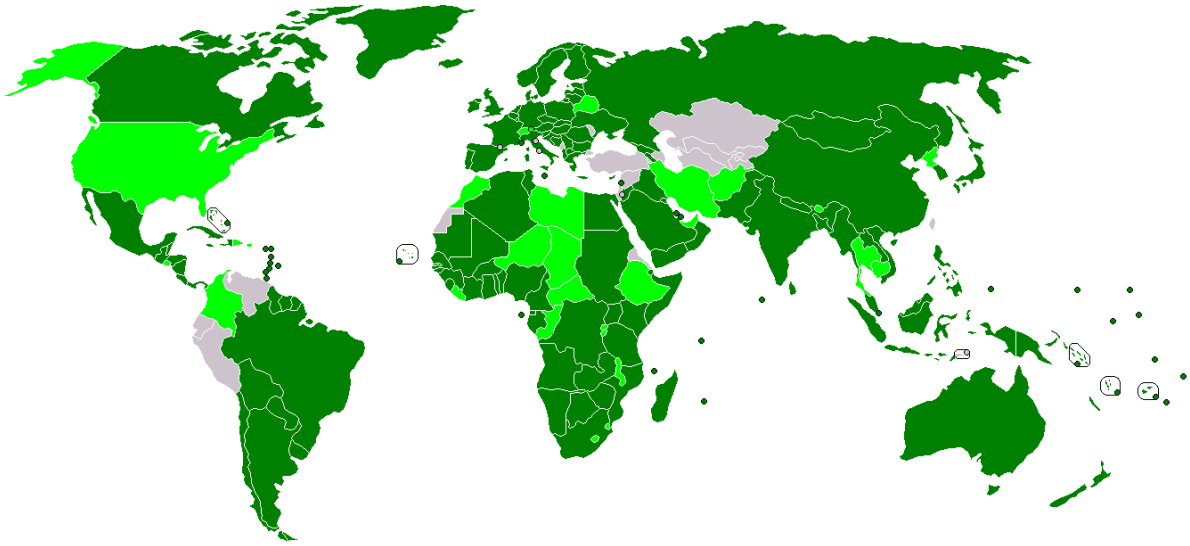


Figure 4. Signature and ratification of UNCLOS (Green ratified, green light signed, grey but not yet ratified, did not sign) (Source Wikipedia, 2010).

The EEZ and territorial waters are defined by UNCLOS and within which specific rules apply. Article 79 of UNCLOS, in particular, concerns the installation of submarine cable and pipelines on the continental shelf and specifies:

All States are entitled to lay submarine cables and pipelines on the continental shelf, in accordance with the provisions of this article.

- Subject to its right to take reasonable measures for the exploration of the continental shelf, the exploitation of its natural resources and the prevention, reduction and control of pollution from pipelines, the coastal State may not impede the laying or maintenance of such cables or pipelines.

- The delineation of the course for the laying of such pipelines on the continental shelf is subject to the consent of the coastal State.

- Nothing in this Part affects the right of the coastal State to establish conditions for cables or pipelines entering its territory or territorial sea, or its jurisdiction over cables and pipelines constructed or used in connection with the exploration of its continental shelf or exploitation of its resources or the operations of artificial islands, installations and structures under its jurisdiction.

- When laying submarine cables or pipelines, States shall have due regard to cables or pipelines already in position. In particular, possibilities of repairing existing cables or pipelines shall not be prejudiced.

Permitting of the cable will be undertaken by the navy's Hydrographic department. Full details of the survey route, vessel and equipment, master and crew are required for the permit application.

A number o the provisions and guidance outlined in the MARPOL Convention are relevant to marine activities, including general requirements over the control of waste oil, engine oil discharges and grey and black waste water disharges. In addition, a number of the Annexes of the Convention relevant such as Annex V (Prevention of Pollution by Garbage from ships) and Annex VI (Prevention of Air Pollution from ships).

Nairobi Convention (1985) and its Protocols

The Convention offers a legal framework and coordinates the efforts of the countries of the region to plan and develop programmes that strengthen their capacity to protect, manage and develop their coastal and marine environment sustainably.

A summary of international treaties and conventions that could potentially be applicable to the Project are presented below:

- **Shipping**
  - International Convention for the Protection Submarine Telegraph Cables (1884)
  - Geneva Convention on the High Seas (1958)
  - UNCLOS (1982)
  - International Convention for the Prevention of Pollution from Ships (MARPOL) London, 1973
    - MARPOL 73/78 Annex I/II
    - MARPOL 73/78 Annex III
    - MARPOL 73/78 Annex IV
    - MARPOL 73/78 Annex V
    - MARPOL 73/78 Annex VI
  - International Convention on Standards of Training Certification and Watchkeeping for Seafarers (STEW)London, 1978
  - International Convention on Civil Liability for Oil Pollution Damage Brussels, 1969
  - International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990 (guidance) Oil Company International Marine Forum (OCIMF) Guidelines 1975
  - International Convention on the Control of Harmful Anti-fouling Systems on Ships, October 2001
  - The International convention for the control and management of ships' ballast water and sediments, 2004
  - International Loadline convention, 1966
  - Convention on the International Regulations for Preventing Collisions at Sea, (COLREGs)1972

- **Waste Management**

  - Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, 1972
  - Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal

- **Habitats, Biological Diversity and Heritage**

  - Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971
  - Convention on Biological Diversity, 1996
  - South Indian Ocean Fisheries Agreement, 2006
  - Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (the Nairobi Convention) 1996
  - Convention concerning the Protection of the World Cultural and Natural Heritage Paris, 1972
  - Convention on the Conservation of Migratory Species of Wild Animals (CMS) (The Bonn Convention 1979) and agreement (Birds mammals and their habitats, 1994)

- **Social/Human rights/Consultation**

  - ILO Freedom of Association and Protection of the Right to Organise Convention. No. 87. 1948
  - UN Convention on the Rights of the Child 1989
  - ILO Worst forms of Child Labour Convention, No. 182 1999
  - ILO Discrimination (Employment and Occupation) Convention, No. 111 1958
  - ILO Equal Remuneration Convention. No. 100 1951
  - International Labor Organisation (ILO) Forced Labour Convention, No 29 1930

4 - PROJECT JUSTICATION

4.1 - INTRODUCTION

The proposed Submarine Cable System would include a new open-access fibre-optic submarine cable system which would expand International telecommunication services to Republic of Seychelles and countries on the East Indian coast of Africa. The network would facilitate transmission of data, voice, internet and television signals allowing for inter country transmission of information, thereby bridging the information gap between Seychelles, East Africa and the rest of the world.

The proposed Project includes a new open-access fibre optic submarine cable system. The Project is intended to increase the capacity for international telecommunication services initially to Seychelles. This region has experienced explosive growth in phone and internet use in recent years. This region however remains severely constrained with respect to access to cable capacity for international transmission and global connectivity.

4.2 - EXISTING DATA TRANSMISSION CAPACITY IN SEYCHELLES

International telecommunication traffic was carried out by radio or satellite systems. One effect of the satellite pricing structure and the high demand for access is a relatively high price for usage.

4.3 - BENEFITS OF THE CABLE PROJECT

4.3.1 - Primary benefits

Increased capacity

The Project will have direct benefits through the increase in available international transmission capacity and the lower cost for such access. The project also expects to offer wholesale costs 75% lower than that of existing systems.

For existing businesses, increased capacity and lower cost will allow faster and more reliable transmission for data and voice call. This can results in an improvement of business performance as well as create opportunities for expansion. Lower entry costs will also facilitate the start-up of new businesses.

The project will also improve the connectivity between Seychelles and African countries on the system.

Local Content and Technology Transfer

The operating company will have its headquarters at Victoria making the Project the first Seychelles-based submarine cable company. Hiring of staff for the operation would draw from the local skills pool and employees would be trained in telecommunications operations and international best practices. The experience would further enhance the local skills base.

4.3.2 - Indirect Benefits

In addition to the direct economic benefits of increased telecommunications access and reliability in Seychelles, many other indirect social and economic benefits would be associated with the proposed development, these include:

- improved educational opportunities through increase in access to information and education resources;
- development of a regional sense of community through greater equality of information sharing across geographical regions and across groups in society;
- economic benefits from the enhanced opportunities for new and small enterprises that may have previously been excluded from technologies by high costs;
- macroeconomic benefits of the potential expansion of technology-reliant industries, such as information technology services and software development businesses.

4.4 - COMPATIBILITY WITH REGIONAL DEVELOPMENT PLANS

The project also supports President James Michel‘s goals to develop the technology sector in Seychelles and bridge the gap between Africa and the rest of the world. The project’s open access approach will make internet access accessible to a broader section of the population including youths and business.

The government of Seychelles as well has elucidated a plan which emphasises development of the information, communication and telecommunication infrastructure. The project supports this objective.

The African development Bank’s current mission also includes promoting the development of the information and telecommunications sector; the bank has undertaken a number of supporting activities such as workshops and business development conferences. The project is fully consistent with the goals of the banks programmes. The bank is also actively seeking opportunities for public and private investments in the sector.

4.5 - PROJECT ALTERNATIVES

4.5.1 - Technology alternatives

The use of fibre optic networks has a number of advantages over satellite and microwave transmissions and radio has largely been phased out due to restricted bandwidth and poor data transmission. Modern fibre optic networks transmit high volumes of voice and data traffic with higher security and reliability and at lower cost than satellite systems. Cable also has a more dependable installation and repair record. Bandwidth demand, particularly as a result of internet activity far exceeds satellite capacity at the present time (**Hogan and Hartson, 1999**).

4.5.2 - Routing alternatives

The Seychelles archipelago is found in the Western Indian Ocean. A submarine system therefore currently offers the best option given the project's objectives.

4.5.3 - No project Alternative

Assuming that no other cable was installed, in this scenario the region would continue to be constrained by the lack of telecommunications capacity, especially in the area of international data transfer; the demand for capacity would continue to grow along with the overall economic growth. At some point in time, a different transmission technology (satellite) may become more viable either due to the increased demands of the marketplace or the relative decrease in the cost of the technology. This would reduce the need for cable based system but maybe only temporarily.

4.5.4 - Conclusion

The project will provide open access to regional telecommunications operators and internet services. The system will ease the difficulties and reduce the costs telecommunications traffic system with the rest of the world. The network will facilitate transmission of data of various bandwidth, voice, internet and television signals allowing for inter country transmission of data thereby reducing the cost of data transfer and bridging the information gap between East Africa and the rest of the world.

5 - PROJECT DESCRIPTION

5.1 - INTRODUCTION

This chapter provides a technical description of the proposed project. It also provides an overview of the planned pre-installation, installation, operations, maintenance and decommissioning activities. A general description of the project setting is also given with additional detail on the baseline environmental and social conditions provided in chapter 6 of this report.

5.2 - PROJECT BACKGROUND

When ultimately completed, the system proposed will comprise a submarine communications cable that will run between Seychelles and east coast of Africa to provide telecommunications capacity for international and internet connectivity to countries between Seychelles and Kenya or Tanzania (**Figure 2**). The cable system will span up to approximately 2 000 km along the entire route.

The submarine cable system would include installation of approximately 2 000 km of subsea cable running from Beau Vallon, Seychelles to shore crossing and landing sites in a West African country: Mombasa in Kenya or Dar es Salaam and Zanzibar in Tanzania.

A desk top study (DTS) was completed as part of the feasibility studies. The DTS identified the preferred route for the cable between Seychelles, Kenya or Tanzania.

5.3 - OVERVIEW OF PROJECT COMPONENTS

The Project components and activities that are covered by this assessment include the pre-installation, installation, operation and maintenance.

5.4 - PROJECT SCHEDULE

Baseline route surveys and engineering commenced in December 2009 (Desk Top Study of route alignment and feasibility, IXSurvey 2009). The route survey would be started in august 2010.

The route survey would be started in august 2010. The BMH will be concreted and will have a metal cover for access (duration 2 weeks). Deep and shallow water cable laying is planned to start in September – October 2010 allowing for final commissioning in (2011). The decommissioning is planned for 2035.

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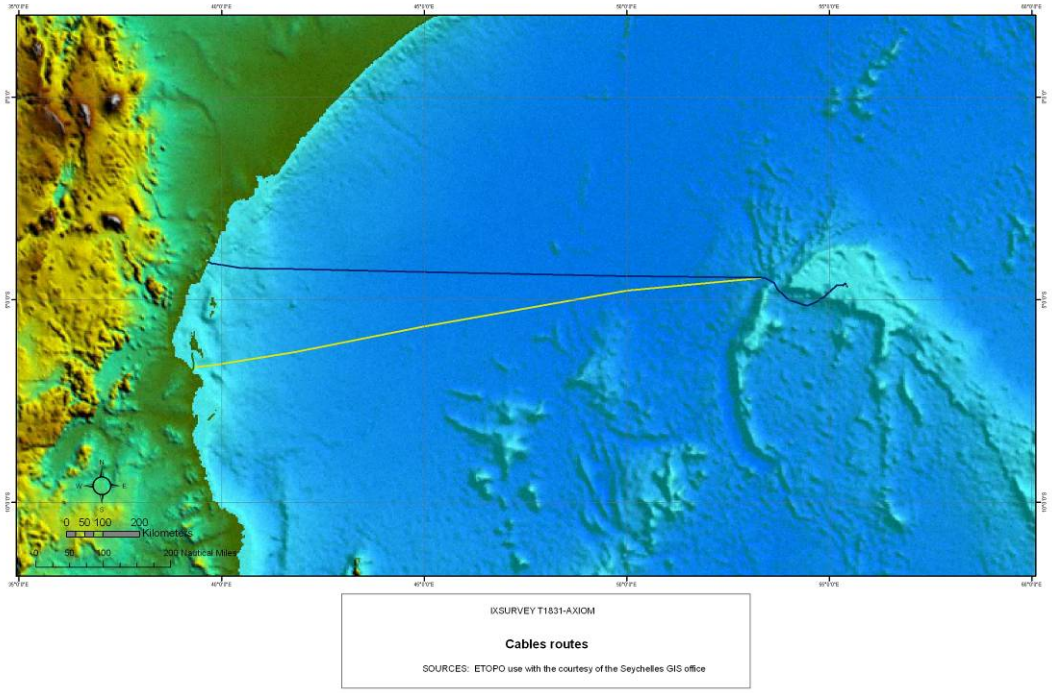
5.5 - PROJECT LOCATION

The submarine cable system would include installation of approximately 2 000 km of subsea cable running from Beau Vallon, Seychelles to shore crossing and landing sites in a West African country: Mombasa in Kenya or Dar es Salaam and Zanzibar in Tanzania.



5.6 - ROUTE DESCRIPTION

Table 5 below provides a summary of the cable route information. Tables 6, 7, 8 and 9 show the cable distance between events.

Table 5. Summary cable route information

Segment	From	To	Route Length (Km)	Min/max Water Depth (meters)
Base configuration	Seychelles (Mahé) Beau Vallon Beach BMH 4°36.737' S 55°25.753' E	Kenya Monbasa Fort Jesus 4° 03.715' S 39° 40.814' E	1 848,76	0/5000
Base configuration Variants	Seychelles (Mahé) Beau Vallon Beach BMH 4°36.737' S 55°25.753' E	Tanzania Dar es Salaam 6°45.633 S 39°15.689 E	1 918,50	0/5000
	Tanzania Dar es Salaam 6°45.633 S 39°15.689 E	Tanzania Zanzibar FUMBA 6°19.118 S 39°17.145 E	52,85	0/60
	Tanzania Dar es Salaam 6°45.633 S 39°15.689 E	Tanzania Zanzibar MBWEI 6°11.976 S 39°12.473 E	76,59	0/60

Table 6. Summary Cable Distances between Events (Segment Seychelles – Kenya)

Event	Latitude South		Longitude East		Cable Distance (km)		Approx
					Between	Cumulative	Depth
					Positions	Total	(m)
LP Mahé	4 °	36,737 '	55 °	25,756 '		0	0
					3,141		
AC1	4 °	35,871 '	55 °	24,313 '		3,141	35
					1,760		
AC2	4 °	36,259 '	55 °	23,454 '		4,900	40
					1,238		
AC3	4 °	36,646 '	55 °	22,915 '		6,138	40
					2,352		
AC4	4 °	37,689 '	55 °	22,204 '		8,490	35
					3,117		
AC5	4 °	38,641 '	55 °	20,831 '		11,608	50
					15,754		
AC6	4 °	38,400 '	55 °	12,400 '		27,361	48
					50,245		
AC7	4 °	56,000 '	54 °	52,000 '		77,606	200
					6,624		
AC8	4 °	57,900 '	54 °	49,000 '		84,230	1000

					7,139		
AC9	5 °	00,000 '	54 °	45,800 '		91,369	1500
					9,058		
AC10	5 °	03,000 '	54 °	42,100 '		100,427	2000
					30,602		
AC11	5 °	08,800 '	54 °	27,100 '		131,029	2418
					54,224		
AC12	5 °	00,000 '	54 °	00,000 '		185,252	3000
					42,109		
AC13	4 °	44,900 '	53 °	43,800 '		227,362	2000
					20,899		
AC14	4 °	35,000 '	53 °	39,000 '		248,261	2000
					31,077		
AC15	4 °	27,500 '	53 °	24,500 '		279,338	4000
					416,721		
AC16	4 °	24,785 '	49 °	45,800 '		696,059	5000
					592,028		
AC17	4 °	18,613 '	44 °	35,165 '		1288,087	4500
					161,888		
AC18	4 °	16,500 '	43 °	10,240 '		1449,975	4000
					155,504		
AC19	4 °	14,800 '	41 °	48,660 '		1605,478	3000
					64,777		
AC20	4 °	14,000 '	41 °	14,680 '		1670,255	2000
					32,601		
AC21	4 °	13,830 '	40 °	57,575 '		1702,856	1500
					58,897		
AC22	4 °	12,451 '	40 °	26,090 '		1761,752	1000
					50,499		
AC23	4 °	08,280 '	39 °	59,391 '		1812,251	700
					10,145		
AC24	4 °	07,442 '	39 °	54,028 '		1822,396	450
					12,608		
AC25	4 °	06,400 '	39 °	47,363 '		1835,004	310
					3,974		
AC26	4 °	06,072 '	39 °	45,262 '		1838,978	220
					4,063		
AC27	4 °	05,255 '	39 °	43,246 '		1843,042	50
					0,361		
AC28	4 °	05,182 '	39 °	43,066 '		1843,403	42
					0,079		
AC29	4 °	05,166 '	39 °	43,027 '		1843,482	50
					0,411		
AC30	4 °	05,084 '	39 °	42,823 '		1843,893	50

					0,689		
AC31	4 °	04,945 '	39 °	42,482 '		1844,582	20
					0,119		
AC32	4 °	04,921 '	39 °	42,423 '		1844,700	16
					2,083		
AC33	4 °	04,503 '	39 °	41,389 '		1846,783	16
					0,395		
AC34	4 °	04,372 '	39 °	41,223 '		1847,178	16
					0,185		
AC35	4 °	04,311 '	39 °	41,145 '		1847,363	16
					0,086		
AC36	4 °	04,267 '	39 °	41,131 '		1847,449	16
					0,465		
AC37	4 °	04,029 '	39 °	41,055 '		1847,914	16
					0,122		
AC38	4 °	03,965 '	39 °	41,041 '		1848,036	16
					0,214		
AC39	4 °	03,852 '	39 °	41,019 '		1848,249	17
					0,025		
AC40	4 °	03,841 '	39 °	41,011 '		1848,274	20
					0,113		
AC41	4 °	03,791 '	39 °	40,978 '		1848,387	26
					0,113		
AC42	4 °	03,748 '	39 °	40,934 '		1848,501	30
					0,076		
AC43	4 °	03,720 '	39 °	40,905 '		1848,577	22
					0,005		
AC44	4 °	03,718 '	39 °	40,903 '		1848,582	22
					0,011		
AC45	4 °	03,714 '	39 °	40,899 '		1848,593	22
					0,003		
AC46	4 °	03,712 '	39 °	40,898 '		1848,597	22
					0,033		
AC47	4 °	03,715 '	39 °	40,880 '		1848,630	21
					0,010		
AC48	4 °	03,715 '	39 °	40,875 '		1848,640	20
					0,079		
AC49	4 °	03,720 '	39 °	40,833 '		1848,719	0
					0,043		
LP Mombasa	4 °	03,707 '	39 °	40,814 '		1848,761	0

Table 7. Summary Cable Distances between Events (Segment Seychelles – Tanzania Dar es Salaam)

Event	Latitude South		Longitude East		Cable Distance (km)		Approx
					Between	Cumulative	Depth
					Positions	Total	(m)
LP Mahé	4 °	36,737	55 °	25,756		0,000	0
					3,141		
AC1	4 °	35,871	55 °	24,313		3,141	35
					1,760		
AC2	4 °	36,259	55 °	23,454		4,900	40
					1,238		
AC3	4 °	36,646	55 °	22,915		6,138	40
					2,352		
AC4	4 °	37,689	55 °	22,204		8,490	35
					3,117		
AC5	4 °	38,641	55 °	20,831		11,608	50
					15,754		
AC6	4 °	38,400	55 °	12,400		27,361	48
					50,245		
AC7	4 °	56,000	54 °	52,000		77,606	200
					6,624		
AC8	4 °	57,900	54 °	49,000		84,230	1000
					7,139		
AC9	5 °	0,000	54 °	45,800		91,369	1500
					9,058		
AC10	5 °	3,000	54 °	42,100		100,427	2000
					30,602		
AC11	5 °	8,800	54 °	27,100		131,029	2418
					54,224		
AC12	5 °	0,000	54 °	0,000		185,252	3000
					42,109		
AC13	4 °	44,900	53 °	43,800		227,362	2000
					20,899		
AC14	4 °	35,000	53 °	39,000		248,261	2000
					31,077		
AC15	4 °	27,500	53 °	24,500		279,338	4000
					391,928		
AC16	4 °	46,300	49 °	59,600		671,266	4692
					579,144		
AC17	5 °	39,800	45 °	0,000		1250,410	4200
					368,972		
AC18	6 °	17,200	41 °	49,500		1619,382	3000
					129,453		
AC19	6 °	28,000	40 °	42,200		1748,835	2000
					53,941		

AC20	6 °	32,800	40 °	14,200		1802,776	1500
					46,102		
AC21	6 °	36,500	39 °	50,200		1848,878	1000
					52,800		
AC22	6 °	40,063	39 °	22,059		1901,678	200
					10,461		
AC23	6 °	43,438	39 °	17,565		1912,139	16
					2,193		
AC24	6 °	-43,662	39 °	16,408		1914,332	16
					1,649		
AC25	6 °	-44,282	39 °	15,776		1915,981	10
					2,520		
LP Dar es Salaam	6 °	-45,633	39 °	15,689		1918,501	0

Table 8. Summary Cable Distances between Events (Segment Tanzania Dar es Salaam - FUMBA)

Event	**Latitude South**		**Longitude East**		Cable Distance (km)		Approx
					Between	Cumulative	Depth
					Positions	Total	(m)
LP Dar es Salaam	6 °	45,633 '	39 °	15,689 '		0	0
					2,520		
AC1	6 °	44,282 '	39 °	15,776 '		2,520	10
					1,649		
AC2	6 °	43,662 '	39 °	16,408 '		4,169	10
					2,193		
AC3	6 °	43,438 '	39 °	17,565 '		6,362	10
					4,696		
AC4	6 °	41,095 '	39 °	18,500 '		11,058	25
					13,048		
AC5	6 °	34,086 '	39 °	18,444 '		24,106	60
					9,875		
AC6	6 °	28,844 '	39 °	17,631 '		33,982	50
					10,008		
AC7	6 °	23,676 '	39 °	16,151 '		43,989	42
					3,055		
AC8	6 °	22,035 '	39 °	16,125 '		47,044	20
					0,212		
AC9	6 °	21,921 '	39 °	16,124 '		47,257	15
					4,564		
AC10	6 °	19,561 '	39 °	16,787 '		51,820	2
					1,028		
LP Fumba	6 °	19,143 '	39 °	17,148 '		52,848	0

Table 9. Summary Cable Distances between Events (Segment Tanzania Dar es Salaam - MBWEI)

Event	Latitude South		Longitude East		Cable Distance (km)		Approx
					Between	Cumulative	Depth
					Positions	Total	(m)
LP Dar es Salaam	6 °	45,633 '	39 °	15,689 '		0	0
					2,520		
AC1	6 °	44,282 '	39 °	15,776 '		2,520	10
					1,649		
AC2	6 °	43,662 '	39 °	16,408 '		4,169	10
					2,193		
AC3	6 °	43,438 '	39 °	17,565 '		6,362	10
					4,696		
AC4	6 °	41,095 '	39 °	18,500 '		11,058	40
					13,048		
AC5	6 °	34,086 '	39 °	18,444 '		24,106	42
					12,768		
AC6	6 °	27,228 '	39 °	18,543 '		36,875	50
					28,040		
AC7	6 °	16,343 '	39 °	08,136 '		64,915	30
					7,458		
AC8	6 °	13,127 '	39 °	10,523 '		72,373	20
					4,217		
LP MBWEI	6 °	11,976 '	39 °	12,473 '		76,590	0

Seychelles landing site

The preferred landing site in Seychelles is located at Beau Vallon, approximately 5 km South-West of Victoria.The GPS measured coordinates of the proposed manhole at Beau Vallon (**Figure 5**) site were (WGS 84): (S) 4°36.692' (E) 55°25.793'.



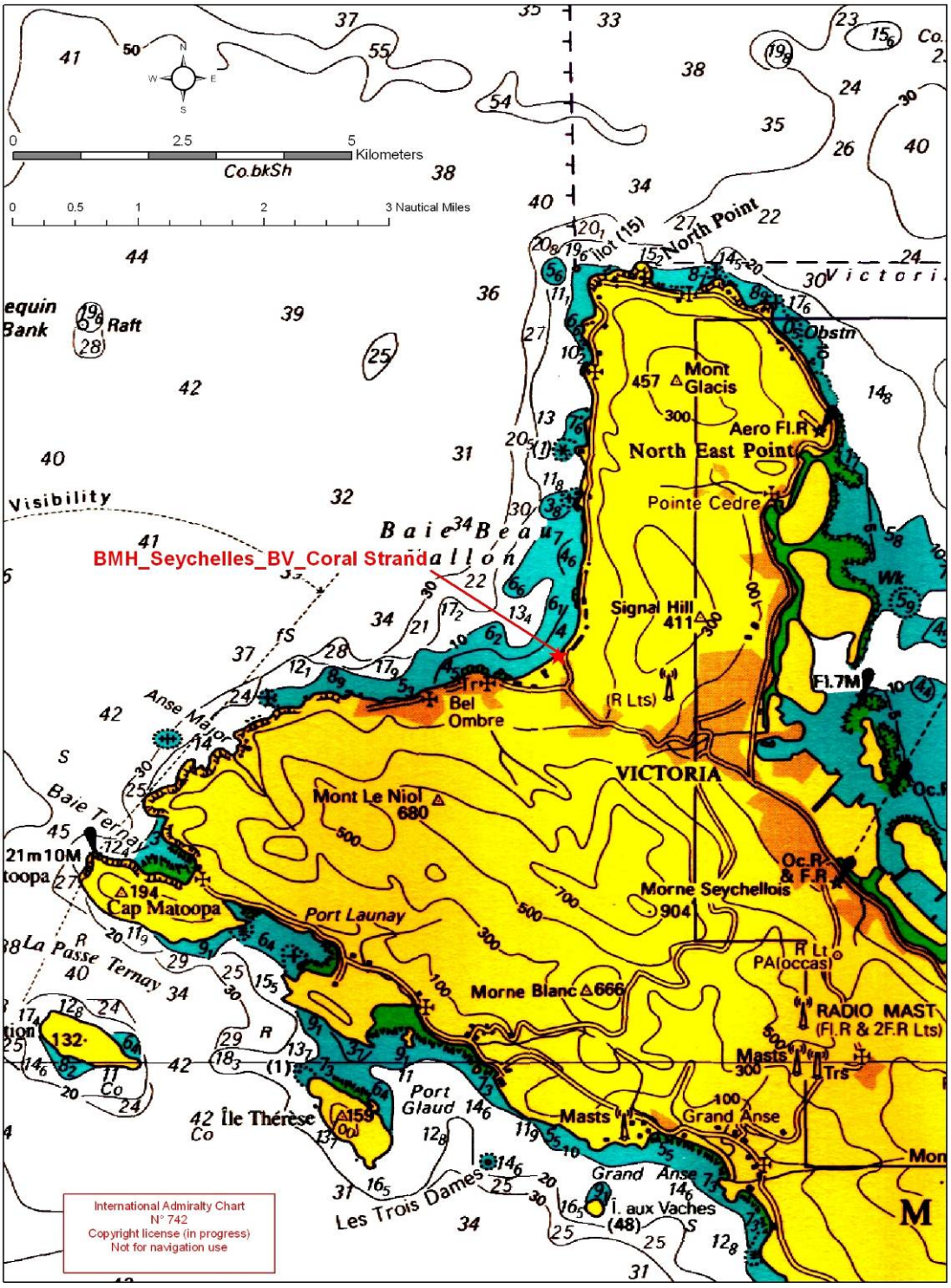



Figure 5. Location of BMA at beau Vallon – Seychelles - Mahé

Site Name	**Beau Vallon Beach**
Landing site information	**Prefered site between Coral Strand Hotel and Al mare restaurant**
Beach Manhole Location	(S) 4°36.692' (E) 55°25.793'
Beach Manhole status	No existing
Beach conditions	
Access to beach	Existing
Surf conditions	< 1 m during visit
Currents	No current observations were made during the site visit
Obstacles	Possible sunken logs
inaccessible areas	None known
Other	N/A
Sediments	
At the Landing Position (LP)	Sand
LP to 5 m contour	Sand
LP to 10 m contour	Sand
Backing	The beack is backed by long establishement road
Sediments movements	yes, strong < 1m (beach profil)
Existing services	
Other BMH	No existing
Planned cable	No existing
Other retired cables	None
Existing cable station	No
Power	Sufficient
Sewage	Yes
Electrivcity substation	Yes
Water treatment plant	Unknown
Land ownership	
Of the LP	Mahé - Government easement
Of the BMH	Unknown
Of the beach	Beau Vallon
Restricted areas	None observed
Permitting issues	Requires investigations
Marine Route Issues	
Distance BMH to 20 meters contour	1 800 m From admiralty chart 742
Distance BMH to 50 meters contour	11 650 m From admiralty chart 742
Survey Permit and Installation Permit	Not required for seychelles registred vessel - requires investigations
Fishing	
Type	Artisanal
Vessel type	Small boat (5 m)
Fish havens	None
Fish farms	None
Hydrocarbon activity	
Rigs/platforms	None
Field development	none
Dredging	
Mineral locations	yes
Sand mining	yes in front of the site
Development Plans	None
Shipping	
Anchorage zones	None in immediate vicinity
Frequency/vessel size	N/A
Shipping routes/channels	Shipping routes/ channels approx East 5 km of site (just East cost concened)
Ports	Victoria port (aprprox 5 km of preferred site)
Ferry	None in immediate vicinity
Development plans	Tourism hotel
Dump sites	
Onshore waste	None
Positive Aspects	Access and short distance from Victoria Back haul available Absence of coral reef barrier
Negative Aspects	The most frequented beach and maybe the most popular on the island

Option - Kenya landing site

The GPS measured coordinates of the existing manhole at Fort Jésus are (**Figure 6**):

WGS 84) : (S) 04º 03.715' (E) 39º 40.814'

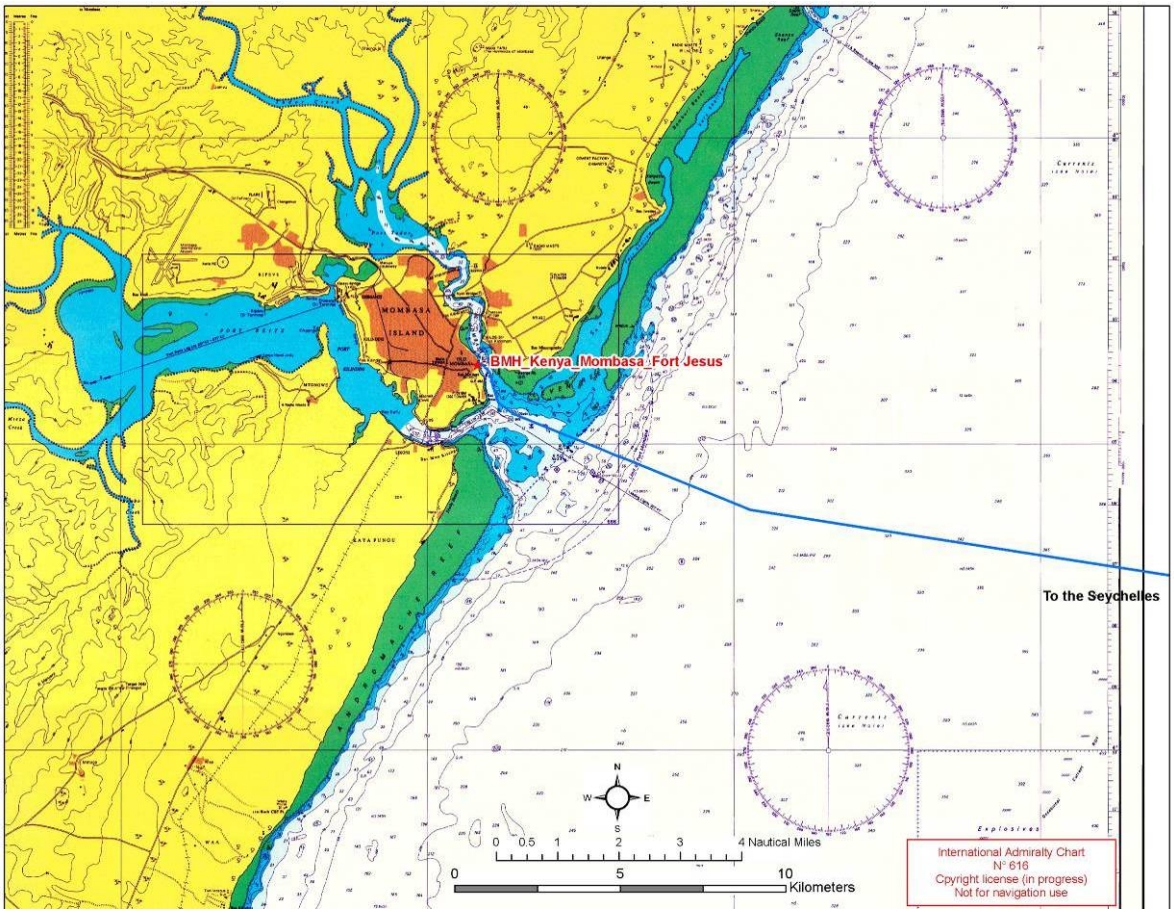


Figure 6. location of BMH at Mombasa

Site Name	**Fort Jésus**
Landing site information	**Prefered site**
Beach Manhole Location	(S) 04° 03.715' (E) 39° 40.814'
Beach Manhole status	Existing
Beach conditions	
Access to beach	Existing
Surf conditions	Largest waves (2 m) occur during the South East Monsoon
Currents	East Africa Coastal Current (1.5 – 2 $m.s^{-1}$)
Obstacles	Possible sunken logs
inaccessible areas	None known
Other	N/A
Sediments	
At the Landing Position (LP)	rocky cliff
LP to 5 m contour	rocky cliff
LP to 10 m contour	rocky cliff
Backing	rocky cliff
Sediments movements	yes
Existing services	
Other BMH	Existing (SEACOM)
Planned cable	Eassy
Other retired cables	Yes
Existing cable station	Yes
Power	Sufficient
Sewage	Yes
Electrivcity substation	Yes
Water treatment plant	Unknown
Land ownership	
Of the LP	Kenya
Of the BMH	
Of the beach	Mombasa Island
Marine Route Issues	
Distance BMH to 20 meters contour	4 371 m From admiralty chart 616
Distance BMH to 50 meters contour	5 797 m From admiralty chart 616
Survey Permit and Installation Permit	Not required for Kenya registred vessel
Fishing	
Type	Artisanal
Vessel type	Small boat
Fish havens	None
Fish farms	None
Hydrocarbon activity	
Rigs/platforms	None
Field development	None
Dredging	
Mineral locations	None
Sand mining	None
Development Plans	None
Shipping	
Anchorage zones	None in immediate vicinity
Frequency/vessel size	Elevated
Shipping routes	Near the channel
Shipping channels	Yes
Ports	Yes
Ferry	yes
Development plans	N/A
Dump sites	
Onshore waste	None
Positive Aspects	Existing landing site with existing conduits existing cable station with space and power available back haul available
Negative Aspects	Proximity to existing cables Archeological sites Fort Jesus is one of Mombasa's biggest tourist attractions

Option - Tanzania landing site

Dar es Salaam

Msasani Bay (Dar es Salaam – **Figure 7**), the GPS measured coordinates of the existing manhole are: **(WGS 84): (S) 6°45.633 (E) 39°15.689**

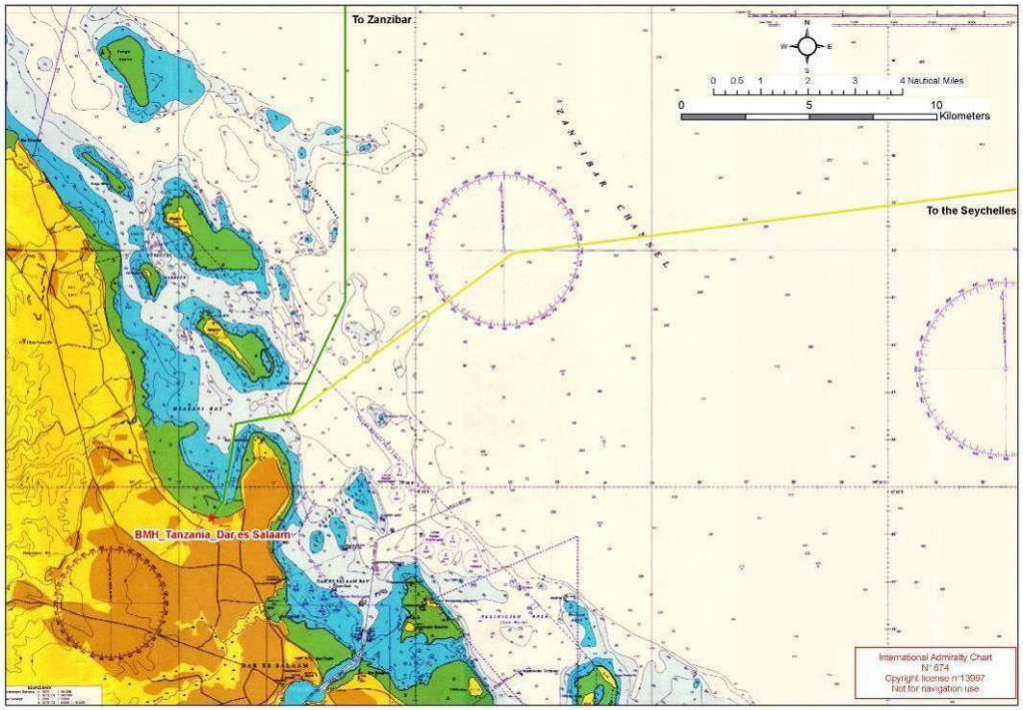


Figure 7. Location of BMH at Dar es Salaam - Tanznia

BMH_Zanzibar_FUMBA

(WGS 84): 6°19.118 (S) 39°17.145 (E)

Zantel antenna (100 meters of BMH proposed)

BMH_Zanzibar_MBWEI

(WGS 84): 6°11.976 (S) 39°12.473 (E)

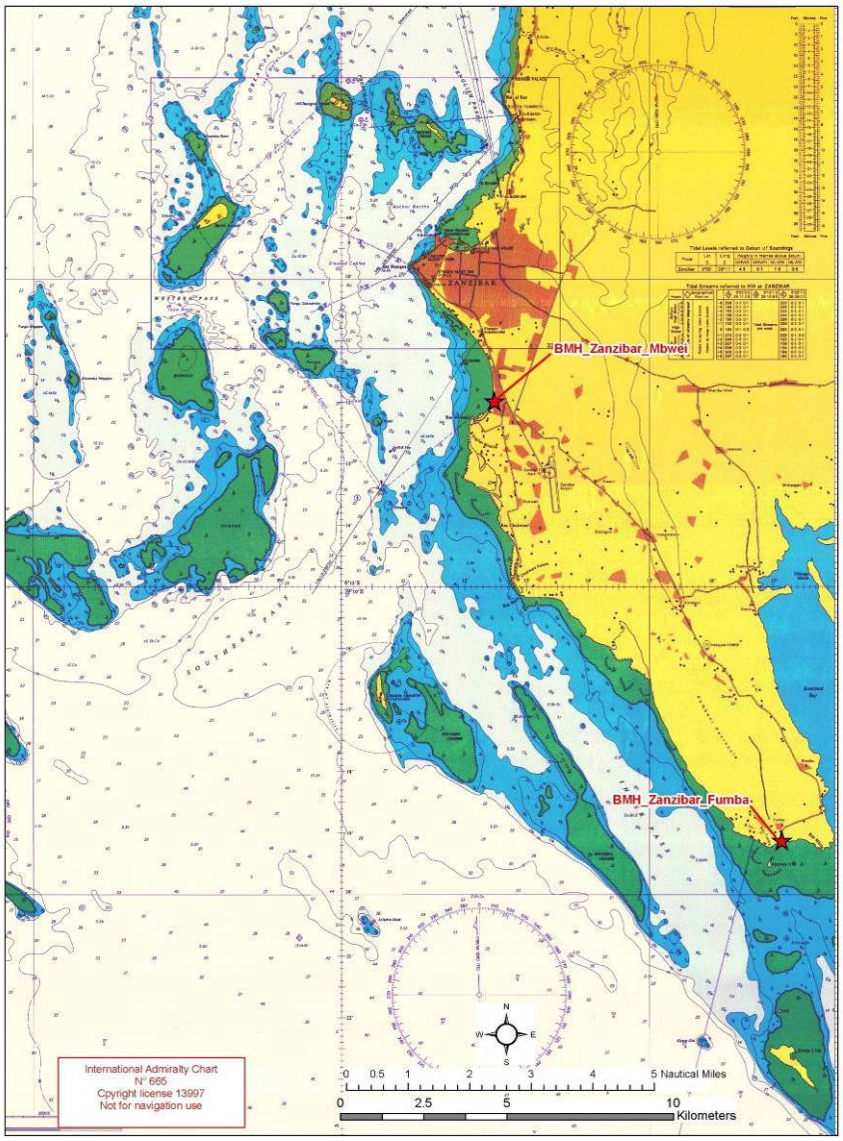


Figure 8. BMH - Zanzibar

Tanzania	Tanzania mainland	Zanzibar	
Site Name	**Dar-Es-Salaam MSASANI Bay**	**FUMBA**	**BDWEI**
Landing site information	**Prefered site**	**Prefered site**	**Alternate site**
Beach Manhole Location	(S) 6°45.633 (E) 39°15.689	(S) 6°19.118 (E) 39°17.145	(S) 6°11.976 (E) 39°12.473
Beach Manhole status	Existing (ZANTEL)	No existing	No existing
Beach conditions			
Access to beach	Existing	Existing	Existing
Surf conditions	2-3m	< 0.5 m during visit	< 0.3 m during visit
Currents	strongest 3.5ms-1	weak <0.5ms-1	weak <0.5ms-1
Obstacles	none	coral patches	coral patches
inaccessible areas	none	None known	None known
Other	N/A	N/A	N/A
Sediments			
At the Landing Position (LP)	Sand	Sand	Sand
LP to 5 m contour	Sand	Sand	Sand
LP to 10 m contour	Sand	Sand	Sand
Backing	Sand	terrigenous	terrigenous
Sediments movements	yes	None	None
Existing services			
Other BMH	Yes (SEACOM)	no	no
Planned cable	EASSy (march 2010)	No existing	No existing
Other retired cables	none	None	None
Existing cable station	Yes	None	None
Power	No (coming soon)	None	None
Sewage	None	None	None
Electrivcity substation	None	None	None
Water treatment plant	Unknown	Unknown	Unknown
Land ownership			
Of the LP	Dar-Es-Salaam	Zantel	Zanzibar
Of the BMH	Zantel	N/A	N/A
Of the beach	Dar-Es-Salaam	Zanzibar	Zanzibar
Marine Route Issues			
Distance BMH to 20 meters contour	6 000	12 000 m	N/A
Distance BMH to 50 meters contour	12 800	12 000 m	N/A
Survey Permit and Installation Permit	Not required for local registred vessel	Not required for local registred vessel	Not required for local registred vessel
Fishing			
Type	Artisanal	Artisanal	Artisanal
Vessel type	Small boat (<5 m)	Small boat (5 m)	Small boat (5 m)
Fish havens	None	None	None
Fish farms	None	None	None
Hydrocarbon activity			
Rigs/platforms	None	None	None
Field development	None	None	None
Dredging			
Mineral locations	None	None	None
Sand mining	None	None	None
Development Plans	None	None	None
Shipping			
Anchorage zones	yes (permanent yacht club mo	temporary recreationnal moorin	temporary recreationnal moorin
Frequency/vessel size	small recreational craft	small recreational craft	small recreational craft
Shipping routes	None	None	closeby
Shipping channels	None	None	closeby
Ports		None	closeby
Ferry	local ferry to Bongoyo island	None	closeby
Development plans	None	None	None
Dump sites			
Onshore waste	None	None	None
Positive Aspects	Existing landing site with existing ducts existing cable station with space and power available back haul available at Zantel head Office	BMH prefered site owned by Zantel unhabited area easy access sandy beach	near Zantel Head Office easy access sandy beach
Negative Aspects	N/A	Coral patches far from head office of Zantel	Power cable crossing Coral patches

5.7 - SYSTEM OVERVIEW – SUBSEA CABLE

The proposal system will consist of subsea cables landings, repeaters and 1 branching unit if Tanzania option selected. A typical submarine cable system is shown in Figure 9.

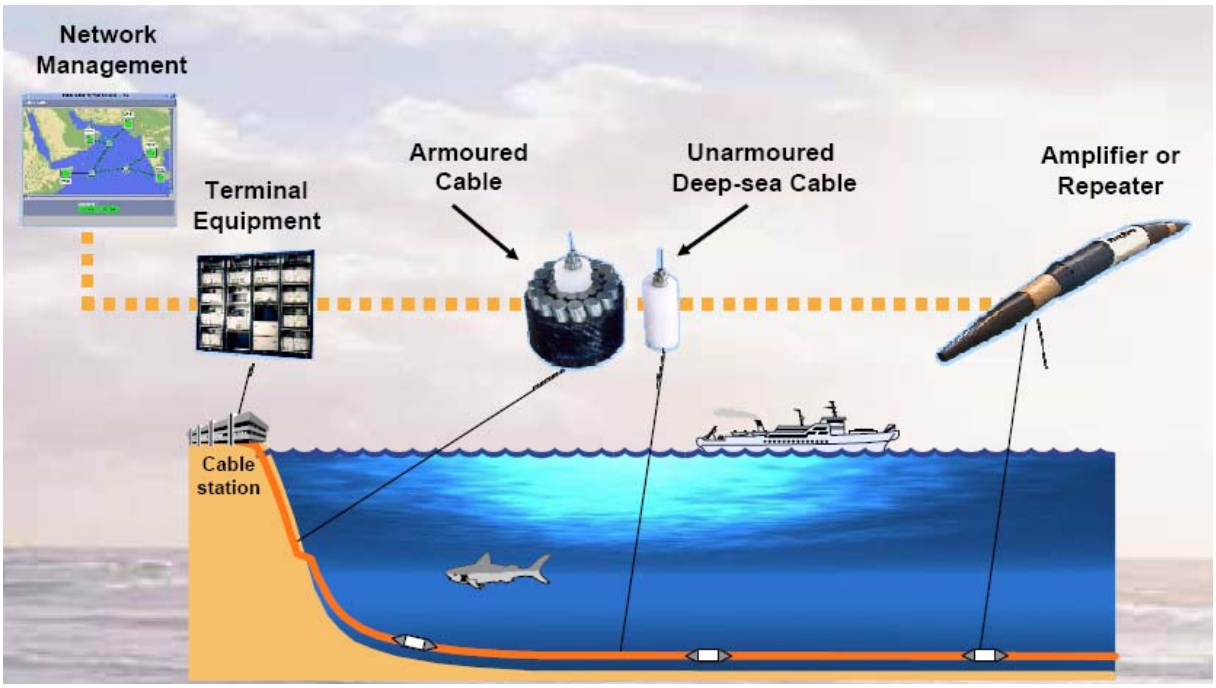


Figure 9. Typical submarine sytem (Source: U.K. Cable Protection Committee & Alcatel Submarine Networks)

Cable engineering specifications for the proposed Project will be based on cable industry standards. The diameter of the subsea cables will vary between 17 and 20 mm for sections without protective armor; armored cables may be as large as 50 mm in diameter.

The cable consists of an inner optical fibre (**Figure 10**), surrounded by a polyethylene or fibreglass core for strength and fibre separation.

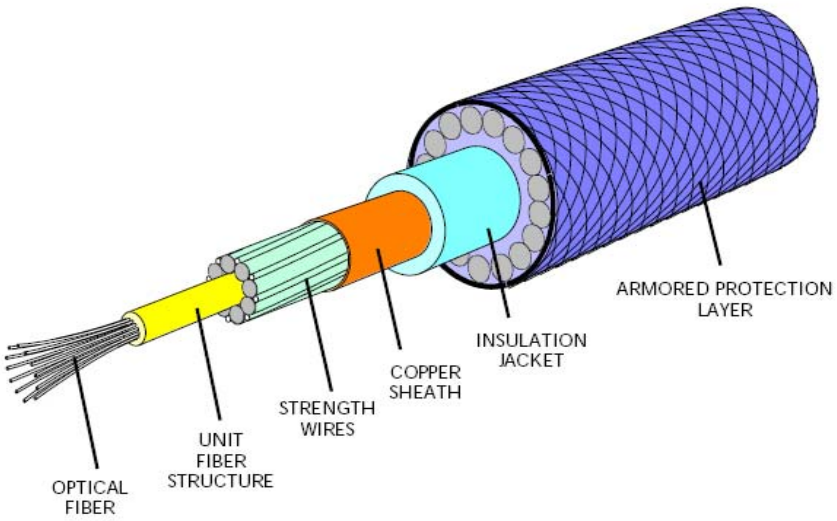


Figure 10. Illustration of cable design (Source Tyco)

Fibre optic cables transmit data via beams of laser-generated light that are internally reflected within the optical fibres. The strength of the light signal degrades with distance and therefore amplifiers are installed along the cable. In the project system optical amplifiers are installed in the marine cable at intervals of approximately 80km. These amplifiers are sometimes referred to as repeaters and are electrically powered.

Repeaters are installed along the cable to boost the signal because the signal loses strength en route. Approximately 20 repeaters are planned along the total route length (**Figure 11**).

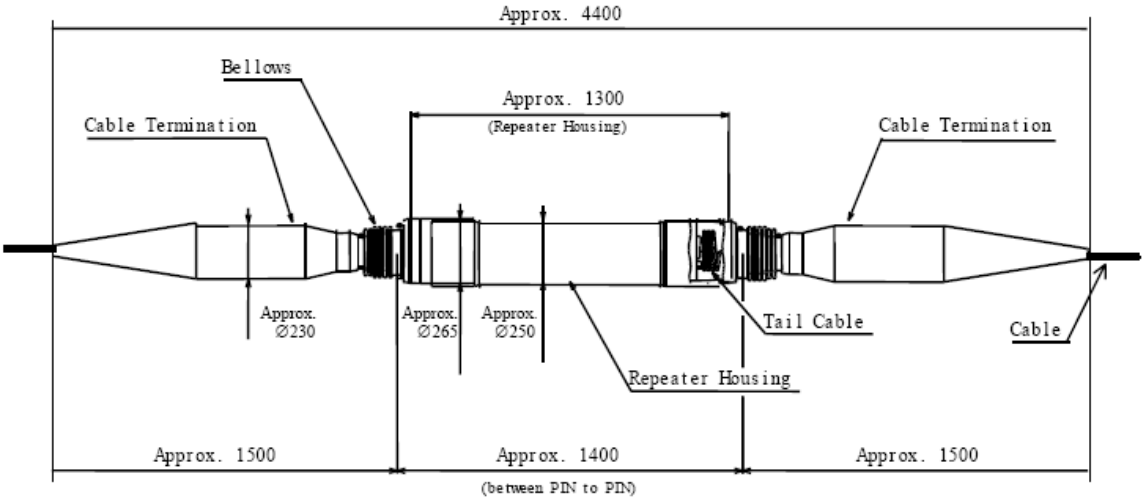


Figure 11. Repeaters plan source NEC

BUs are pieces of equipment used in submarine telecommunications cable systems to allow the cable to split to serve more than one destination (**Figure 12**). There is one BUs planned for the Tanzania route segments under consideration.

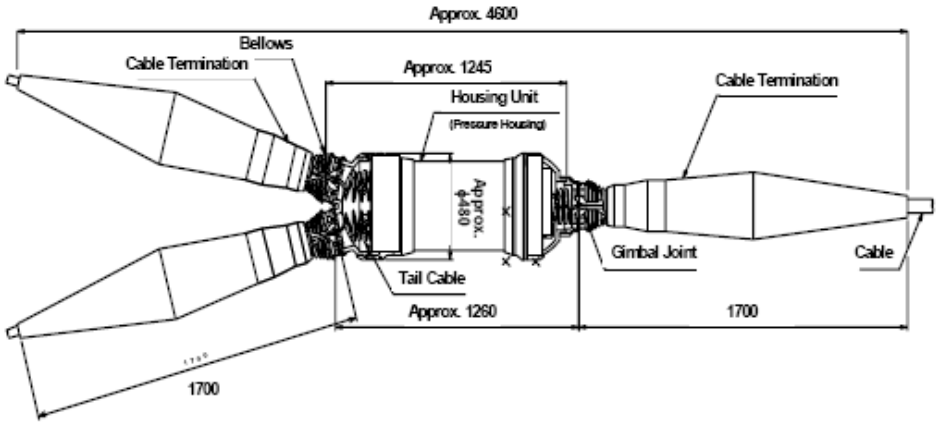


Figure 12. Branching Unit BU plan Source NEC

Wherever possible, it is desirable to engineer a route that requires the minimum length of armouring and burial due to cost. There are also time implications, as each layer of armouring requires a pass through the factory.

To achieve a secure cable system, some form of protection must be provided. This essentially falls into the categories of burial and / or armouring. On the continental shelf sections, protection can be most reliably achieved by burial, which places the cable below the depth of penetration of the threat.

Armouring of a cable is routinely performed in areas of high risk. All fibre optic cables are based around the core cable which changes little between different armouring types. The cable is armoured by placing layers of galvanised steel wires around this central core. While manufacturers offer a wide range of different cable constructions (**Figure 13**), the basic types of armouring available, and their typical characteristics, are summarised in Table 10.

Table 10. Typical cable armour characteristics <u>for guidance only</u> (refer to manufacture for specific properties).

Cable Type	Characteristics	Water Depth
Light weight (LW)	Deep water cable for areas where no significant hazards exist	< 2 500 m
Light weight protected (LWP)	Light weight cable with an abrasion resistant covering. Suitable for aras where rugged topography is crossed, suach as the mid Indian ridge	< 2 500 m
Single Armor Light (SAL)	A relativly light weight cable for use in areas where good burial is possible, and external threat risk is relatively low	1 500 - 2 500 m
Single Armor (SA)	Usually used in areas where only limited burial is possible	100 - 1 500
Double Armor (DA)	A well protected cable for use in areas where little or no burial is anticipated and for shore ends	0 - 100
Rock Armor (RA)	Similar to double armour but with improved impact resistance and more flexible, hence better able to conform to an undulating rock seabed	< 200

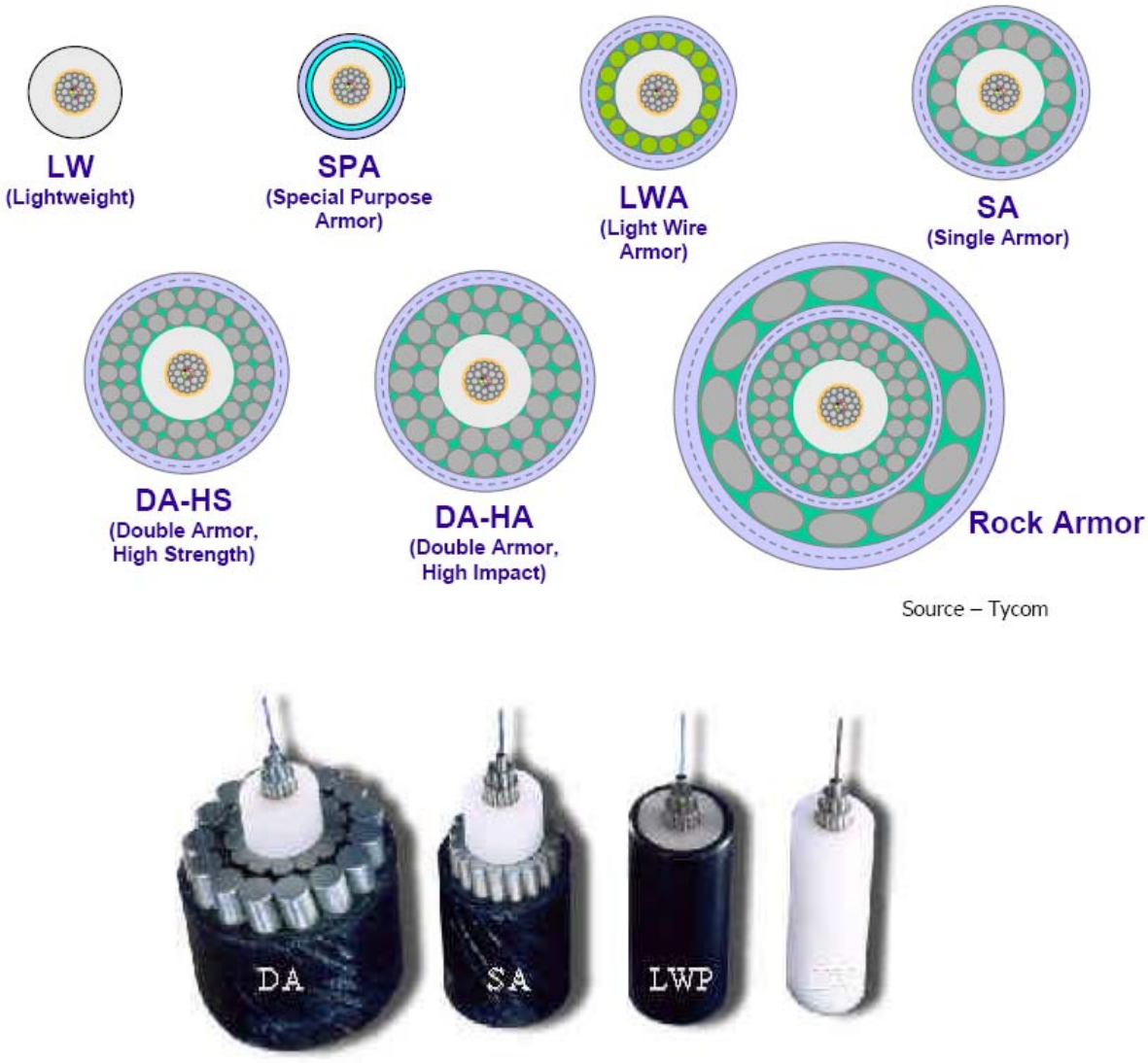


Figure 13. Cable Armouring (DA, SA, LWP, LW)

5.8 - WORKS DURING PRE-INSTALLATION

These activities include a detailed cable route survey to investigate the safest possible environment for the cable and prepare for installation as well as engineering design and fabrication of the subsea equipment.

5.8.1 - Cable route survey

Prior to installation of the cable, marine geophysical survey will be realized to investigate the better route (safest route) for the cable. This survey will be complemented by an inspection survey in the area of the shore approach to the landing sites (**Figure 14**).

Cable routes are carefully surveyed to minimize environmental impacts and to maximize cable safety. Seabed mapping systems accurately chart depth, topography, slope angles & seabed type.

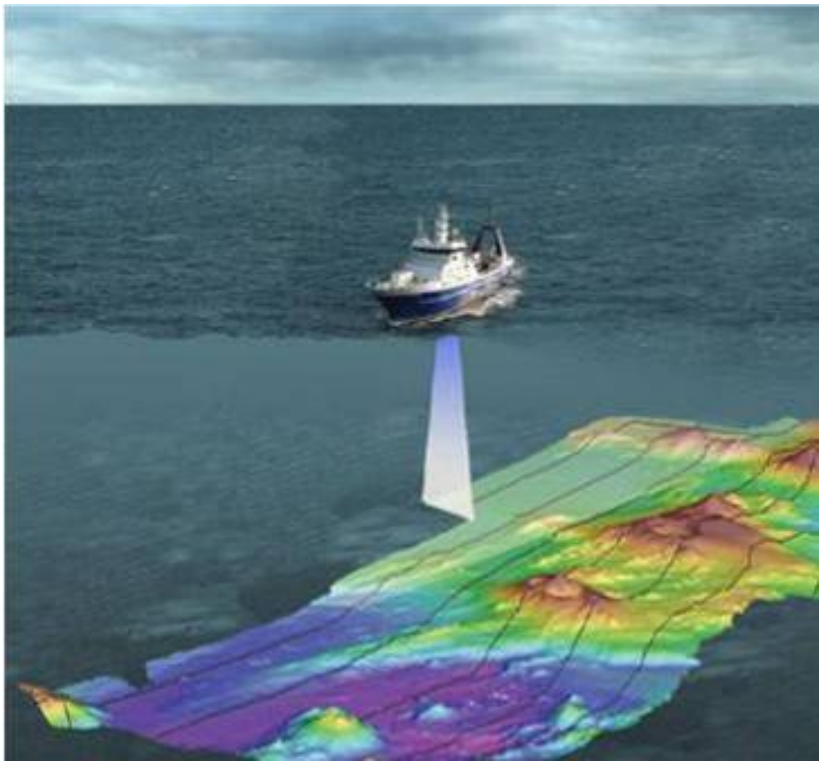


Figure 14. Cable route survey (Source NIWA)

In shallow water, the diver inspection will include probing of the seabed and visual recording in order to assess the feasibility of cable burial within a corridor width (300 m).

To complete, supplement the side-scan sonar and sub-bottom profiler date, a seabed-sampling program will also be conducted where the cable will be buried. The conditions of the seafloor and shallow subsurface layers, including sediment characteristic along a 600 m corridor between 3 m and 1 000 m water depth.

Before the cable is laid, a Pre Lay Grapnel Run (PLGR) is required along those sections of the route that require cable burial. This involves dragging a grapnel along the entire length of the buried cable route as an attempt to clear the sea bed of debris, i.e. wires

or hawsers, fishing equipment, etc., which may have been deposited along the route. Any debris recovered during these operations is discharged ashore upon completion of the operations.

5.8.2 - Engineering design and fabrication of subsea

Detailed cable design would be carried out in this phase using input from the cable route survey. Cables specifications will be developed to ensure protection of the cable in a manner appropriate for the marine environment. The equipment will be fabricated off-site (United States, France...).

5.9 - INSTALLATION OF THE SUBMARINE CABLE

Telecommunication cables are generally laid unburied on the seabed in deep waters off the continental shelf, where the risks of damage by activities such as fishing or vessel anchoring are minimal. In shallow waters cables are generally buried to a target depth of one metre below the seabed, using a towed plough.

For installation, a purpose built ship (**Figure 15**) will accurately place the cable on or under the seabed along the route determined by the pre-installation survey.

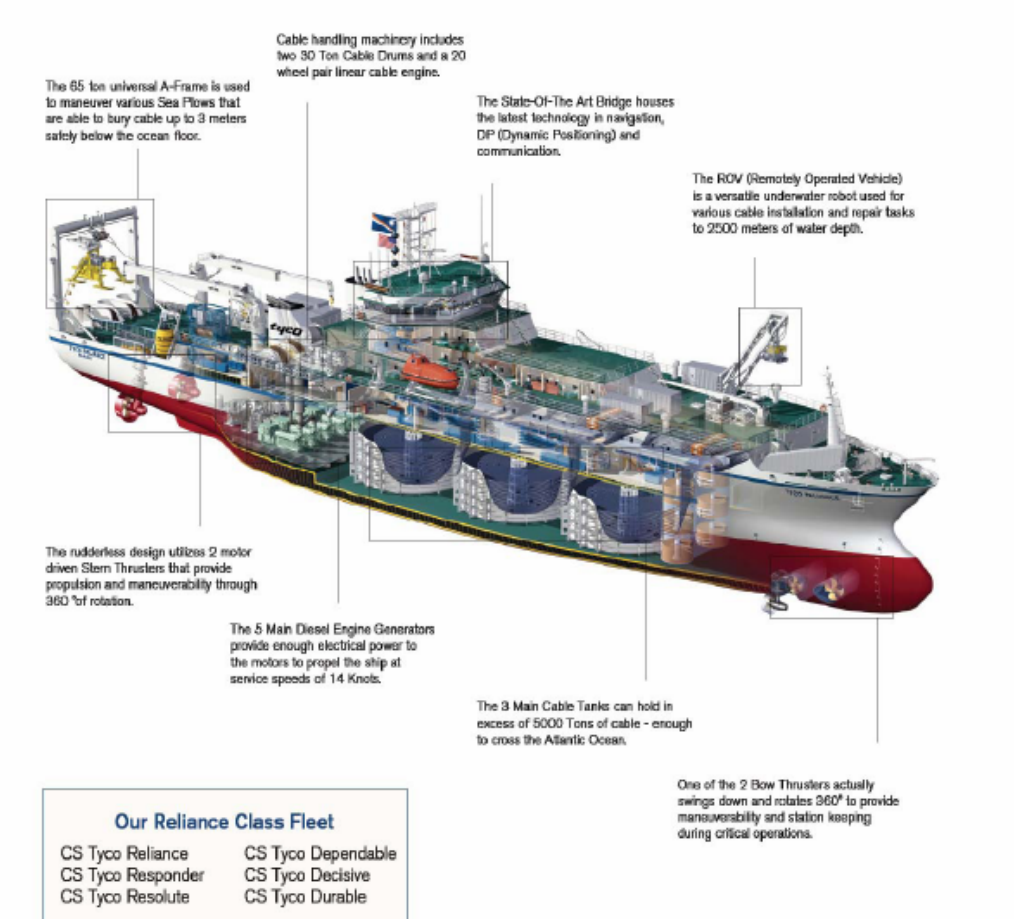


Figure 15. typical cable lay vessel (Source Tyco)

5.9.1 - Cables burial

Subsea cables are usually buried to minimize the risk of damage by, for example, anchors and fishing gear. The cable burial depth depends on factors like types of threats present, the type of habitat, the hardness of the sediment or the depth of water.

Where cables cannot be buried, e. g. in areas of exposed bedrock, or where it is not legally required to bury them, they are layed directly on the sea bed and covered fully or partially with mechanical protection (e.g. dumped rocks), or, in unconsolidated sediments, the cable is expected to self-bury. Emu Ltd (2004) specifies typical burial depths dependent on seabed types (**Table 11**).

Table 11. Typical subsea cable burial depths (after Emu Ltd 2004).

Seabed type	Typical burial depths [m]
Exposed bed rock	0.0
Chalk	0.0 – 0.6
Stiff clay	0.4 – 0.8
Clay	0.6 – 1.2
Gravel	0.4 – 1.0
Coarse sand	0.4 – 1.0
Silty sand	0.6 – 1.2
Sand waves	0.0 – 3.0
Intertidal mud flats	0.6 – 3.0
Beach sand	1.0 – 2.0

According to the context at Beau Vallon site (longshore drift) cable would be buried at least 2 m below the seabed.

Indeed, the beach of Beau Vallon is ever changing. Erosion (the loss of beach sand) is usually caused by high, steep waves with relatively short periods whilst accretion (beach sand build-up) is usually associated with lower waves and longer periods. Also, because waves often approach the shore at an oblique angle, long shore currents can be created. There is a continuous interchange of sand between dunes, beaches, sand bars in the surf zone.

Nearshore

At locations where the cable comes ashore the cable ship is stationed offshore near its minimum working water depth of around 10m (**Figure 16**).

Due to the shallow water depth, cable burial at each of the shore ends may be undertaken by excavation of a trench using a single grab dredger and through the placing of the cable within the trench by divers. Shallow water laying may be aided by scuba divers while deepwater laying is sometimes aided by remote operated vehicles. After the cable has been laid inside the trench, it would be covered with concrete mats and backfill materials.

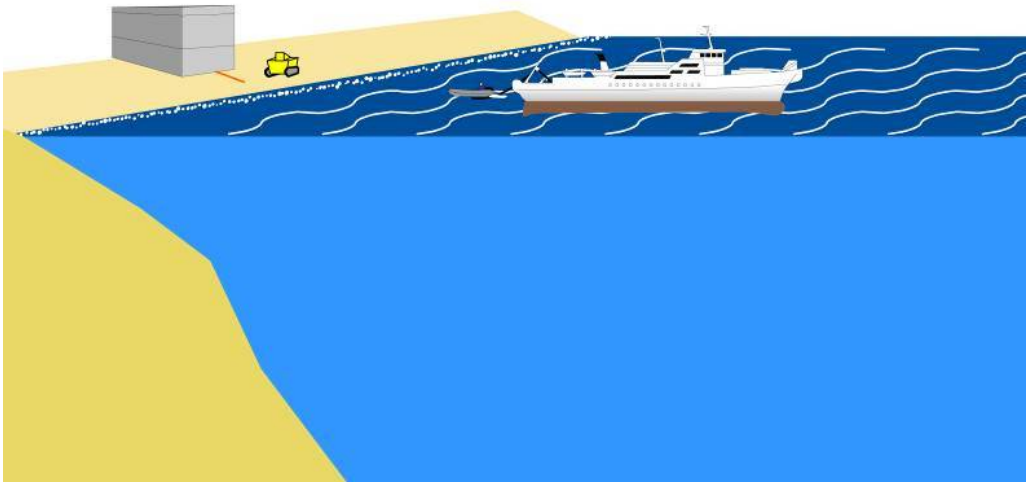


Figure 16. Cable ship is stationed offshore (Alcatel Submarine Networks)

A messenger line is passed ashore from the cable ship, and is wound onto a winch located on the beach, via the beach manhole (**Figure 17**).

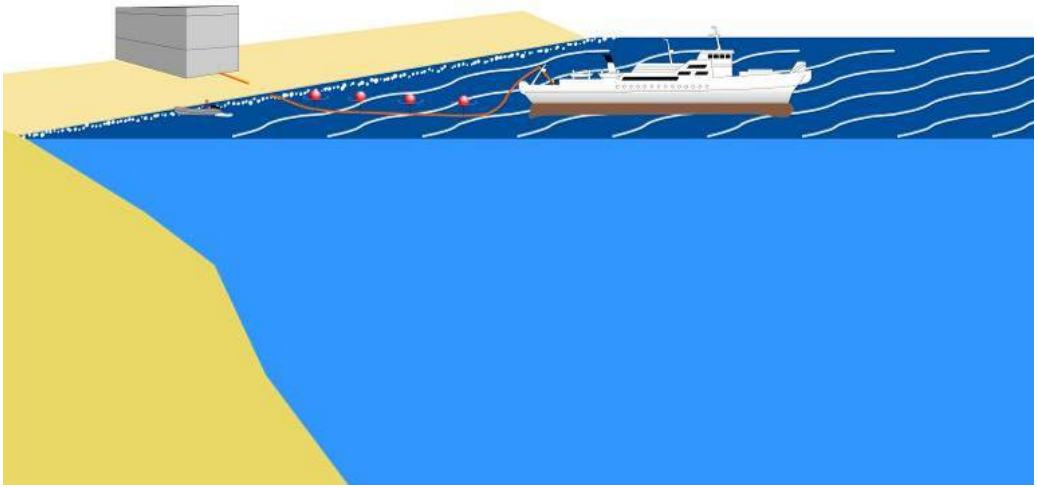


Figure 17. Messenger line (Alcatel Submarine Networks)

The cable will be paid out from a cable barge staying at deep water, floated on buoys and pulled to the landing manhole by a winch installed on land.

The messenger line is connected to the cable on the cable ship, and the line and cable are then winched ashore through the pre-dug trench and into the beach manhole. After the cable is secured in the manhole, the cable ship begins moving away from the beach to progress the offshore installation (**Figure 18**).

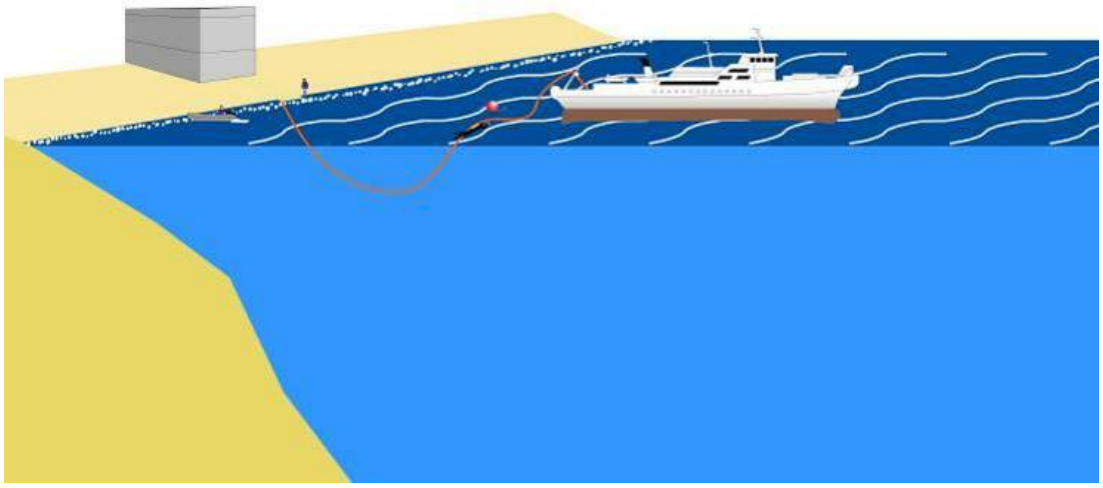


Figure 18. Progression to offshore installation (Alcatel Submarine Networks)

The shallow water segment of cable, between the low water level and 10 m water depth, lies on the seabed until divers with water jetting machines bury it, normally to a target depth of 1 m.

This process begins immediately after installation in order to avoid risk to the cable and potential interference with other activities. The diver-held water jetting machines remove and liquefy sediment, and the cable is placed in the trench they produce. The process produces some localized turbidity and disruption of bottom-dwelling flora and fauna.

The trench is allowed to backfill naturally at varying rates, depending on local currents, sediment characteristics and the resultant movement of sediments.

A short underwater trench of approx. 1m (W) x 1m (D) will be excavated by dredging at the shallow water using a small powered backhoe machine on a barge up to ~500m from shore or 40 m water depth. Beyond this point the water depth is expected to be sufficient for the cable burial machine to be employed (a plough) (**Figures 19, 20**).

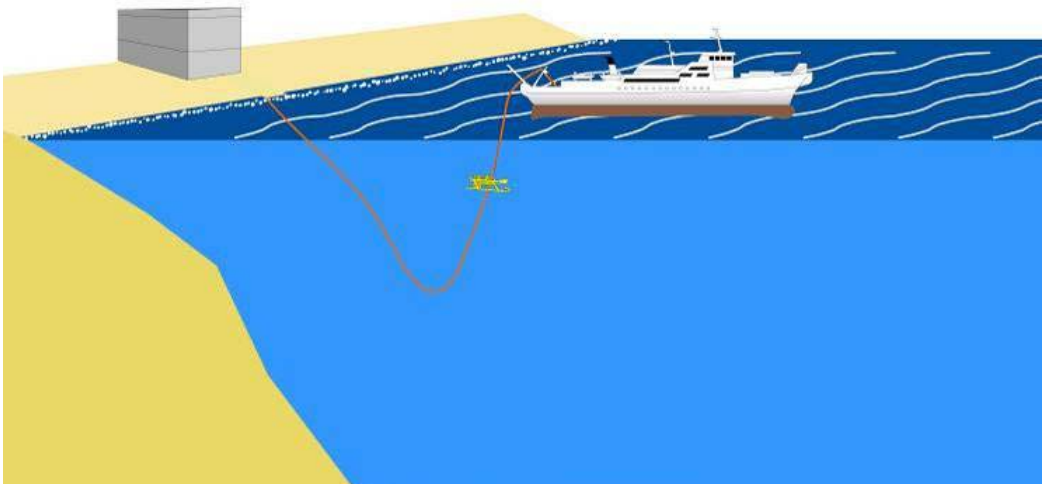


Figure 19. Cable burial machine (Alcatel Submarine Networks)

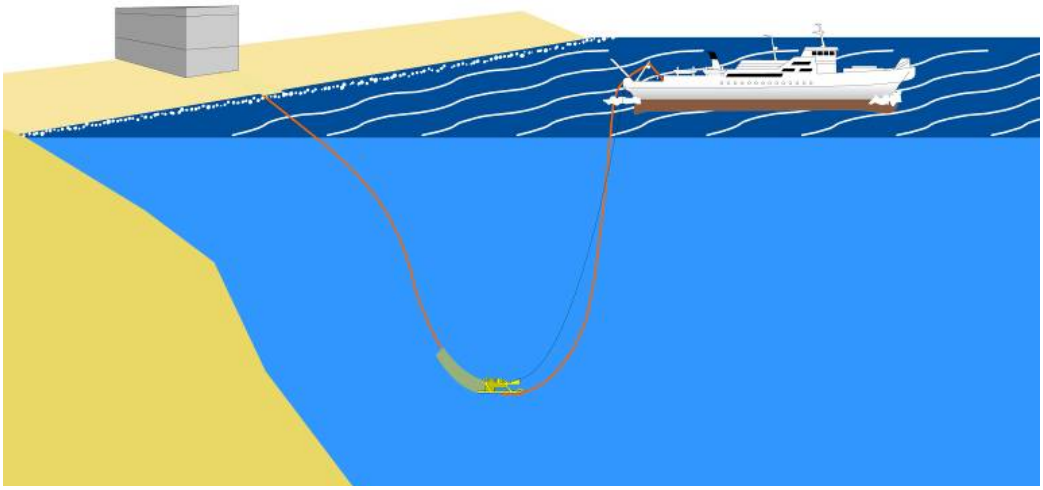


Figure 20. Cable burial machine started (Alcatel Submarine Networks)

Offshore

The cable is installed by the cableship, and buried wherever seabed conditions permit from the landing point until the cable reaches a depth of 1000m, or the edge of the continental shelf (**Figure 21**)

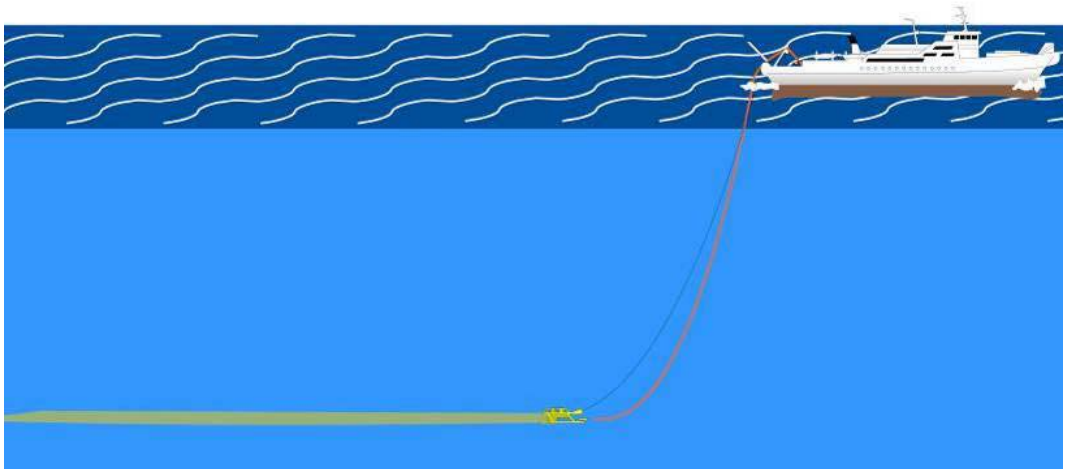


Figure 21. Cable buried with a plough offshore conditions (Alcatel Submarine Networks)

Offshore, cables would be buried in a narrow (<1 m wide) trench that would be cut by a water jet or plough while the cable is being laid.

The burial is accomplished by a sea plough. A plough towed by the cable ship opens a furrow in the seabed on the order of 0.75 m wide (**Figure 22**).

Figure 22. Typical sea plough

The communications cable passes through the plough and exits the plough share at the aft lower extremity. As the plough moves forward, the cable is left in the bottom of the furrow. The furrow fills by natural movement of sediment. Normal target burial depths are on the order of 1m.

In water depths greater than 15 m at points where the cable crosses an existing active cable, the plough is lifted off the seabed and the cable is laid on the seabed (a fly-over). Later the cableship returns with a Remotely Operated Vehicle (ROV) to bury the cable using water jets at this crossing point. In rocky areas, places with hard bottom or steep slopes, the cable is laid on the seabed.

Deep water

In deeper water, where burial is considered unnecessary, the plough is recovered and the cable is laid unburied on the seabed.

Onshore

Beach Manhole

The marine cable is connected to a land cable at the beach manhole. Since landing areas are often located in sandy places near city areas, beach manholes are often located in or near beaches that are used for recreation. There may be some localized disruption of recreational activities during construction with machines trenching and pulling cable, but after installation, recreational beachgoers are typically unaware of the cable and it has no effect on their activities.

On the beach, the cable is typically installed in flexible steel pipe with outside diameter on the order of 0.2m, in a trench two meters deep dug previously by equipment such as a backhoe. In cases of severe erosion, if the pipe becomes exposed it may be reburied.

The BMH provides a chamber situated above the high-tide level where the marine and terrestrial cables are connected. Once constructed, with the exception of the manhole cover, there is little or no visible evidence of a BMH. **The beach will be restored to its original state after the completion of cable installation.**

Installation of the manhole at each site will take less than two weeks at each site.

Construction of terminal station

From the BMH the cable will continue a short distance to a 'cable station' where it will connect with terrestrial networks (Figure 22).

A typical landing configuration is shown in Figure 23.

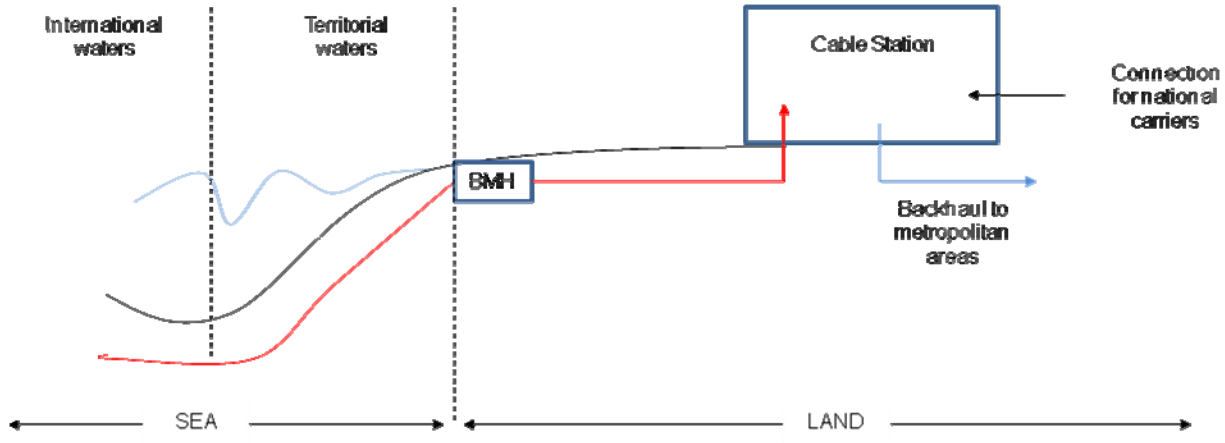


Figure 23. Typical landing configuration

A Cable Landing Station (CLS) will be required in order to connect the cable to the domestic cable infrastructure. The preferred location for the CLS is at Victoria. CLS will be located at Victoria in Cable and wireless office (4.5 km).

Construction of terrestrial ducted systems

The cable will be routed from the BMH to the CLS along an existing road. The cable will be installed in an existing conduit alongside the road.

Construction activities will include:

- Construction of the BMH
- Cable laying from the waterline to the BMH (20-30m trench on the beach)
- Cable laying via a trench (existing ducts) from the BMH to the Cable Station (cable and wireless)

Similar cable landing structure will be constructed at opposite shore (Kenya or Tanzania). When the cable laying barge reaches the opposite shore (Kenya or Tanzania), the cable will be detached from the burying machine and paid out from the cable laying barge to form a loop line on the sea surface.

5.9.2 - Operation and maintenance/repair

Once in place and connected, the cable system requires no intervention. The cable is to be regularly serviced during a standard 25 years design life. Power is provided to the system through electrical connection in the cable. This also provides power to the repeaters. The electrical current is fully shielded from the environment. Cable repair and maintenance may be required as a result of damage, failure, age /redundancy or clearance of congested routes.

Onshore, the CLSs will require power for their operations. Power will come from the national electricity grid with backup provided by diesel-powered generators.

Cables have to be recovered from the seabed for repairs, replacement or removal. Recovery may result from damage, failure, age/redundancy or clearance of congested routes (**Figure 24**).

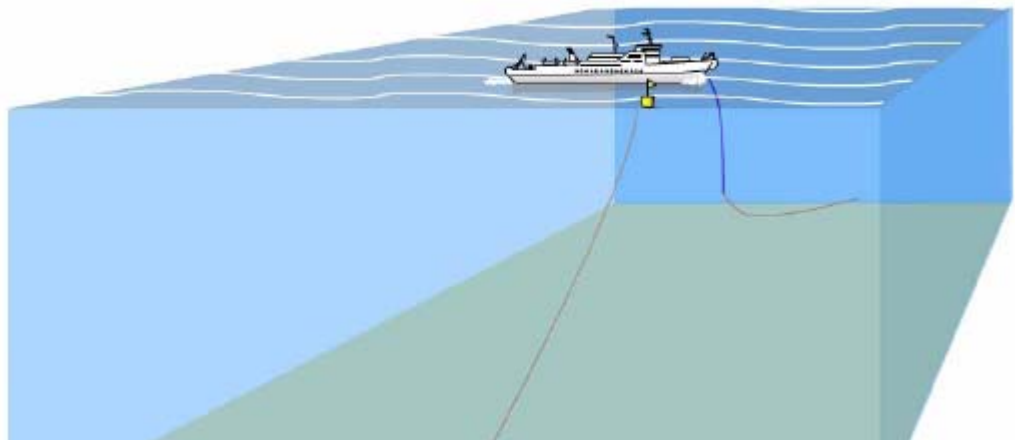


Figure 24. Replacement or removal of a cable (Alcatel Submarine Networks)

5.9.3 - Decommissioning activities

An evaluation should consider environmental issues in conjunction with technical, safety and cost implications to establish the best practicable environmental options for the decommissioning of the cable. An assessment ill also be conducted to ensure that nothing which could be constituted as an hazard for other users of the aera or for the environment with be left at the site. The site will be left in a safe and environmentally acceptable condition.

6 - INITIAL STATE OF ENVIRONMENT

The study area of Greater Beau Vallon is situated in the North West of Mahé and covers a total area of 1,100 hectares. Elevation varies from 0 to 880 metres. The area has an enclosed body of water with two embryonic fringing reefs.

This area has an enclosed body of water with two embryonic fringing reefs, each being approximately 500 meters wide, one being located along the north western coast and the other along the southern coast.

The sandy beach extends approximately 1.8 km bounds to the north with piles of granite rocks and to the west with granitic reefs. Apart from this beach the coastline of the bay consists of some small creeks separated from one another by the in-situ rock.

6.1 - INITIAL STATE OF MARINE ENVIRONMENT

6.1.1 - Geology

Seychelles 115 granite and coral islands extend from between 4 and 10 degrees south of the equator and lie between 480km and 1,600km from the east coast of Africa in the western Indian Ocean.

This Indian Ocean republic occupies a land area of 455 km² and an Exclusive Economic Zone of 1.4 million km². It represents an archipelago of timeless beauty, tranquillity and harmony that is famous for its world-beating beaches and for its great diversity which rolls from lush forests down to the warm azure ocean.

Of these 115 islands, 41 inner islands Inner Island constitute the oldest mid-oceanic granite islands on earth while a further 74 form the 5 groups of low-lying coral atolls and reef islets that are the outler islands.

The Inner Islands which are mostly granitic, cluster mainly around the principal islands of Mahé, Praslin and La Digue. There are 43 Inner islands in total – 41 granitic and 2 corallines. Mahé is the largest island of the Seychelles archipelago with its caoital Victoria (**Figure 25**).

The Outer Islands are those situated beyond the Seychelles plateau. They comprise 72 low-lying sand cays and atolls lying anywhere between 230km and 1150km from Mahé. Less visited than their granitic cousins due to their relative remoteness, these pristine miniature worlds, some little more than sand spits or lonely rocky outcrops, offer untouched habitats for many species of wildlife.

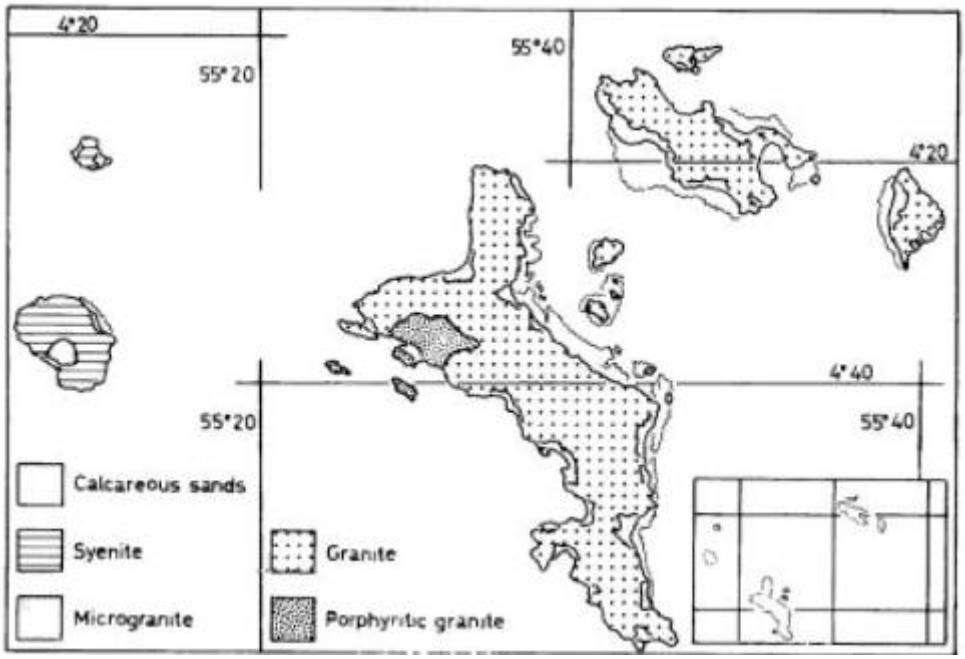


Figure 25. Geology of the granitic Seychelles after Baker (1963). Note location by latitude and longitude and omission of water areas between principal island groups

The spectacular granite outcrops of the Seychelles islands in the central Indian Ocean are an evidence for the continental drift theory (**Wegener, 1924**). Ridge-plume interactions have been responsible for separating a thinned continental sliver from a large continent (India) (**GAINA *et al.,* 2002**).

The granites of the Seychelles microcontinent were emplaced 750 Ma, during the late Precambrian. Thermally-induced rifting in the Somali basin and transform rifting along a fracture zone began in the late Permian 225 million years ago, with Gondwana supercontinent beginning to break up about 167 million years ago when East Gondwana, comprising Antartica, Madagascar, India and Australia, began to separate from Africa (**Figure 26**).

East Gondwana then began to separate about 115-120 million years ago when India began to move northward (**Plummer, 1995**).

The Seychelles then underwent two more stages of rifting to isolate it from Madagascar and India. Between 84-95 million years ago rifting separated Seychelles/India from Madagascar (Figure 26). An initial period of transform rifting moved the Seychelles/India block northward (**Plummer, 1995**).

At 84 million years ago oceanic crust started to form in the Mascarene basin (**Schlich, 1982**), causing a rotation of the Seychelles/India land mass.

This continued until 65 million years ago when new rifting severed the Seychelles from India forming the currently active Carlsberg Ridge. The rift jump coincided with the maximum output of the Deccan traps (**Duncan & Pyle 1988**), and volcanic found on the Seychelles Plateau have also been linked with this event (**Plummer, 1995**).

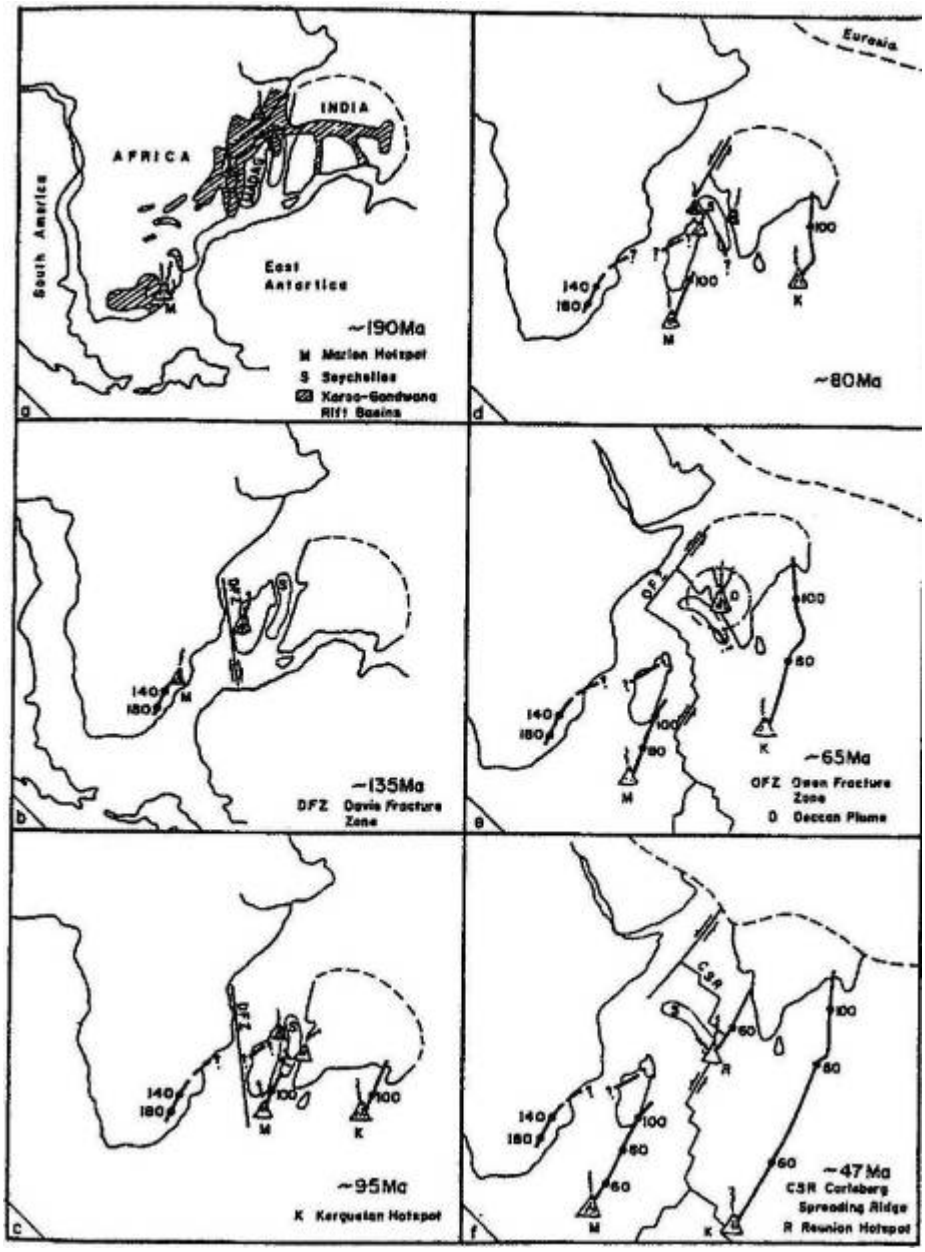


Figure 26. Dismantling of Gondwana to the establishment of the granitic islands of the Seychelles archipelago, history of the eastern edge of Africa (Plummer 1995, in Duvat 1999).

The interior geologic structure of Seychelles is mainly composed of Granit, this Granit layer extends to a depth of 13 km (**Figure 27**).

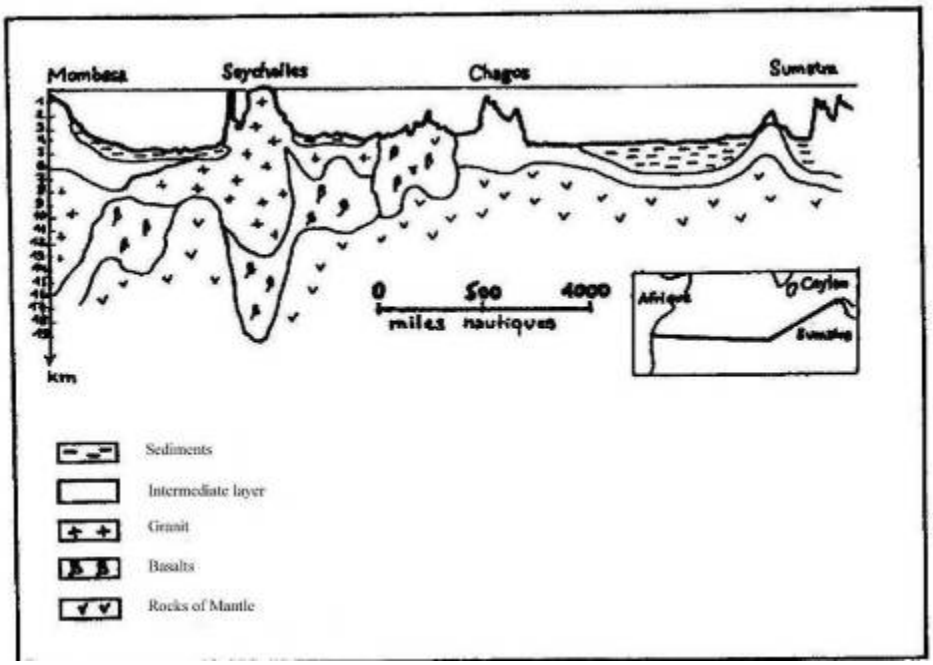


Figure 27. Schematic view of the structural layer along Indian Ocean from Mombasa to Sumatra (Duvat, 1999)

Low-lying areas of Beau Vallon are the coastal plain area and low-lying areas around the main river mouths. The sediments of the former are dominantly calcareous whilst the latter are characterised by sediments consisting of fine clays and quartz derived from laterites. The coastal shorelands of Beau Vallon consist entirely of calcareous sands. The soil types in the mountainous areas behind the coastal plain comprise laterite and kaolinitc clays forming red earth giving a base of dense vegetation (**Grancourt 1995**).

6.1.2 - Soils

The coastal shorlands of Beau Vallon consists entirely of calcareous sands. The coastal plain is composed of a number of different soil types (**Figure 28**) :

- Sandy alluvial soils and marsh dominate most of plateau with the more elevated areas consisting predominantly of clay/sandy red earth which tends to be a mixture of sand
- Laterites and to a lesser extent pale brown kaolonitic clays
- Pockets of laterites and kaolinitic clays (red earth) behind the coastal plain

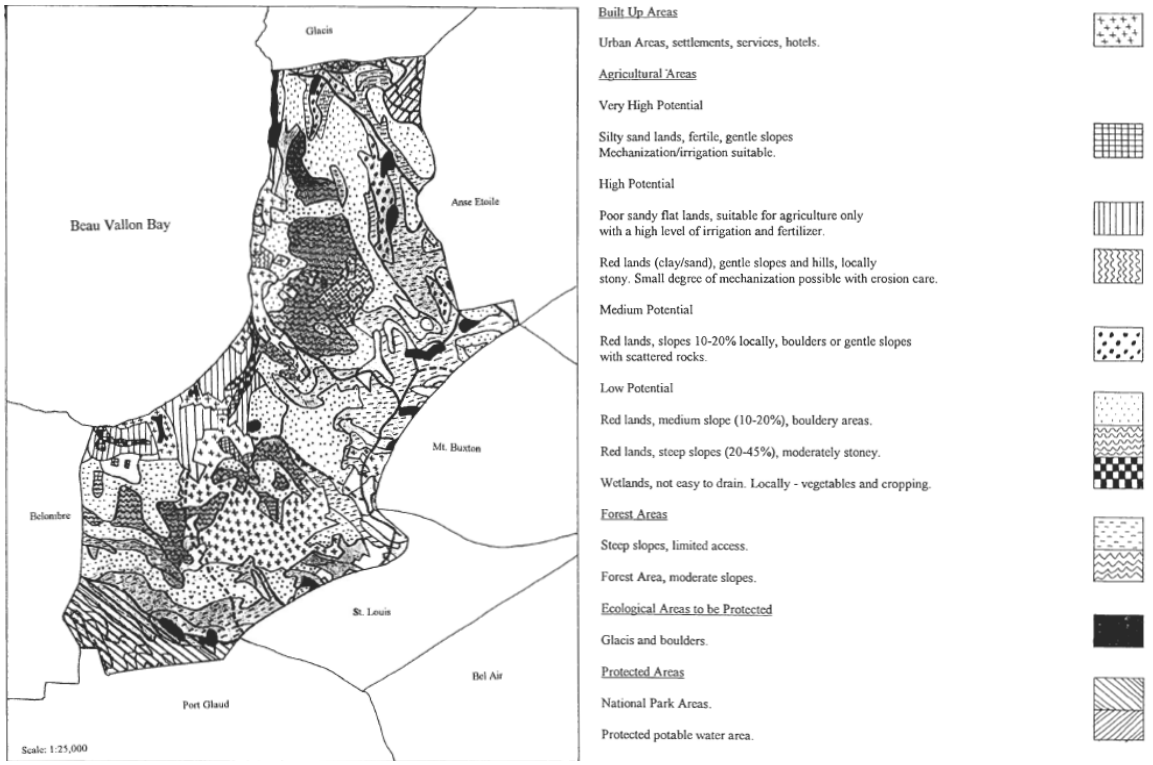


Figure 28. Soils types - Beau Vallon (Source Grancourt 1995)

6.1.3 - Hydrology

There are two main rivers emptying into the bay, the Sullivan River and the Mare Anglaise river. These form the main estuaries in the area (**Figure 29**).There are also five smaller rivers in the study area. There is no in-depth seepage and virtually no groundwater reservoirs. In spite of the retarding effect of the very dense vegetation, the runoff water concentration times are very short. As a consequence, rainfall immediately causes flooding in certain areas.

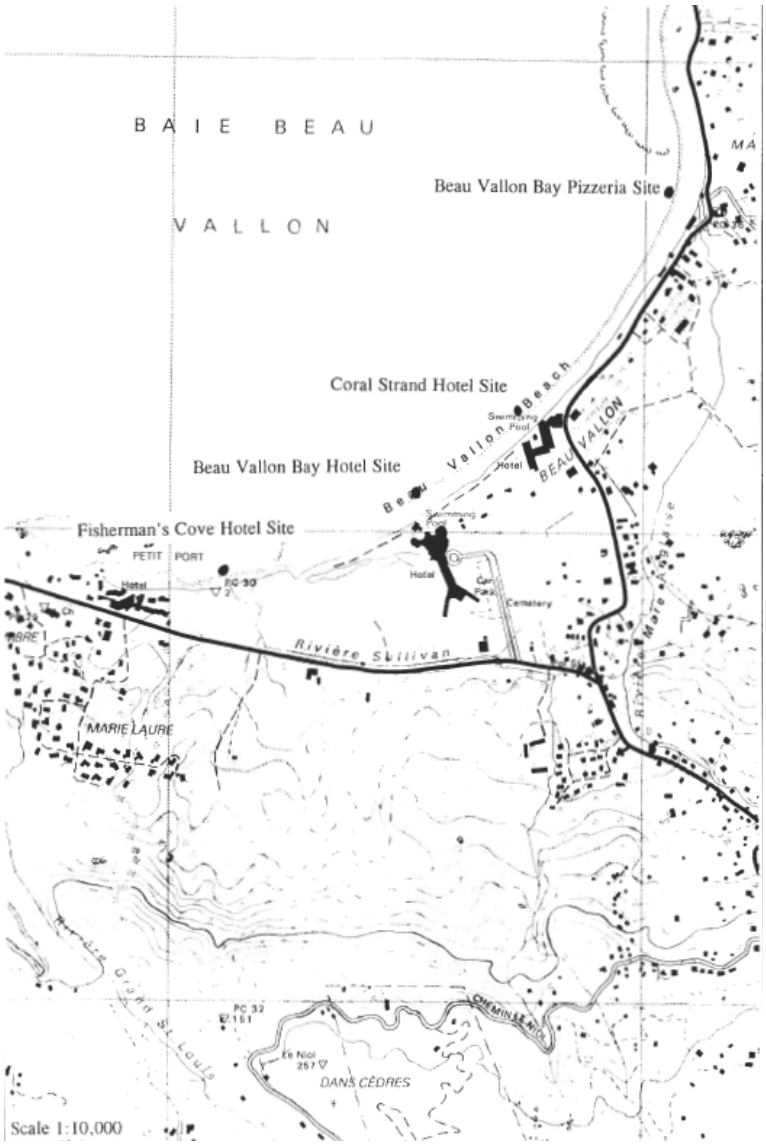


Figure 29. Rivers at beau vallon (Source Grancourt, 1995)

6.1.4 - Meteorology

In January and February the islands receive their life-giving rains, rejuvenating the rivers and streams and teasing the vibrant foliage into rainbows of colour.

The months between May and September bring drier, cooler weather, and livelier seas - particularly on south-eastern coasts – and winds of 10-20 knots.

The table 12 below is a summary of statistical averages for the Seychelles International Airport from 1972 to 2005 (http://www.seychelles.com).

May to September

The average temperature is of 27°C and there are 8 hours of sunshine per day. The south east trade winds waft a pleasant, cooling breeze over the islands and at times the sea can be quite choppy on certain coastal areas. It's the period of lowest rainfall and humidity, and arguably the most comfortable.

October to November

This is a calm period between the two main weather systems, resulting in light, breezes (spasmodic), calm seas and higher humidity. Average temperature of 32°C and 7 hours sunshine per day can be expected.

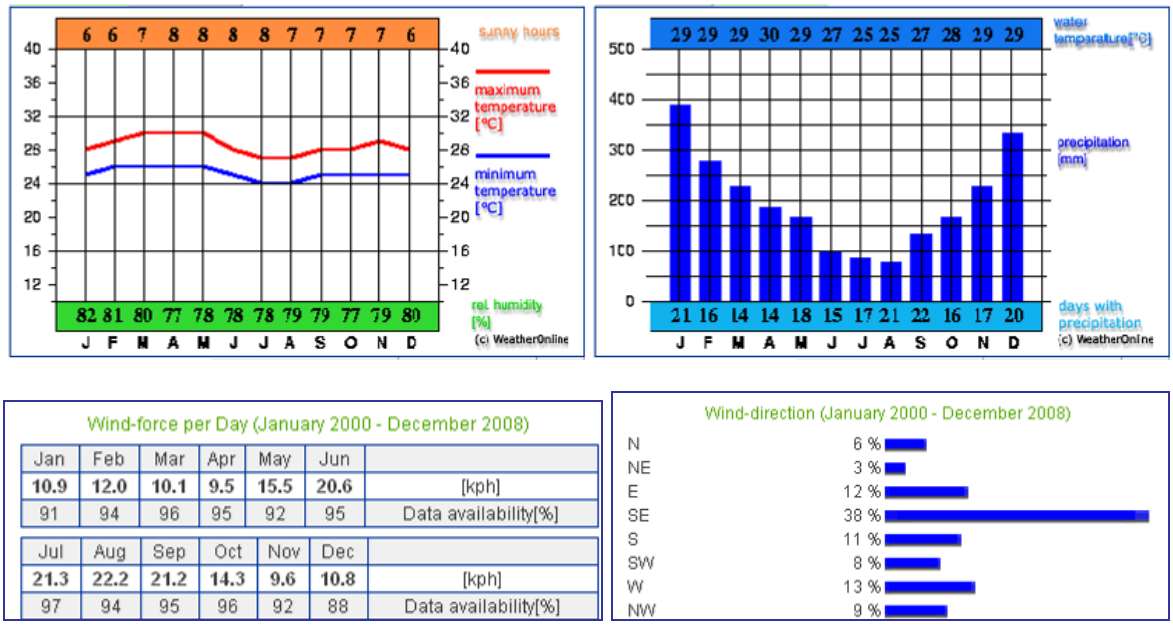
March to may

Generally, there are calm seas, light breezes, 7 to 8 hours of sunshine per day, average humidity and rainfall.

Table 12. Statistical averages for the Seychelles International Airport from 1972 to 2005.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	26,9	27,4	27,8	28,1	27,8	26,7	26	26,5	26,5	26,9	26,9	26,9
Rainfall (mm)	402,6	283,2	194,9	186,7	151,6	105,1	76,6	119,3	154	189,7	206,3	302,8
Relative humidity (%)	82	80	80	80	79	79	80	80	79	79	80	82
Predominant wind direction	NW	NW	NW	SW-NW	SE	SE	SE	SE	SE	SE	SW-NW	NW
Wind speed (Kts)	6,3	6,3	5,2	4,9	7,8	10,4	11,4	12,1	11,3	7,9	5,4	5,4

Statistical meteorological information (**Figure 30**) can also be visualised on the internet website Weather Online (address: http://www.weatheronline.co.uk). Among the available information available in Mahé, for the period running from January 2000 to December 2008, the following figures resume the monthly variations of: maximum and minimum temperature, number of sunny hours, relative humidity, number of days with precipitation, cumulative precipitations, and wind characteristics.



Wind-force per Day (January 2000 - December 2008)

Jan	Feb	Mar	Apr	May	Jun	
10.9	12.0	10.1	9.5	15.5	20.6	[kph]
91	94	96	95	92	95	Data availability[%]

Jul	Aug	Sep	Oct	Nov	Dec	
21.3	22.2	21.2	14.3	9.6	10.8	[kph]
97	94	95	96	92	88	Data availability[%]

Figure 30. Statistical climatology characteristics in Mahé (Source: Weather Online)

The averages maximum and minimum temperature are relatively stable month after month, with highest values during the period from March to May and coolest ones during July-august. The relative humidity is nearly constant (77% in April and October, to 82% in January). The number of sunny hours per day varies between 6 (December to February) and 8 (April to July).

The rainiest period is December to February with monthly about 300mm of rain, and the driest one is June to august with monthly less than 100 mm of rain.

The windiest period is June to September (average wind speed over 20 kph), and the calmest period are the months of April and November (average wind speed less than 10 kph). The dominant wind direction is the South-eastern sector (more than the third of the time).

The climate is largely influenced by the monsoon, which is characterized, in this area mainly by 2 seasons: the period of November to March, and the period of May to September. Between them, there are the inter-seasons. Two systems of winds characterise respectively these 2 seasons: the norois (North-westerly winds) and the suete (South-easterly winds). The period of suete is the windiest, as it can be observed from the data.

The dates of reversing winds, and consequently the duration of the seasons are varying from a year to another one. The first reverse can occur in October or November, and the second one in May or June.

Consequence: The Beauvallon site is probably much exposed to the norois winds, whereas the Anse aux pins site is probably much exposed to the windiest suete winds.

Note: The norois (North-westerly winds), corresponds to the North-east monsoon. The corresponding winds are oriented North-east in the North hemisphere, and passing throw the equator, they are turning towards the west, deviated by the Coriolis effect.

6.1.5 - Oceanographic characteristics

Most of the Western Ocean tides are semidiurnal or mixed, mainly semidiurnal. Tidal ranges vary greatly within the region (**Alusa and Ogallo, 1992**). Based on the spring tidal range, the tides are characterized as mesotidal (1-2 m) found mainly in the Seychelles. Table 13 show tidal levels at Port Victoria

Table 13. Tidal levels referred to datum soundings (data approximate) according to chart N°740 UKHO

Place	Lat S	Long E	Heights in metres above datum			
			MHWS	MHWN	MLWN	MLWS
Port Victoria	4°37’	55°27’	1.6	1.3	0.8	0.5

6.1.5.1 - Swell

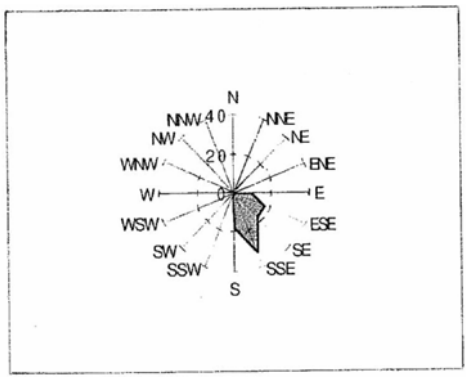
The swell conditions encountered in the Seychelles islands area has been described by Cazes-Duvat (**1999**). From this study, the main features of the swell can be retrieved.

The Seychelles archipelago is concerned by 2 kind of swell:

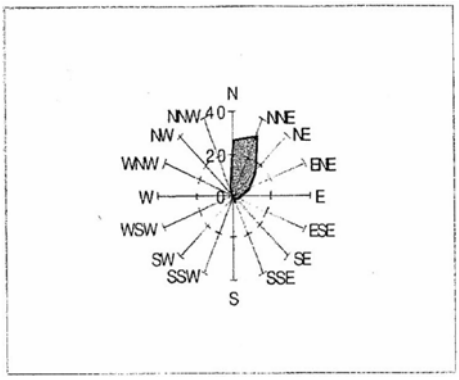
- the seasonal swells generated by the alternative system of the monsoon,
- the exceptional cyclonic swells coming from tropical latitudes.

Seasonal swell:

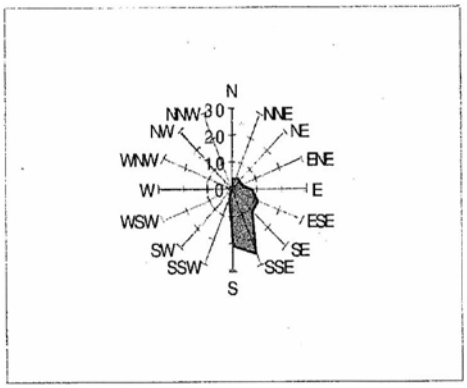
The monsoon is characterized in the Seychelles area by two seasons with winds of opposite direction and 2 inter-seasons. During these two seasons, the winds are regular, generating some swell of similar directions than the wind ones. Then the directions of swell come from two main sectors: south-east and north-east (first direction of the North-east monsoon winds). Measurements made offshore of the islands (between latitudes south 2° and 7°, and longitudes east 45° and 50°), during the period 1960-1991, show regular swell during periods of norois and suete (regular winds), and much variability in the swell directions during the inter-season (variability in the directions of swell and winds for about 15 to 30 days). It can be illustrated with the following wind directions roses extracted from a report of Cazes-Duvat (**1999**).



Direction rose of swell:
June to August (suete)



Direction rose of swell:
December to February (norois)



Direction rose of swell: September to November (inter-season)

Storm swells (cyclonic origin)

Even if the islands of the Seychelles archipelago are, in theory, located at too small latitude to be submitted to cyclones, some storm swell can be observed near the islands. They could have their origin at a few hundreds or thousands kilometres south off the archipelago, and reach the islands if the fetch conditions are favourable.

The following map 31 (extracted fom Cazes-Duvat (**1999**)) shows the path of the tropical storms in the Indian Ocean, and let observe that most of them doesn't affect the islands of the North of the Seychelles archipelago. The frequency of storm passing throw this area is 4 events from 10 000 (**Meteo-France, 1992**).

Little information can be found on the effects of those swells, but waves generated can be of several meters height, and, some have, in the past, flooded coastal areas and carried off parts of beaches.

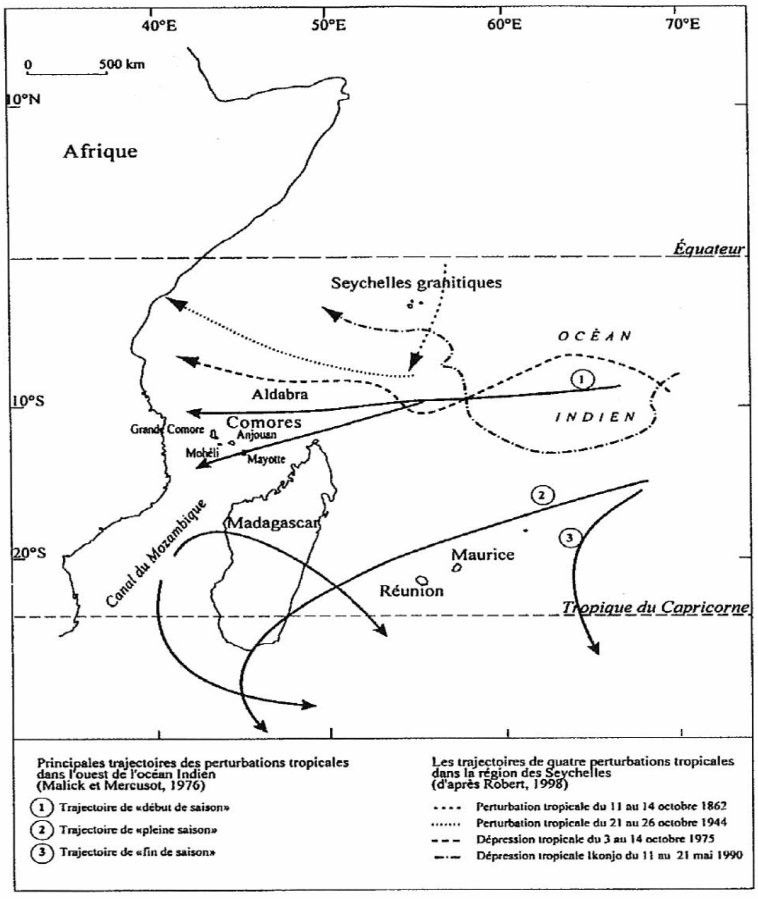


Figure 31. Trajectory of tropical storm in the Seychelles area.

Heights of swell and sea state

The monsoon swells are largely dominating and correspond to most events of calm to rough sea at low latitude in the Indian Ocean. In the North Seychelles area, the swell heights are less than 4 meters (calm to rough) for 60 to 93% of the time, following the season. Events with very rough (4 to 6 m) to very high (6 to 9 m) swells (international meteorological code) correspond to 0.06% of the North-easterly swells and 2.69% of the suete ones.

The swell heights are varying seasonally, generally as following:

- norois: this season is characterised by a high frequency of calm sea states and a lack of formed swells (small heights, < 2m, during 92.87% of the time)
- suete: swell heights are small during 60.07% of the time, moderate (2 to 4m) during 37.22% of the time, and rough (> 4m) during the rest of the timeinter-seasons: intermediates behaviours

Consequences

According to the geographic location of the Beauvallon site, this location is partially sheltered of swell, especially during the South-east monsoon (highest sea states due to strongest winds).

6.1.5.2 - Currents

Cutler and Swallow (**1984**) have realised a mapping of the marine currents of the South latitude, northward of 25° South and eastward of longitude 100°. The study was conducted over the period 1854-1974 and show for the North islands of the Seychelles archipelago, four periods, which have been described, in particular by Cazes-Duvat (**1999; 2001**):

- During austral summer (20 December - 20 April): the islands are situated into the Equatorial Counter Current. It is slow, 1 to 2 knots in average, and the flux towards the Seychelles comes from a North/North-west to West/South-west direction.

- A transition period (21 April to 19 June): no dominant direction of the waters, which flow with a very slow velocity (0.5 knots).

- During austral winter (20 June to 19 September): the Equatorial Counter Current pass into the North hemisphere. The South Equatorial Current shows a net lane at 10° South, but its direction is disrupted further to the North, and there is no dominant and stable direction at the Seychelles latitude.

- A second period of transition (20 September - 19 December): the Equatorial Counter Current is taken back into the South hemisphere. At the beginning it is centred on the Equator. From the 21 November it is like in the austral period, with a velocity of 1 to 2 knots and a direction West to East, and the 20 December it comes into the southern hemisphere. During this period, a divergence zone appears between the Equatorial Counter Current and the South Equatorial Current (between 6° and 9° South, varying location from one year to another, relatively to the North-east monsoon intensity). It conducts to an upwelling phenomenon south-east of the Granitic islands (**Piton, 1976**).

6.1.5.3 - Particular features of the different sites

The swell directions, and consequently the longshore currents, show inversions according to the season (**Figure 31**). The resulting longshore drift gives the balance of the longitudinal sediment transfers.

According to Cazes-Duvat (**1999, 2001**) the inversion of directions explains the important longitudinal sediment reversals of certain beaches. The beaches are more or less exposed to a swell sector relatively to their geographical location. When they are exposed, they are slimming, and when they are sheltered, they are deepening.

Consequently, the beaches of the Mahé Island are submitted to two major phenomena and one can sometimes be dominant, relatively to the reefs:

- Transversal transfers: they are responsible of the alternation of recharging and emptying of the beaches.
- Longitudinal transfers: they transport the sands from one end to the other, of a same beach.

The resulting longshore drift on the beaches of Mahé Island are illustrated on the following map 32 (extracted from **Cazes-Duvat, 1999, 2001**):

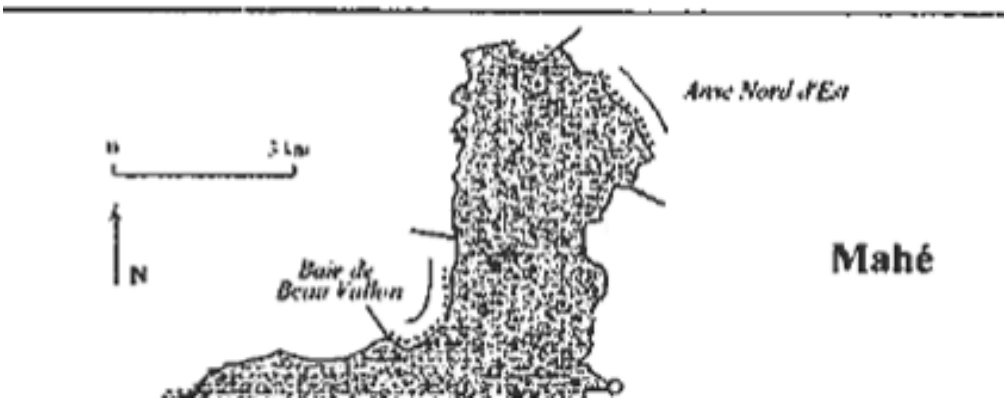


Figure 32. Mapping of the resulting longshore drift of the beaches of Mahé, La Digue and Prsalin Island (extracted from Cazes-Duvat, 1999, 2001)

The longshore drift is oriented from North to South/South-west (**Figure 31**). The foreshore area in front of the site point is about 450 meters length.

A survey conducted by SETOI (**1990**) during August 1989 and January 1990 enhanced the mean features of the current, prevailing in the Beauvallon anse. It has been described in the technical report of the Seychelles Fishing Authority (**Grandcourt, 1995**).

Two current meters were deployed. Measurements are resumed in the following table 14.

Table 14. Currents in beau vallon bay

Parameter	Current Meter 1 (August)	Current Meter 2 (August)	Current Meter 1 (January)	Current Meter 2 (January)
Temperature (°C)	26.5	27.0	28.5	*
Speed (Knots)	0.1	0.5	0.1	*
Depth (m)	9.5	9.5	9.5	*
Direction	NNE	ENE	SSW	*

Summary of Current Meter Readings Taken at Beauvallon

Note: * : data not available

The analysis of the data showed a clear alternate phenomenon depending on the direction of the prevailing winds:

- South-east trade winds: currents veer counter clockwise in the bay
- North-east monsoon (North-west winds): currents assume clockwise direction

The bay is a confined area since the current speeds are generally extremely weak.

The sandy beach of Beau Vallon is approximately 1.8 kilometres long with an average width of 30 metres at low tide. Sand dunes exist only in a few small areas protected by beach debris and by Takamaka trees. The sand is yellowish-white in colour and fine to medium. The Beau Vallon Beach is the most built-up beach in Seychelles and sea walls and buildings on the high water mark are evident. The beach is very active and seasonal movement of sand takes place. However, there is definite evidence of beach erosion characteristic of such highly disturbed sandy coasts (Shah, 1998).

6.1.5.4 - Salinity and sea water temperature

Monthly averages sea surface temperatures data, measured at Mahe (Seychelles), are available on the Weather Online website (address: http://www.weatheronline.co.uk). They are reported in following table 15.

Table 15. Temperature of sea water measured at Mahé

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tw (°C)	29	29	29	30	29	27	25	25	27	28	29	29

The sea surface temperature in Mahe remains at least at 29°C between November and May (30°C in April). It reaches its minimum (25°C) during July and August. The lowest sea surface temperatures occur during the South-east monsoon.

The surface salinity takes a value of about 35.2 PPS and does not vary significantly all over the year.

Marine water quality

The coastal areas close to the two river outlets, namely the Mare Anglaise and the Sullivan River have the highest level of faecal contamination at least for 1.3 months in each year and deemed unbatheable according to European standards for bathing water.

The unsuitable levels are expected to occur after periods of heavy rains. In only 2 months on average per year are the levels of faecal coliform at its lowest level.

The best area for swimming is located in front of Coral Strand Hotel. (Payet, 1996) Indicators of sea water quality in terms of faecal coliform values around the Beau Vallon coast showed 60% of values unsatisfactory for recreational use by WHO standards (Payet, 1996).

The level of faecal coliform in the water is depended upon rainfall and the inputs discharged by hotels. The observable trend of faecal coliform along the Sullivan river shows that there is a contribution of faecal coliform from the hotels. There is also a relatively rapid decay of faecal coliform close of the coast, probably as a result of the wetland area present at the river outlet. The relative contribution of point source pollution (e.g. from hotels) in terms of faecal coliform to the overall quality of the coastal waters is estimated to be about 43%.

The poor turn-over of water in the bay induces a decrease in seawater sodium chloride concentration, itself highly detrimental to coral life, and therefore to all marine organisms associated with the coral reef ecosystem and trapping of nutrients and polluting substances.

Up to now, there is little evidence of medical problems associated with contamination due to sewage in the Beau Vallon area.

6.1.6 - Coastal terrestrial habitats

According To UNEP report 2008 (Bijoux *et al.)*

The coastal plateau is made up of calcareous sand derived from adjacent fringing reefs which have accumulated over the last 6,000 years. These coastal plateau have been colonised by coastal plants such as coconut (*Cocos nucifera*), takamaka (*Calophyllum inophyllum*) and badamier (*Terminalia catappa*). Coastal brackish water marshes are also present and have important role in settling out sediments from freshwater before entering the sea. The islands have many white sandy beaches which are used extensively by the hotel industry and the locals for picnics. Many of these beaches are also used for nesting by marine turtles. The terrestrial coastal habitats of many of the inhabited inner islands have been heavily modified for human settlement, industries, public infrastructure and tourism.

6.1.7 - Mangrove forests and coastal wetlands

8 species of mangrove described from the Seychelles occupying a total area of 29 km2 (Spalding et al., 2001). The 8 species are Rhizophora mucronata, Bruguiera gymnorrhiza, Ceriops tagal, Sonneratia alba, Lumnitzera racemosa, Avicennia marina and Xylocarpus granatum and Xylocarpus moluccensis.

Though all 8 species are fairly common on most of the Seychelles granitic islands, there is only one location (Port Launay, Mahe) where all 8 species are found together.

Mangroves once covered many shores of the granitic islands, especially close to river mouths and marshland (Shah et al., 1997). Since men first settled in the Seychelles in the late 1700s mangrove forests have been cleared to make way for coastal construction. There is presently a proliferation of mangrove in the Seychelles. This is clearly visible on the east coast of Mahe, from Victoria to Pointe Larue, in the lagoons created by coastal reclamation and in places such as Anse Soulliac in the Port Launay Marine National Park, where the mangrove forest is slowly extending seawards.

Wetlands carryout critical landscape level functions related to the regulation of fresh water, nutrients and sediment inputs into marine areas. They have an important role in pollution control through their absorptive capacity for organic pollutants and nutrients. By trapping and stabilizing fine sediments they control the quality of marine coastal waters. They are also exceptionally important in maintaining coastal food webs and populations of animals that live as adults elsewhere and live within the mangrove at different stages of their life cycle, such as birds, fish and crustaceans.

Wetlands of Seychelles spread all over the three main islands and In other inner and outer islands as well. The largest wetlands are present on Aldabra Astove. Whereas on Mahe, Praslin, La Digue and Silhouette wetlands of considerable area and significant biodiversity are present. There is a wetland at Beau Vallon (Total area: 2147, Perimeter – 227.5m, 0.215ha) (**Figure 33 and 34**).

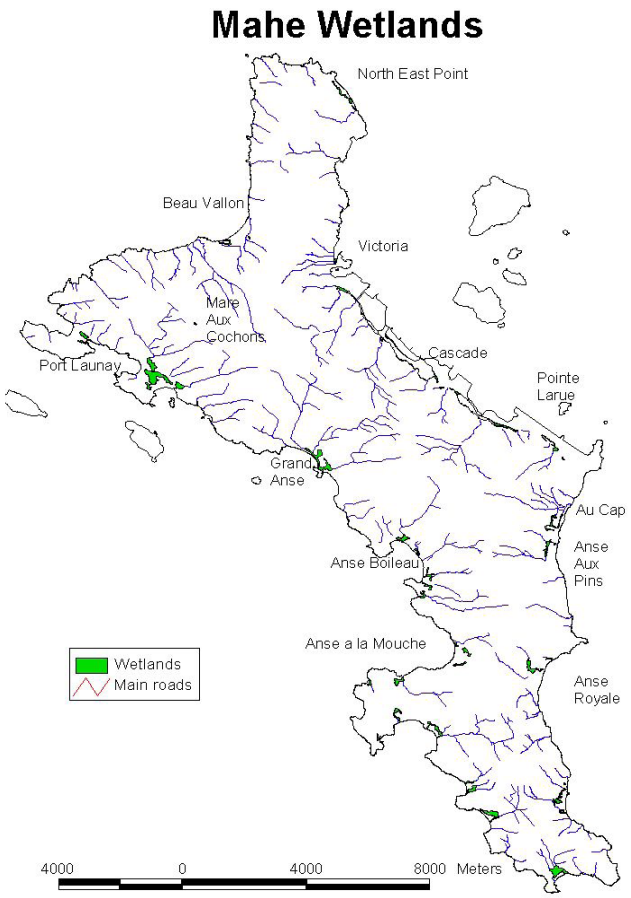


Figure 33. Wetlands at Seychelles Mahè

Figure 34. Wetland at beau Vallon

6.1.8 - Marine ecosystems

The ecological characteristics of the Beau Vallon coastal zone are numerous both spatially and in biodiversity, which include brackish water marshes, coastal vegetation, coral reefs and other marine fauna and flora. There are eight areas that can be considered as special ecosystems (**Table 15**).

Table 16. Special ecosystems at Beau Vallon (Source Grancourt 1995)

Area	In m^2	Description
Northern Fringing Reef	700,000	Coral Reef
Southern Fringing Reef	260,000	Coral Reef
Northern Fringing Reef Flat	250,000	Inter-tidal and Littoral Ecosystem
Southern Fringing Reef Flat	62,500	Inter-tidal and Littoral Ecosystem
Mare Anglaise River Estuary	5,500	Ecosystems of Estuaries and Enclosed Seas
Sullivan River Estuary	3,900	Ecosystems of Estuaries and Enclosed Seas
Mare Anglaise River Wetlands	46,800	River and Stream Ecosystems
Sullivan River Wetlands	15,600	River and Stream Ecosystems

6.1.8.1 - Coral reef

There are 2 main types of reefs, granite reefs and carbonate reefs (fringing reefs, atolls and platform reefs). Fringing reefs are characteristic of the granitic islands.

Along the east coast of Mahe (Anse aux Pins), the reef is continuous and unbroken apart. On the other hand, the on the west coast of Mahe they are mostly small and discontinuous and are mainly (Stoddart, 1984) and are generally narrower than those found on the east coast.

The ecological characteristics of the Beau Vallon coastal zone are numerous both spatially and in biodiversity, which include two fringing coral reefs zones, about 1 km^2 (**Figure 35**):

- Northern fringing reef 0.70 km^2
- Southern fringing reef 0.26 km^2

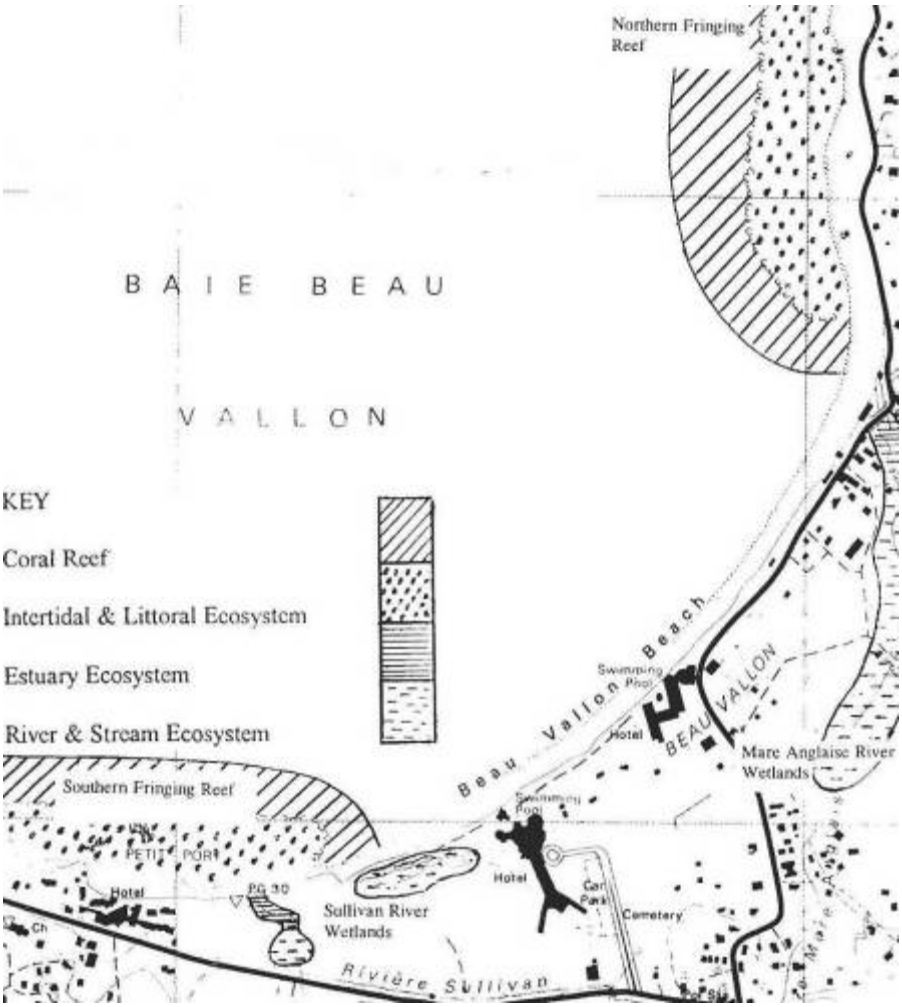


Figure 35. fringing coral reef zones at Beau Vallon (after Grancourt, 1995)

6.1.8.2 - Seagrass bed

Extensive seagrass beds were not found in the site surveys. Seagrasses seen were in < 1.5 depths near fringing reef (**Figure 36**).

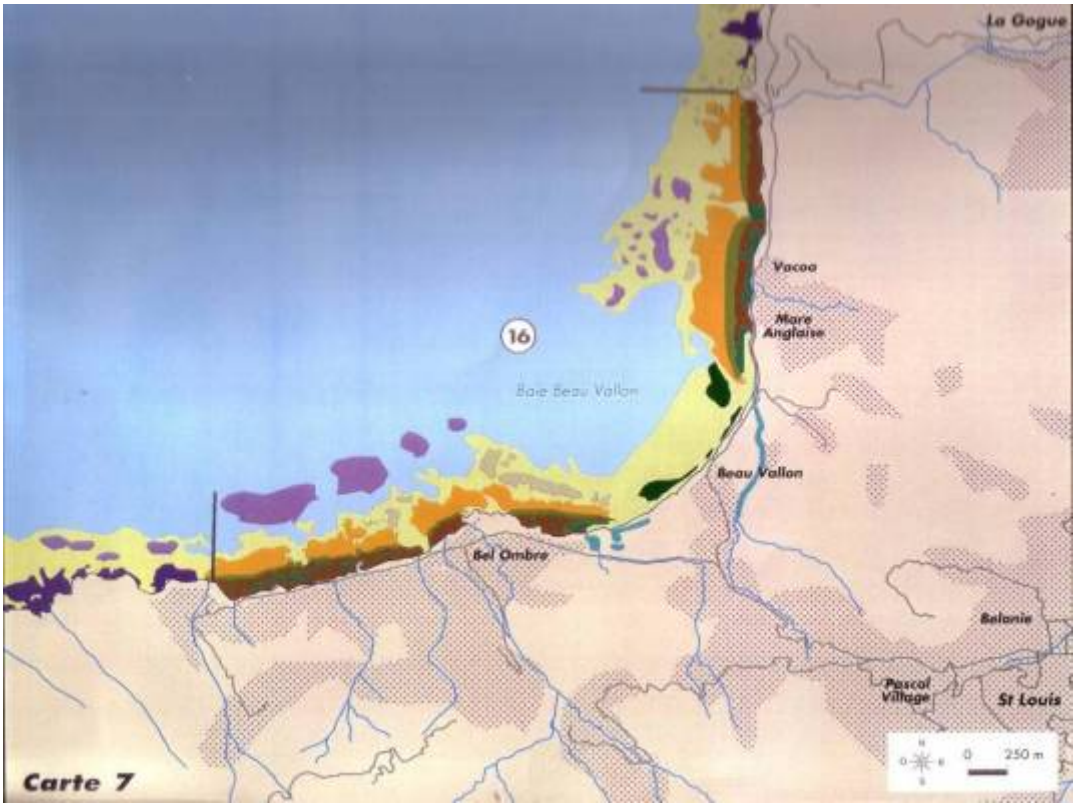


Figure 36. Map showing the main habitat types at Beau Vallon in dark green Seagrass bed (Duvat, 1998) (dark green : monospecific stands, green mixed seagrass zone and light green: seaweed and seagrass mix)

Photograph 1. *Halodule uninervis and Zostera capensis n*ear the northern fringing reef)

6.1.8.3 - Rocky shores and sandy beaches

Although rocky shores are a common feature in the granitic islands, as well as in the raised coralline islands, they were generally poorly studied, mostly because of difficult human access.

The intertidal communities are relatively narrow due to the low tidal range, the commonest animals found there being limpets, barnacles and rock crabs.

The long sandy beach lays in a large, calm bay with flat waterfloor.

6.1.8.4 - Sediment/Soft bottom habitats

Sediment and soft bottom habitats are the most common marine habitats in the Seychelles but are often over looked often as a result of their lack of marine life and the depths (deep sea) at which they are often found. To date very little work has been done on these 2 habitats. However the sea floor of the Mahe Plateau has been mapped to some degree of detail (**Figure 37**).

As can be seen hard substrate makes up 45% of the Mahe plateau. The rest of the plateau is made up of soft sediments of different categories of which muddy sand and mud are the most common.

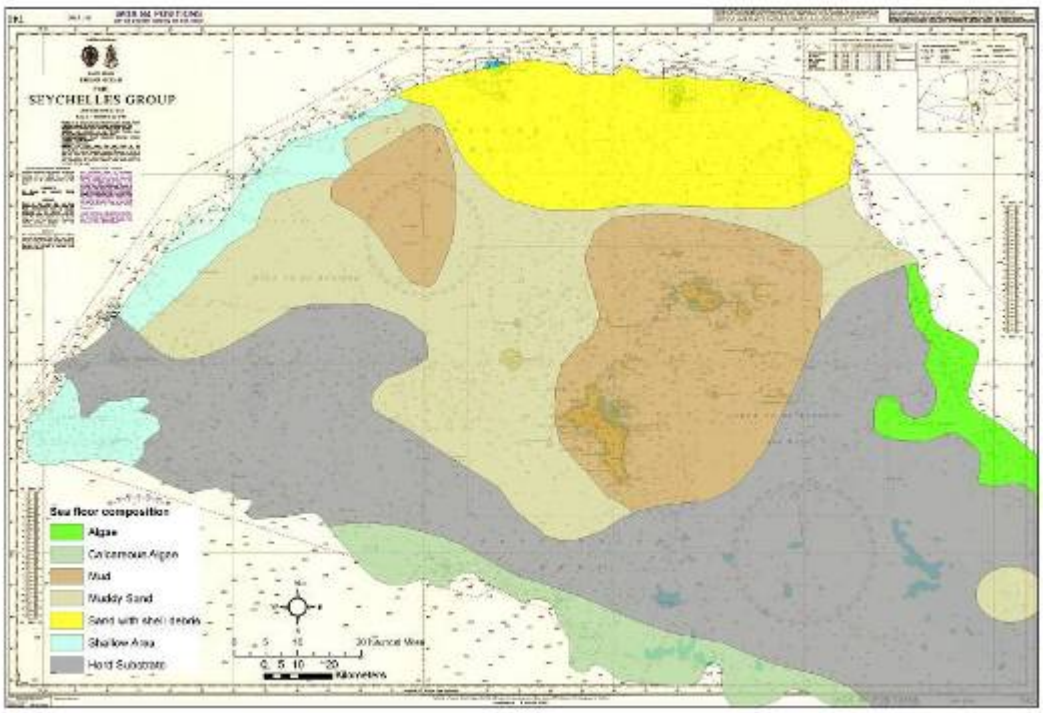


Figure 37. Soft bottom habitats on plateau of Seychelles

6.1.9 - Marine Fauna

Seychelles is pa pristine sanctuary for diverse species of flora and fauna. The islands are home to exciting diversity of birdlife that can be discovered in the wild or in specially designated reserves.

Marine mammals

According to UNEP report 2008

Two orders of marine mammals (Sirenia and Cetacea) occur in Seychelles waters.

In 1963, the humpback whale was officially protected in the southern hemisphere but captures continued up to 1974. In 1979, the Indian Ocean Whale Sanctuary (**Figure 38**) was created (IWC, 1980; Holt, 1983) prohibiting the further capture of whales.

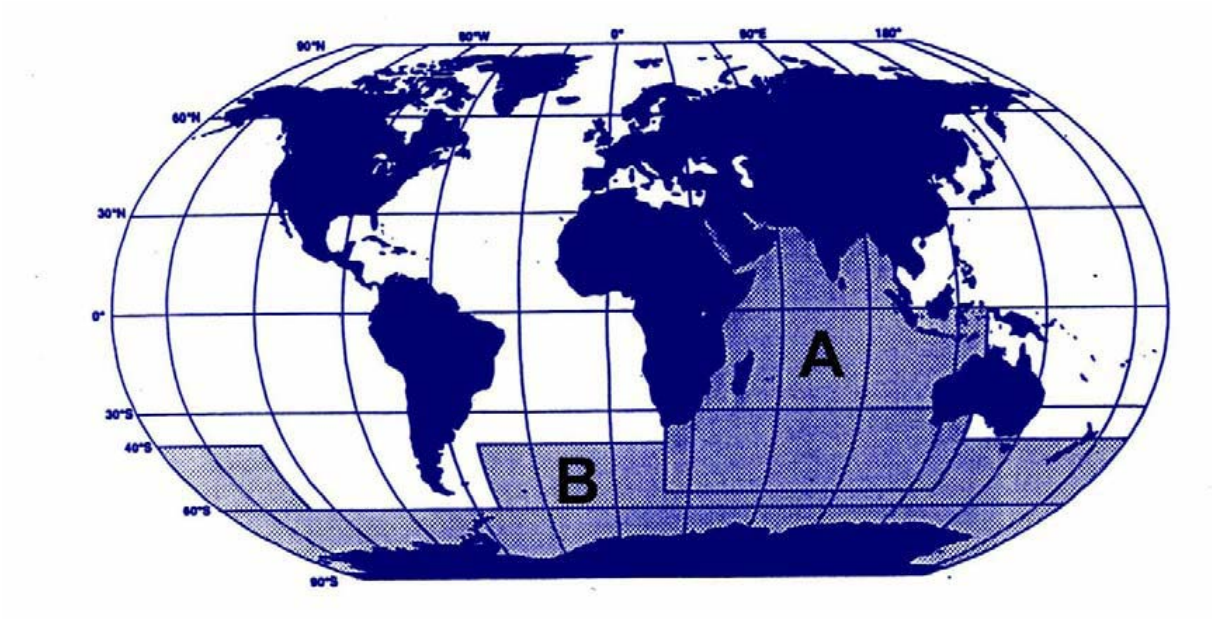


Figure 38. Indian Ocean Whale santuary

Today, both baleen (Mysticetes) and toothed (Ondoctocetes: dolphins, beaked whales and sperm whales) whales are still found in the Seychelles. Over 26 species have been observed, comprising 7 dolphin species of which 4 are common and 19 whale species (**Table 16**).

Table 17. Known dolphins and whales of the Seychelles. Adapted from: Wendling et al., 2003.

Scientific names	Vernacular names	References
Dolphins		
Stenella longirostris	Spinner dolphin	Anon., 1997; Ballance and Pitman, 1998
Stenella attenuata	Spotted dolphin	Anon., 1997; Ballance and Pitman, 1998; Leatherwood et al., 1984; True, 1894 *as cited in* Racey and Nicoll, 1984
Stenella coeruleoalba	Striped dolphin	Ballance and Pitman, 1998
Tursiops truncatus	Bottlenose dolphin	Anon., 1997; Keller et al., 1982
Lagenodelphis hosei	Fraser's dolphin	Ballance and Pitman, 1998
Steno bredanensis	Rough toothed dolphin	Anon., 1997; Ballance and Pitman, 1998; Keller et al., 1982
Grampus griseus	Risso's dolphin	Anon., 1997; Ballance and Pitman, 1998; Keller et al., 1982

Toothed Whales		
Globicephala sp.	Pilot whale	Anon., 1997; Ballance and Pitman, 1998; Keller et al., 1982; Leatherwood et al., 1991; Leatherwood, 1986; Leatherwood et al., 1984
Peponocephala electra	Melon-headed whale	Anon., 1997; Ballance and Pitman, 1998; Keller et al., 1982; Nishiwaki and Norris *as cited in* Racey and Nicoll, 1984; British Museum of Natural History *as cited in* Leatherwood et al., 1991.
Orcinus orca	Killer whale	Anon., 1997; Blanford, 1891 *as cited in* Leatherwood et al., 1991; IWC, 1982; Eyre, 1995; Kasuya and Wada, 1991, Keller et al., 1982
Feresa attenuata	Pygmy killer whale	Anon., 1997; Ballance and Pitman, 1998; Chilman *as cited in* Racey and Nicoll, 1984; Keller et al., 1982
Pseudorca crassidens	false killer whale	Anon., 1997; IWC, 1981a *as cited in* Leatherwood et al., 1991; Keller et al., 1982
Ziphiidae	Beaked whales	Racey and Nicoll, 1984
Mesoplodon grayi	Gray's beaked whale	Anon., 1997; Keller et al., 1982
Mesoplodon pacificus		Keller et al., 1982
Mesoplodon densirostris	Dense beaked whale	Anon., 1997; Gray, 1846 *as cited in* Racey and Nicoll, 1984; Keller et al., 1982
Ziphius cavirostris	Goose beaked whale	Anon., 1997; Keller et al., 1982; JS Taylor in litt 20 October 1974, *as cited in* Ross, 1979
Baleen Whales		
Kogia simus	Dwarf sperm whale	Ballance and Pitman, 1998
Physeter macrocephalus	Sperm whale	Anon., 1997; Ballance and Pitman, 1998, Eyre, 1995; Robineau, 1991, Kasuya and Wada, 1991, Leatherwood et al., 1984; Racey and Nicoll, 1984
Megaptera novaeangliae	Humpback whale	Anon., 1997; Reeves et al, 1991; Robineau, 1991
Eubalaena glacialis	Right whale	Anon., 1997; Lionnet, 1972 in Racey and Nicoll, 1984
Balaenoptera physalus	Fin whale	Anon., 1997; Robineau, 1991, Keller et al., 1982
Balaenoptera borealis	Sei whale	Anon., 1997; Robineau, 1991, Seychelles Archives, *in* Keller et al., 1982
Balaenoptera acurostrata	Minke whale	Anon., 1997
Balaenoptera edeni	Bryde's whale	Anon., 1997; Eyre, 1995, Robineau, 1991, Kasuya and Wada, 1991
Balaenoptera musculus	Blue wale	Eyre, 1995, Robineau, 1991

The area north of Mahe (Carana, Machabée and Beau Vallon) is also known to be regularly visited by bottlenose dolphins hunting in groups of 4- 5 to 10 - 12 individuals. It is also believed that this could be the same school that is regularly observed in the Ste Anne area. However the above mentioned dolphin with the bended dorsal fin has not been sighted in the proximity of Mahe Island suggesting that the schools around Mahe are not the same as the ones observed around the La Digue/Praslin/Curieuse area.

Birds

Seychelles is not situated along any important migratory route, however many migratory species, especially waders, occur regularly. Some of these migratory waders show site-fidelity to Seychelles as wintering or stopover grounds e.g. *Arenaria interpres* (Ruddy turnstone). Very few species of waders occur in concentrations of international importance, except for *A. interpre*s and *Dromas ardeola* (Crab plover).

and Curieuse is of particular interest. The Seychelles islands are the only place in the African and Western Indian Ocean regions where this Asian species can be found. Two subspecies of waterbirds, *Butorides striatus degens* (Green-backed heron) and *Bubulcus ibis sechellarum* (Cattle egret) have been described in the granitics.

Seabird colonies of regional or global importance are found in the granitic islands on Aride, Cousin, Cousine and Bird Island.

Sea turtles

Four species of sea turtles are found in Seychelles waters. However, only the Green turtle (*Cheloniamydas*) and the Hawksbill turtles (*Erethmochelys imbticata*) nests in the Seychelles. Hawksbill turtles nest mainly in the granitic islands whereas Green turtles nest mainly in the outer islands. The other 2 species found in Seychelles waters are the Leatherback turtle (*Dermochelys coriacea*) and the Loggerhead turtle (*Caretta curetta*).

The Marine National Parks of Ste. Anne and Curieuse and the two Special Reserves of Cousin and Aride and the island of Cousine remain some of the most important hawksbill nesting sites in Seychelles.

Aldabra atoll is both a Special Reserve and a UNESCO World Heritage site and has one of the largest populations of nesting green turtles in the Seychelles.

Species of special importance

According to UNEP report 2008

Sharks

Eighteen toothed sharks are known from the Seychelles and it is estimated that there is between 50,000 and 56,000 Mt. of shark biomass on the Mahe Plateau with an additional 34,000 Mt. on the other banks (**Shah et al., 1997**).

Recent longline trials on the slopes (300 – 1000 m) around the Mahé Plateau yielded a possible new deepwater shark species and first records for other cartilaginous and teleost groups (Boullé, 2002).

The whale shark is also common in Seychelles waters. The earliest report of whale sharks, *Rhincodon typus*, in Seychelles dates back to 1868, some 40 years after the species was first described by Dr Andrew Smith from a specimen caught in Table Bay, Cape of Good Hope, South Africa. E. Perceval Wright is quoted as having described the sharks as being common in Seychelles and was able to dissect two sharks while on the islands. Unfortunately, Wright did not publish all of his findings and the preserved specimens he sent to Dublin, Ireland, for analysis were never recovered. The presence of whale sharks, known locally as '*Sagren*', in the coastal waters of Seychelles was therefore well known but little research has been done on their population dynamics or life history. In view of this, a pilot project was set up in by MCSS in November 1996 to tag and monitor whale sharks in Seychelles. To date more than 100 whale sharks have been tagged.

Sea Cucumber

The sea cucumber fishery in the Seychelles has seen a rapid development during the past decade. By 1999 there were already signs of population depletion, including lower volumes of high value species and fishers having to travel further and dive deeper to maintain catch rates, and concerns were raised regarding the sustainability of the fishery (Aumeeruddy et al., 2005). As a result a survey of sea cucumber density at 246 sites throughout the Amirantes and Mahé Plateau was undertaken by SFA in 2004. Two species were considered as over-exploited, 3 as fully-exploited, and the remainder as either under-exploited or at virgin levels (Aumeeruddy et al., 2005). After this survey that TAC was calculated at 1707 t. However, 68% of the TAC is made up of lower value species such as *Holothuria atra.* Shallow water high value species are overexploited or showing signs of significant local depletion.

About 2 dozen sea cucumber species are exploited in the Seychelles and are sold mostly to Hong Kong and Singapore, with smaller markets in Korea, Taiwan and Malaysia.

6.1.10 - Protected area

There are no protected areas in the vicinity of the proposed landfall.

6.1.1 - Ramsar site

There are no RAMSAR site's in the vicinity of the proposed landfall.

6.2 - SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

About 20% of the land of Beau Vallon is urban development with housing and hotels. There is relatively dense development along the coast with three of the island's largest hotels and several guesthouses and restaurants. It is a prime tourism and leisure activity area. It is also an important fish-landing site, with some limited fishing activity.

Various economic activities take place within the Beau Vallon Bay area, including tourism, recreation, restaurants and artisanal fishing.

6.2.1 - Population

The area of Beau Vallon has a population of some 7,000, or 9% of the total Seychelles population. The annual population growth rate is estimated at 2%, the number of inhabitants per dwelling is 4.5 and urban development density is at 10–15 dwellings per hectare. Plans for the sub-division of land are already under way, and new development of apartment buildings in the next five years will increase population and land use conflicts. A total of 512 additional units will be completed in the study area in the next years, corresponding to a net population increase of some 1,152 inhabitants.

6.2.2 - Tourism

Beau Vallon is a very important coastal tourism area on Mahe. Beau Vallon is the first tourism site on Mahe with several large hotels. It is also an important area for the tourists who stay in hotels around the north of Mahe as they do not have the benefit of a large beach.

There are three main hotels in the area

- Fisherman's Cove (70 rooms and suites)
- Berjaya Beau Vallon Bay (155 standard rooms, 25 superior, 1 victoria suite, 1 garden suite, 48 deluxe rooms, 1 junior suite and 1 presidential suite),
- Coral Strand Hotel (130 rooms).

There are 10 Guest House / Small Hotel:

- Augerine Guest House (12 comfortably furnished rooms and 3 junior suites)
- Beau-Vallon Bungalows (12 confortable bungalows)
- Coco D'or (24 standard and 3 deluxe rooms)
- Panorama (10 rooms)
- Romance Bungalows (7 rooms)
- Sun Resort (20 rooms)
- Villa De Roses (cosy family-run guesthouse)

- Le Niole Guest House
- Pti Payot (3 self-catering chalets)
- Georgina's Cottage (5 rooms)

There are 8 restaurants

- Domaine Du Soleil
- Restaurant al mare
- Golden Sands
- La Fontaine
- La Perle Noire
- Berjaya Beau-Vallon Bay
- Boat House
- Mahek
- Coco D'or

Recreational Sector

Beau Vallon is a very important zone for recreation not only for the tourists but also for the local community. Recreational activities include

- swimming,
- snorkelling,
- diving and other water sports.
- Events (Seychelles Round table Regatta, Bazar Labrin...)

Seychelles Round Table Regatta

One of the most exciting events of Seychelles is the Seychelles Round Table Regatta which will be held in August. This annual FREE 2-day fun fair event is held at Beau Vallon beach with water sporting events being the focus.

This event includes activities for young and old alike, such as Yacht race, swimming competitions, amateur boxing tournament, beach tugs-of-war, live music, souvenir items and a traditional craft market which you can participate. The entertainment is served with plenty of food and drink including regional specialties such as spicy coconut curries and "la daube", a delicious dish made from breadfruit, yams, cassavas and bananas.

SUBIOS
in November, an underwater festival, **SUBIOS**, is celebrated in Seychelles. This three-week festival promotes awareness and conservation of the region. It attracts conservationists, filmmakers, photographers and underwater enthusiasts from across the world.

In 2009, the first weekend of October saw a sporting event on the beautiful beach of Beau Vallon. The Seychelles Underwater Festival, an event organized by the Seychelles Tourism Board in collaboration with the diving centers, several hotels, Air Seychelles and other individuals also grouped some of the best athletes in the archipelago.

Bazar Labrin

The Bazar Labrin, organized by the Seychelles Tourism Board (STB), takes place every Wednesday evening from 1630hrs to 2100hrs Beau Vallon Beach.It's a typical Creole bazaar specialising in delicious Creole dishes, locally grown fruits and vegetables, local arts and crafts.

Eco-Healing Seychelles Marathon

Following the success of the first and second marathons, the third Eco-Healing Seychelles Marathon is due to commence on 28th, Feb, 2010 at 7 am at Beau Vallon Bay, Mahé. This marathon will feature 10km, 21km (full course marathon 42.195km) and a new 10km walking event.

The recreational sector provides additional employment and maintains a state of holiday ambience in the area.

There are 5 Diving Centers

- Big Blue Divers
- Diables Des Mers
- Island Ventures
- Marine Divers
- Underwater Center

Several dive sites (e.g. coral gardens) are found within the bay itself and there are others on the outskirts (**Figure 39**).

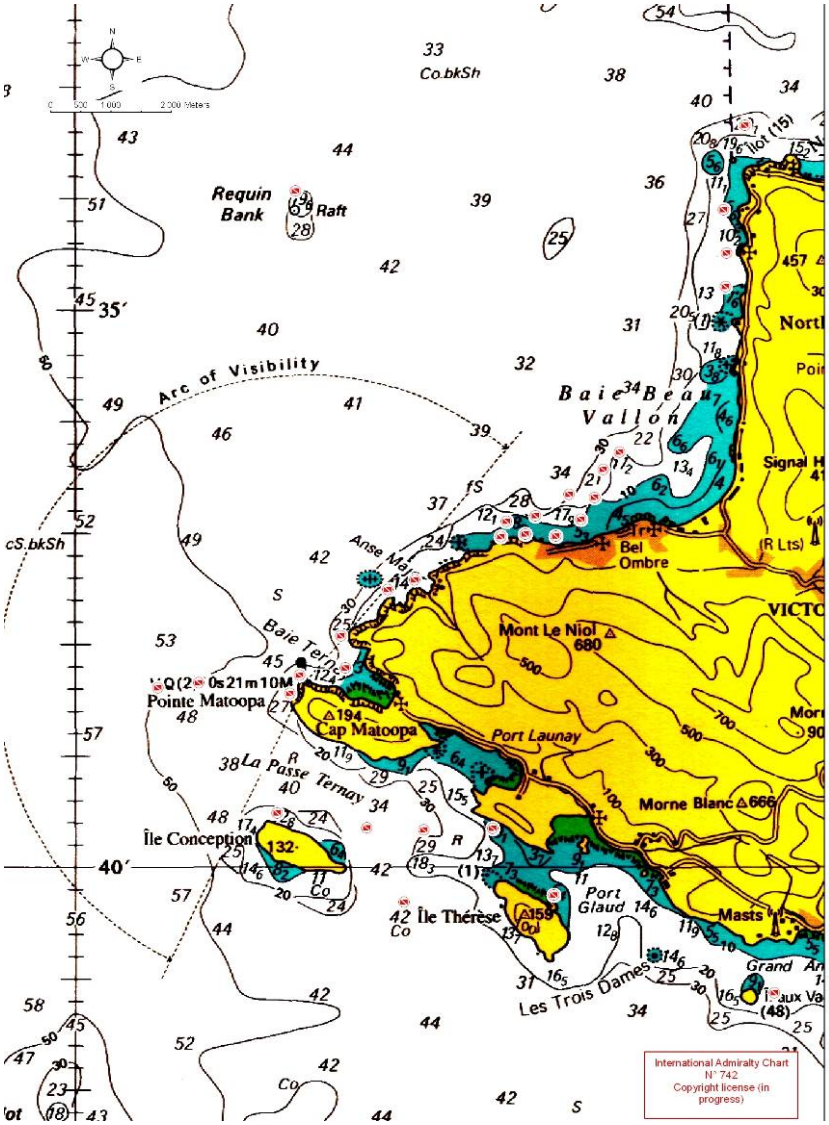


Figure 39. dive sites in the vicinity of landing site

There are 2 Bakery (Yvon Bakery and Croissant Bakery)

There is a Hair Dressing Saloon (Nadia's Hair Dressing Saloon***)***

There is one Butchery, The Camille's Butcher Shop

Public Services

Existing services include schools, a home for the elderly and a district clinic.

Health Centre	1
Police Station	1
Fire Hydrants	13
DA's Office	1
Community Centre	1
Day Care Centre	1

Historical Monuments / Heritage

Beau-Vallon District does not have any Historical Monuments or Heritage Sites. But identifications of potential Historical Sites have been ear-marked together with the National Heritage of Seychelles based at La Bastille. They are as follows:

- *Pti Simityer*
- *Mr.Pierre Guislain's Shop.*
- *Lakres an bwa.*
- *Macouti shop.*
- *Lakaz Mm George -Grann Kaz Mike vicinity Mare- Anglaise).*
- *Ros Gorrilla*

6.2.3 - Fishing

As a lot of small, island state, Seychelles has a high reliance on marine resources. It has one of the highest per capita consumption in the world (80 kg/year). Fisheries and ancillary services also account for 15 percent formal employment. Seychelles is characterized by wide range of marine habitats: shallow water fringing reefs, granitic reefs, banks and plateau shelves, drop-offs, lagoons, seamounts and pelagic habitats.

The fisheries sector comprises of:

- **Industrial**

  The industrial subsector is made up of the purse seine and longline fisheries for tuna and tuna-like species (all foreign-owned vessels).

- **semi-industrial**

  This fishery targets swordfish and tuna by local vessels ranging from 12 to 23 m in length

- **Artisanal sub-sectors**

  This sub-sector is the most complex of the three. It exploits a high diversity of species and habitats, leading to a wide array of boat-gear combination and strategies. These fisheries are strictly reserved to local vessels. These fisheries have a big socio-economic importance, as they provide most of the fish consumed locally.

The total catch of the artisanal fisheries has remained stable between 4 000–5 000 tonnes/year since 1985, with a catch of 4 583 tones in 2005 (9.7 percent increase over 2004). Three main fisheries account for the majority of the catch:

- The semi-pelagic handline fishery is the most important in weight landed (44 percent in2005). Principal species: *Carangoides* spp.*, Caranx* spp.*, Sphyraena* spp.*, Euthynnus affinis* and larger tuna species).

- The demersal handline/dropline fishery targets large numbers of species dominated by snappers, groupers and emperors (*Lutjanus sebae, L. bohar, Aprion virescens, Epinephelus chlorostigma, Lethrinus nebulosus)*.

- The trap fishery is largely restricted to inshore areas around the granitic islands and targets mainly *Siganus* spp.*, Lethrinus* spp.*, Epinephelus* spp*.*

Coastal fishing at the Beau Vallon bay is mainly dominated by hand-lines, traps and beach seines. The most important species caught are Carangidae, the red snapper, green snapper, groupers, and the Indian mackerel (Grandcourt, 1995).

With about 25 fishing boats, the greater Beau Vallon area is the second largest fishing site on Mahé. The annual tonnage caught is estimated at some 1,100 tons (. Most fishing activity takes place from boats: there is also a small amount of artisanal fishing by foot.

Boat owner's (registered with SFA) – 8

- Clifford Reginald – Beau-Vallon
- Garry Jean-Baptiste - Beau-Vallon
- Antonio Houareau – Mare-Anglaise
- Ralph Tirant – Mare-Anglaise
- Gabriel Payet – Mare-Anglaise
- Raymond Mousbe – Mare-Anglaise
- Kenneth Hoareau – Pascal Village
- Allen Esparon – Pascal Village

Agriculture

All farming activity in Beau Vallon is carried out by family farms. Animal pollution sources from cattle, pigs, poultry etc. give a total of 2,260 population equivalent.

6.2.4 - Shipping and anchorages

Port Victoria is a busy international shipping port and the major hub for the Western Indian Ocean tuna fishery. In 2003, Port Victoria handled 88 % of the 449 300 tons of tuna caught by purse seiners in the Western Indian Ocean (SFA, 2003). Shipping import cargos to Port Victoria include bulk oil (53.4 % of total imports in 1997 – 2002), general cargo (42.5 %), bulk cement (3.8 %) and liquid petroleum gas (0.3 %). The current decline in trade volume is largely caused by the drop in general cargo imports from 304 000 tons in 1998 to 92 000 tons in 2002 (Portfocus, 2003).

All vessels visiting the Seychelles Islands are advised that Port Victoria is the only official Port of Entry/Exit of the Seychelles and must therefore call at Port Victoria, Mahe to carry out all Health, Port, Security, Immigration and Customs formalities upon initial entry into Seychelles or upon ultimate departure for a foreign port The main shipping port in the Seychelles is Port Victoria which is located on the eastern side of Mahé Island.

Port location	Port Victoria
Port name	Port of Port Victoria
Port Authority	Port Victoria Port Authority
Address	PO Box 47 Victoria Mahe Seychelles
Phone	248 224 701
Fax	248 224 004
Email	hm@seychellesports.sc
Web site	
Latitude	4° 37' 35" S
Longitude	55° 27' 50" E
Port type	Seaport
Port size	Small
Admiralty charts	740, Approaches 742
Airport	International is about 7 Km from the port

There are two recreational mooring areas at beau Vallon (**Figure 40**).

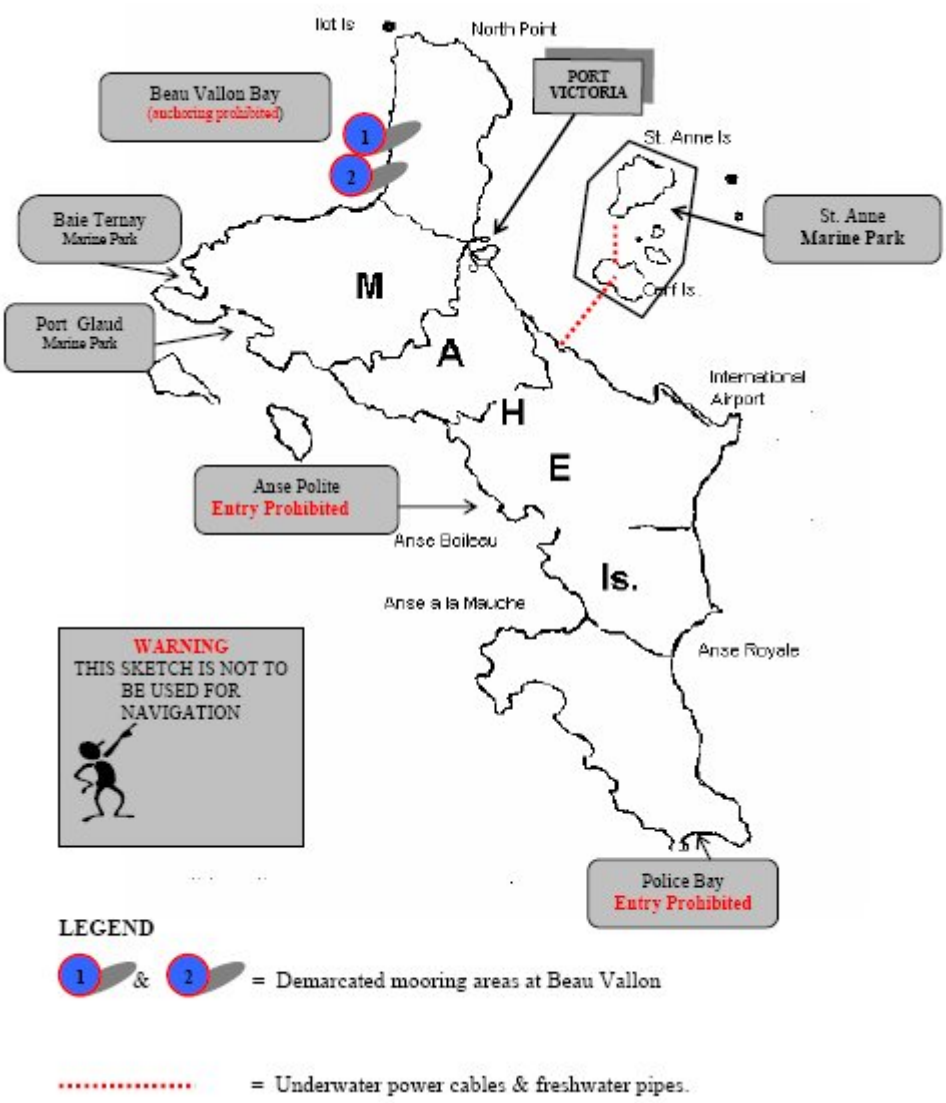


Figure 40. Mahé island and its surroundings (indicating protected areas, mooring areas and Marine parks)

6.2.5 - Hydrocarbon exploitation

The potential for producing oil and gas exists, with offshore geophysical and geological exploration continuing over the Seychelles Bank.

On the Seychelles plateau, there are two actively oil companies (East African Exploration (EAX) and Petroquest Intl (**Figure 41**).

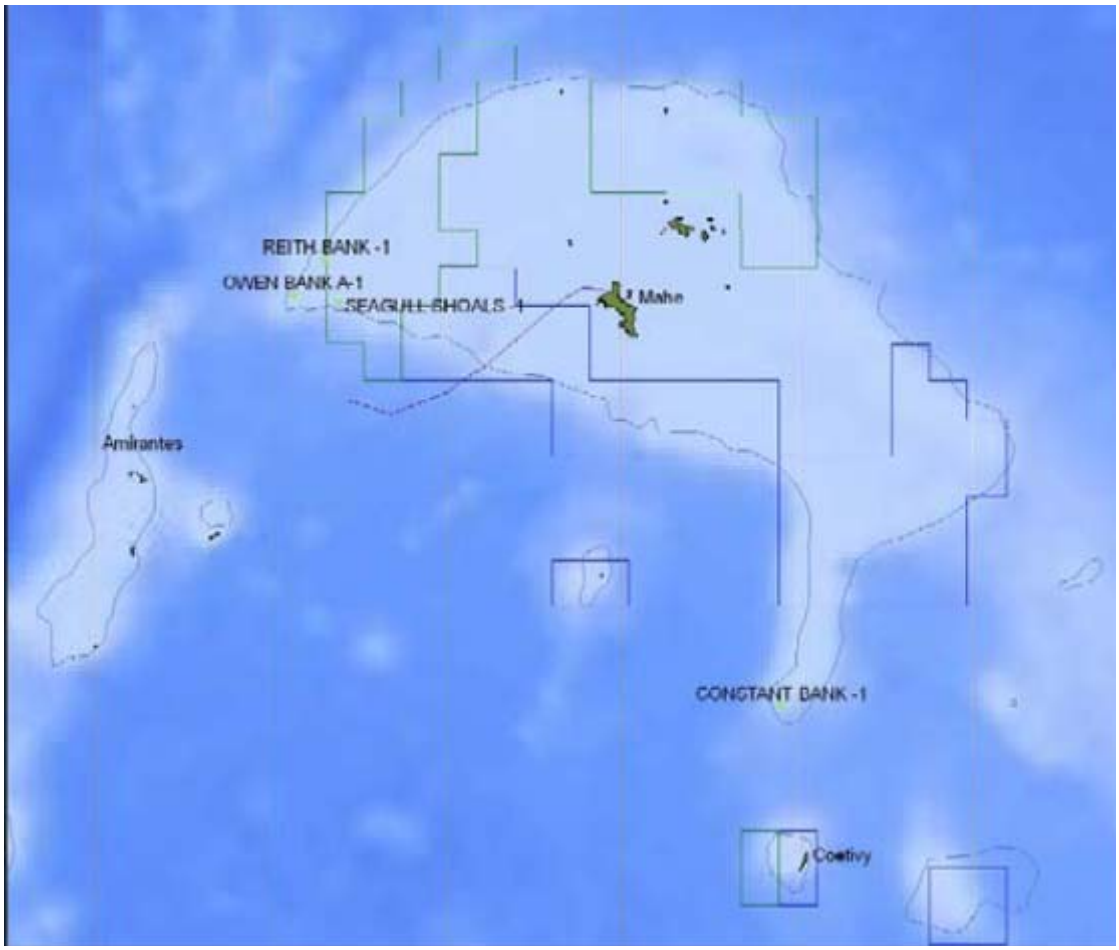


Figure 41. Licensed areas, green lines EAX and blue lines Petroquest (SEYPEC report, 2009)

According to SEYPEC report 2009

The proposed cable route crosses the Petroquest area. Currently Petroquest has acquired new seismic data over the area and is in the process of interpreting the data to identify drillable prospects. There is currently no activity in the area that will affect the laying of the cable. It will nevertheless be imperative that the accurate track of the cable be communicated to Seypec so that future drilling activities in the area do not affect the cable.

Future hydrocarbon exploration activities in the area may include geophysical surveys and drilling. Drilling may need to include anchoring of the drilling vessel which has a high potential of damaging the cable if not done with the cable location in mind. Once the cable has been laid, Seypec will need to obtain accurate data on its location to help prevent damage during drilling operations. Seypec will thus expect this information to be made available.

6.2.6 - Mining

Mining activities in the Seychelles is mostly restricted to the mining of granite from land and coral aggregates from the sea floor. Other mining activities include mining of sand and gravel. The removal of sand and gravel is regulated by the Removal of Sand and Gravel Act of 1982 which was introduced to control the damages which was being caused to beaches and river beds through the removal of sand and gravel.

There is a mining are in the vicinity of landfall site (**Figure 42**).

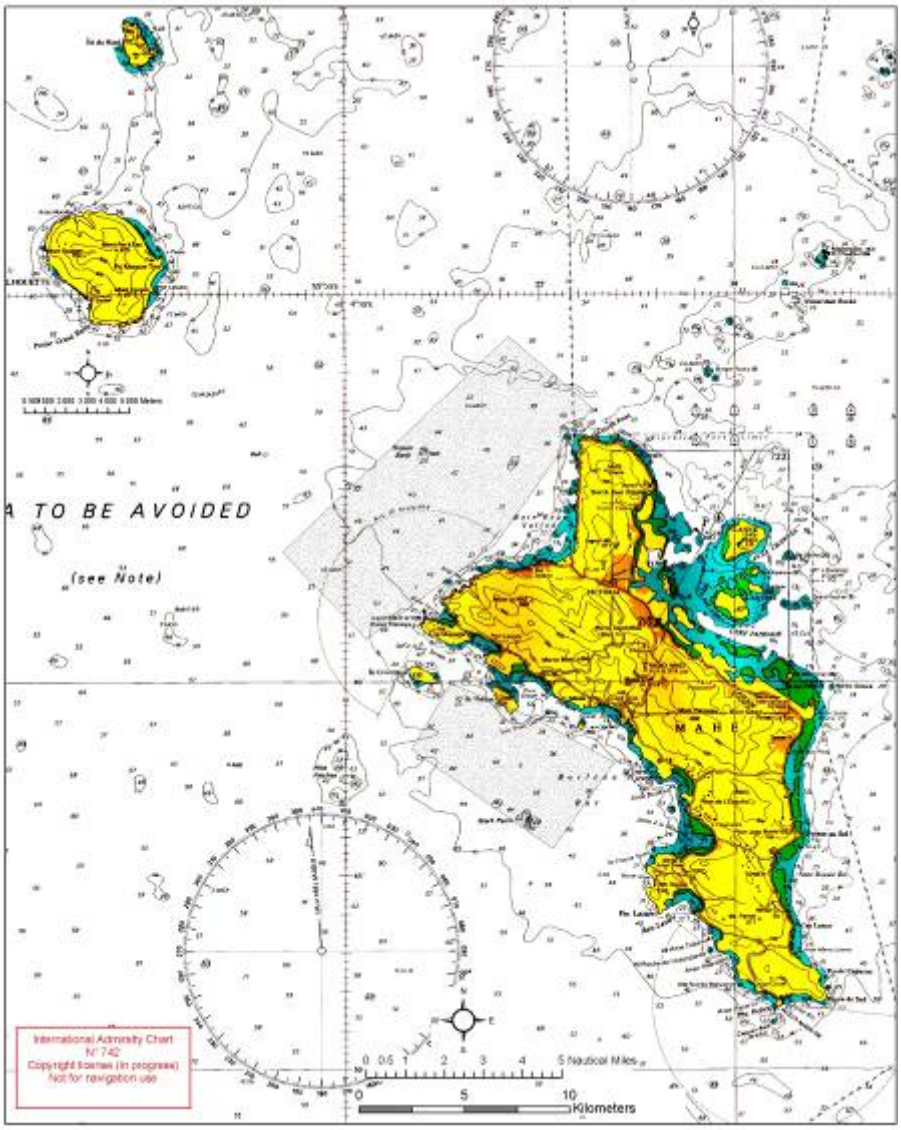


Figure 42. Sand extraction areas in Seychelles

6.2.7 - Dumping, dredging and reclamation

There are no reported dumping areas in the vicinity of the proposed landfall. There are no dredging operations in the area.

6.2.8 - Submarine pipeline/cables

There are no submarine cables or pipeline in the vicinity of the proposed landfall.

6.2.9 - Military activities

There are no naval or coastguard bases near the landfalls. Exercise areas are not marked on the charts, and it is difficult if not possible to obtain detailed information about existing or planned areas military operations.

6.2.10 - Charted obstructions and wrecks

No obstructions have been reported in the area of the proposed landfall(s).

7 - IDENTIFICATION OF IMPACTS

7.1 - INTRODUCTION

This chapter discusses the environmental and social impacts that may results from the proposed development. Potential impacts are identified, mitigation measures listed and residuals impacts, taking these measures into account, are described.

Supporting baseline environmental and social information is contained in chapter 6 of this report. Cross references to other sections of this report are made where impacts are likely to be either directly or indirectly interlinked. A full description of the proposed project activities is provided in chapter 2.

Potential impacts on environmental and social resources arising from the proposed development include direct and indirect (both permanent and temporary) impacts within the development area and surrounds. There is also potential for impacts relating to cumulative impacts of the proposed cable system and other developments.

The following sections outline these impacts, giving detailed explanations and assessment with regard to the predicted significance of the impacts. Where appropriate mitigation, management and enhance measures are identified to avoid, reduce or remove the predicted impact.

7.2 - DEFINITION AND TYPES OF IMPACTS

An impact it any change to a receptor brought about by the presence of a project component or by the execution of a project related activity. Evaluation of baseline data provides important information for the process of evaluating and describing how the project could affect the environment (physic, biologic and socio-economic). Impact nature and type are:

- **Positive**

  An impact is considerate to represent an improvement on the baseline or introduces a positive change. For example, section 7.4 describes this aspect

- **Negative**

  Introduces a new undesirable factor

  - **Direct**

    Direct interaction between the project planned activity and the environment (occupation of a site and the pre-existing habitats, other activities...)

  - **Indirect**

    Impact that result from other activities that are encouraged to happen as a consequence of the project

  - **Cumulative**

    Impacts that act together with other impact, affect the same resource/receptor

Impacts are described in terms of significance. Significance is a function of the magnitude and function of the extent, duration and intensity of the impact. The degree of change brought about in the environment:

- **Extent**
  - ***On site*** (limited to the site area only)
  - ***Local affect*** (an area in a radius of 30 km around the area)
  - ***Regional*** (affect regionally the important environment resources, ecosystems)
  - ***National*** (affect nationally important environment resources, have a macro-economic consequences)
  - ***International*** (affect internationally important resources such as protected areas – international conventions)
- **Duration**
  - ***Temporary*** (short duration and intermittent/occasional
  - ***Short-term*** (during construction period)
  - ***Long-term*** (during the life of the project, but ceases when the project stop operating)
  - ***Permanent*** (cause a permanent change in the affected receptor, resource (destruction of an habitat such as coral reef..) and edurs substantially beyond the project lifetime
- **Intensity**

	Environment	
	Biophysical	**Socio-economic**
Negligible	No detectable	No perceptible change people's away life
Low	No affectt/No changes the natural functions	People are able to adapt with relative ease and maintain pre-impact livelihoods
Medium	affect the natural functions	Able to adapt with some difficulty and maintain pe-impact livelihoods but only with a degree of support
High	Alterations Temporarily or Permanently cease	Those affected will not be able to adapt to chnage and continue to maintain pre-impact livelihoods

7.3 - GENERIC IMPACTS

Modern submarine telecommunication systems are fiber optic cables using pulses of light to transport information. Coaxial cables, as the former standard, use electric current to carry information and are sporadically still in service. However, long-distance optical cables require repeaters and thus also need a constant power supply. Whereas coaxial cables have a diameter of up to 10 cm, fiber optic cables are only 2 – 5 cm thick.

Submarine cables are usually buried to minimize the risk of damage by, for example, anchors and fishing gears.

Submarine cables have a wide range of potential impacts on the marine environment due to their placement (i.e. cable-laying) as well as due to their operation. The various potential impacts of submarine cables differ considerably in terms of their spatial extent, duration, frequency and reversibility. A general overview is given in Table 17.

Table 18. Main environmental impacts associated with submarine cables

Phase	Installation, maintenance, repair work and removal	Operational phase
Submarine Telecommunication cable	Seabed disturbance	Introdution of artificial hard surbstrate
	Damage/disturbance of organisms	
	Re-suspension of contaminants	
	Visual disturbance	
	Noise (Vessels, laying machinery…)	
	Emissions and wastes from vessels	

The various impacts act on different components of the ecosystem in different ways. Seabed disturbance may impact benthic organisms, underwater noise is most relevant for marine mammals, electromagnetic fields may have effects on sensitive fish and marine mammals and visual disturbance (including visual and aerial noise) has the potential to displace sensitive sea birds and seals. The extent of such impacts is determined by the technical design of the cables, the laying equipment. Some environmental impacts are mainly linked to the installation phase and/or maintenance, repair activities and removal. Others are only relevant during operation.

7.4 - POSITIVE IMPACTS OF THE PROJECT

A number of positive benefits are predicted to be associated with the proposed development. Many of the positive aspects of the project relate to macro and micro-economic opportunities and benefits resulting from increased Information and communication technology connectivity, but many other secondary benefits including, social, employment and educational impacts will also be realized. T he positive aspects of the project are discussed in chapter 4, section 4.3.

7.5 - NEGATIVE IMPACTS AND MITIGATION MEASURES

Potential impacts are described for the pre-construction, construction, operational and decommissioning phases of the project.

For activities with significant impact, the project would be required to identify suitable and practical mitigation measures and fully implement them. The implementation of the mitigations is ensured through the Environmental Management Plan (EMP) (Chapter X).

7.5.1 - Pre-construction

The phase refers to initial route selection work including the desk top study (DTS) which delineated the cable route, and subsequent onshore/offshore route selection survey work, the marine survey. It therefore includes a number of onshore surveys and the use of vessels and survey equipment. There are no impacts resulting from DTS phase work (selection of the cable route).

7.5.1.1 - Environmental impacts

Several techniques are used during route selection studies that include geophysical and geotechnical survey equipment, such as:

<u>Geophysical and geotechnical equipment</u>

- Side scan sonar
- Sub-bottom profiler
- Multibeam/Singlebeam
- Magnetometer
- Corer (gravity or vibrocorer)
- Grabber
- Cone penetrometer

These equipments use non intrusive techniques to record sea bed bathymetry. Coring, grabbing or penetration tests involve minimal ground disturbance at location.

Impacts from these survey techniques are all considerate to be low.

Impacts that may results from the operation of survey vessels are described in section.

7.5.1.2 - Social impact

There no discernible social impact associated with the pre construction phase.

Indeed, cable survey could cause temporary disruption o the flow of shipping traffic or other activities (scuba diving, swimming...). This is particularly the case if the survey vessels have to maintain station for some time (during core penetration for example). However, these operations are limited to short periods of time and other marine traffic/activities can generally avoid working area without significant diversion.

The project will notify the Ports Authority and main activities, so that vessels in the area would be warned in advance of the ongoing operations through a “Notice to Mariners or to marine users (divers...)’ report transmitted daily. The cables routes avoid the major ports but the contractors will heighten awareness for potential danger posed by and to other vessels/activities (diving, snorkelling...) when working in areas.

7.5.2 - Construction

For obvious reasons of scale proportions the project does not impact the following environmental conditions:

- Local and regional meteorological conditions
- offshore metocean conditions
- local tide cycles

  Regarding these conditions, because their causes are global / at large-scale, they are very few impacted by a local disruption

- Local geology or hydrogeology

  For example, installation of the BMH will not involve the construction of any new access roads or large impermeable surfaces that may impact the current surface or ground water flow. The impacts on hydrology are therefore predicted to be negligible.

-

  The project does not imply a disturbance of the substratum; works will only concern shallow/superficial sedimentary layers

- Regional coastal geomorphology

  The geomorphologic effects (bathymetric and sedimentary changes) of the project are very much localized to the work site.

7.5.2.1 - Environmental impacts

Construction activities will result in some negative environmental impacts during route clearance and cable laying, particularly to benthic biota along the survey route.

However, at any one location the disturbance will occur over a very short duration, natural recovery will readily occur and impacts will therefore tend to be minor in nature.

7.5.2.1.1 - Offshore and shallow water

The pre-laying grapple run

The grapnel will penetrate the seabed to a depth of up to 0.8 meters. Due to the intrusive nature of this operation some negative impact is unavoidable. Impacts include the generation of:

- a small amount of turbidity
- through physical contact mortality or injury to marine organisms, particularly plants and other organisms that have low mobility.

The pre-laying grapple run and cable installation will have some minor physical impact on sea bed geology. This impact will be limited to the area where the cable will be installed only and will vary in intensity depending on the installation method (cable burial in a trench or laying on the seabed).

Cable laying

The laying of cables leads to seabed disturbance and associated impacts of damage, displacement or disturbance of flora and fauna,

- increased turbidity
- release of contaminants
- alteration of sediments.

These effects are mainly restricted to the installation, repair works and/or removal phase and are generally temporary. In addition, their spatial extent is limited to the cable corridor (in the order of 5 m width if the cable has been ploughed into the seabed).

Some mobile benthos is able to avoid disturbance and though sessile species (bivalves, tubeworms etc.) will be impacted.

The cable installation process will only result in short term direct impacts to the subtidal bottom habitats and assemblage present on intertidal area at the Beau Vallon beach landing point. The short term loss of benthic organisms directly along the cable routes is not considerate to represent an unacceptable ecological impact. The rapid natural reinstatement of the seabed will result in the area being available or rapid recolonisation and hence, no permanent impacts are anticipated from cable project.

Raised turbidity and suspended sediment levels can have a number of adverse effects on marine organisms, particularly in areas that would normally have clear waters.

Where suspended sediment concentrations are present for prolonged periods, or are particularly high and widespread, visibility can be reduced affecting the ability of some fish to feed.

Raised turbidity can also reduce light penetration in the water column and reduce photosynthesis/productivity in sea grasses and affecting the coral reef presents in the area (2 fringing reefs).

However the duration, spatial extent and level of suspended sediment associated with route clearance and cable installation in this project are unlikely to cause such problems.

Nevertheless, turbidity levels should be minimized during cable lay operations by minimizing the duration and extent of physical seabed disturbance.

Mitigation

No immediate mitigation known due to temporal nature of impact (less than 24h) would be selected. But this can be achieved using the sea plough burial method in preference to jetting wherever possible. The impact of turbidity generation is assessed as being of low significance.

The Project will implement mitigation measures to reduce the risks of impacts on fauna with particular attention is paid to sensitive marine species including marine mammals and turtles. This will include:

- monitoring for the presence of marine mammals and turtles during marine activities;
- working with an appropriate environmental organization to develop a notification process;
- minimizing the impact of lighting at the beach areas.

With appropriate mitigation the significance of impacts on fauna are predicted to be negligible.

Air quality – Vessels operations

Cable laying will require use of dedicated cable lay vessels resulting in a number of general environmental impacts and risks. During normal operational activities vessels emit exhaust gases.

Assuming that the vessels are well maintained, emissions of pollutants will be minimal and within allowable limits.

Mitigation

To minimize air emissions the Project's cable laying vessels will operate in line with the requirements specified under MARPOL 73/78 Annex VI, Prevention of air pollution from ships.

When mitigated by compliance with MARPOL requirements, the impact of vessel operations on air quality is assessed as being of low significance.

The project should require that construction contractors operate only well maintained engines.

Solid waste -Vessels operations

A variety of non hazardous (packaging…) and hazardous (oil wastes, paints…) wastes are typically generated during vessels operations.

Hazardous wastes can clearly have a toxic effect on organisms and can in some circumstances lead to bioaccumulation and ultimately lethal or sub lethal affects if badly managed. In addition, some non hazardous waste types can be equally harmful, particularly non degradable plastics that can remain at sea for many years posing an entanglement risk to sea birds and marine life.

Annex V of MARPOL prohibits the disposal to sea of any plastics whilst restricting the discharge of other non hazardous waste in coastal waters and in designated "Special Areas".

Hazardous waste should be stored on board the vessel until it can be disposed at a suitably equipped port, respecting the requirements of the Basel Convention on Transboundary Shipment of Hazardous Wastes.

Mitigation

When mitigated by compliance with MARPOL requirements, the impact of solid waste in vessel operations is assessed as being of low significance.

Aqueous Discharges - Vessels operations

Planned aqueous discharges can include sewage water, grey waters (discharge from showers and sinks) and potentially contaminated drainage from the ship deck. Sewage and grey waters can have high bacteria levels, surfactants and a high Biological Oxygen Demand (BOD5), all which can result in potential human health issues and harm to marine organisms, particularly in sensitive areas or locations with poor mixing and dilution potential.

These wastewaters should therefore be managed in accordance with applicable international regulations and guidance, including the requirements of MARPOL 73/78, Annex IV (sewage).

MARPOL, Annex 1 also addresses discharge of oily waters, for example bilge waters. For ships of 400 gross tonnage and above, for control of oil from machinery spaces, waste water must have an oil concentration below 15ppm without any prior dilution. More specifically:

- Within special areas – discharges are prohibited, except when the ship is proceeding en route, and the oil content of the effluent without dilution does not exceed 15 ppm, and the ship has in operation oil filtering equipment with automatic 15 ppm stopping device.

- Outside special areas - discharges are prohibited, except when the ship is proceeding en route, the oil content of the processed bilge water (from machinery spaces) effluent is less than 15 ppm, and the ship has in operation an oil discharge monitoring and control systems, oily-water separating or filtering equipment

Mitigation

When mitigated by compliance with MARPOL requirements and the impact of aqueous discharges (excluding ballast waters)in vessel operations is assessed as being of low significance.

Ballast water management - Vessels operations

It is possible that invasive (predominantly non-native) species may be unintentionally introduced. This has a potential impact habitats and fauna and flora if invasive species become highly aggressive, outcompeting native species and altering the structure and community composition of marine ecosystems.

Mitigation

Marine vessels will be required to adhere to International Maritime organization (IMO) regulations on bilge and ballast water discharge in order to avoid unintentional introduction of non-native species to the marine environment.

7.5.2.1.2 - Onshore

At the landing location there will be a small amount of construction work and environmental impact associated with the cable installation and construction of the onshore facilities. Much of this impact will be typical of general construction activity, resulting in short term waste generation and nuisance impacts (Noise, air quality...).

Cable laying, construction of BMH

In the terrestrial environment small amounts of soil will be disturbed during the excavation of the cable trench and during construction of the BMH.

The extent of the impact is limited to on-site and local. The duration will range from temporary to permanent as some impacts will last only a short while (effects of disturbance during construction) and some will cause a permanent change (habitat removal). Although the habitat type and flora species present are predominantly common and widespread, the magnitude of the change will be low as some natural processes will be affected as a result of small amounts of habitat loss, degradation or disturbance. The impact significance pre-mitigation is minor.

Mitigation

The Project will implement mitigation measures to minimize the extent of the impact to the terrestrial environment and to restore areas that are disturbed. This will include:

- limiting clearing and restoring areas of disturbance;
- using controls to prevent incursion into adjacent areas;
- implementing a hazardous materials management plan;
- to prevent habitat alteration the reinstatement of trench material would be advised. Where possible and appropriate, top soil will be segregated and replaced on other back fill material to promote regeneration of vegetation.
- All soil that is disturbed during trench digging will be restored to approximate original depths as the trenches are backfilled.

Waste

Construction wastes will be generated during onshore construction. Overall these are expected to be relatively small quantities although they may include some hazardous waste (oily rags, spent fuel cans, batteries etc.).

If a good waste management plan is planned, the impact of onshore waste is as being of low significance.

Mitigation

Waste management is required to avoid the risk of harm to the environment and human health

Air quality

The local air quality in the close proximity of onshore construction activities will be affected by emissions from mobile (construction vehicles) and stationary machinery (portable generators).

Mitigation

Assuming that the engines are well maintained, emissions of pollutants will be minimal and within allowable limits.

Dust

There is potential some dust generation during the construction at the shore crossing BMH and ducts. Dust is most likely to be generated during the transportation of materials on unpaved roads and during trench digging and soil movement.

Increased levels of dust in the air have the potential to impact environment (flora, communities) and social resources. However, the construction (BMH and ducts) period will be very short (approximately 3 weeks); any dust would be limited to the construction area, access route and very near surrounds only. Dust related impacts largely reversible within a short timescale. Therefore, no impacts are predicted to occur as a result of increased dust.

Mitigation

Dust suppression techniques, such as increasing the moisture content of excavated materials and roadways by applying water or non toxic chemicals, can be used to reduce the amount of dust in the air, particularly where construction activities are taking place in close proximity to dust sensitive receptors e.g. residential/commercial areas. Other dust management measures include speed restrictions on dust generating vehicles.

Noise

Construction trafic typically consists of large, heavy vehicles which will generate noise and vibration during the transportation of materials for construction of the landing site (BMH and ducts).

Impact to local residences, restaurants, hotel are not predicted to occur as the increase in noise levels associated with the construction of the landing site will only be small, will be limited to short construction period, and because construction will be take place during day-light hours only.

Mitigation

The project will require contractors to use equipment and vehicles that are in good working order, well maintained, and that have all noise suppression equipment intact and in working order

Contractors will be required to implement best driving practices when approaching and leaving the site to minimize noise emissions

7.5.2.1.3 - Protected area

There are several marine and coastal protected areas within the region including those which are statutorily protected by international and national legislation. One of the several protected areas to the study area is the Baie Ternay marine national park site, which is located 6,5 km south west of Beau Vallon. There are no marine protected areas near the proposed project site.

7.5.2.1.4 - Ramsar site

There are no Ramsar sites near the proposed project site.

7.5.2.2 - Social impact

This is Mahé's most popular resort beach with both visitors and locals alike. This sweeping bay of white sand and clear waters on the north-western coast of Mahé offers a very safe swimming area.

With hotels stretched out along its sand, together with water sport and diving centres, this is the beach for those wishing to do something a little more energetic than soaking up the sun.

Beau Vallon is also very safe for children, as there are no strong currents, no rocks or corals underfoot and a lifeguard service is supplied. During the south-eastern trade winds, the sea is extremely calm and the beach is at its absolute best.

Beau Vallon is a very important zone for recreation not only for the tourists but also for the local community

7.5.2.2.1 - Human health and safety

There is potential for impacts on human health and safety to occur as a result of accidents and unplanned events that may occur during the Project installation activities.

The project activities have the potential to results in a direct and indirect negative impact on human health and safety within the development area and near surrounds.

Extend of the impact is limited to on-site and local. The duration will range from temporary to permanent as some impacts will last only a short while (minor injury) and some may cause a permanent change (mortality related to vehicle or vessel strike).

At particular risk are artisanal fishermen and other vessels (divers, jet ski…) that may move at night-time or in reduced visibility conditions when the Project activities are taking place. Collision of Project vessels with fishing boat and nets or other vessels could results in damage of vessels and equipment, injury or loss of life.

Collision of Project vessels with fishing boats and nets or other vessels could result in damage of vessels and equipment, injury or loss of life. In the terrestrial environment, human health and safety could be impacted through road traffic accidents involving construction vehicles.

In onshore environment, human health and safety could be impacted through road traffic accidents involving construction vehicles. The risk of other injury associated with the construction activities at the landing site will be limited to the work force only (as the site will be secured to avoid public incursion into the active development area), but there is some risk of public injury associated with the installation of the cable between the landing site and CLS as this construction will not be fenced.

Mitigation

- All active construction areas will be marked with high-visibility tape to reduce the risk accidents
- All open trenches and excavated areas will be backfilled as soon as possible after the construction has been completed. Access to open tranches and excavated areas will be secured to prevent pedestrians or vehicle from failing in.
- The project will require all contractors to implement an Environmental, Health and safety plan which will outline procedures for avoiding health and safety incidents and for emergency medical treatment.
- Contractors will be required to wear suitable personnel protective equipment (hard hats, high-visibility vests, safety boots and gloves and life vests)
- All construction and cable repair workers will sufficiently trained in the safe methods of working with fibre optic cables to avoid injury associated with laser lights and fibres.
- While a ship is laying its manoeuvrability is restricted, as such it will display the day signals and lights of a hampered vessel to avoid collision with other vessels at sea.
- Vessels will increase watch when navigating in areas that are kwon to be used by fishermen and other vessels. If other vessels are observed within the near vicinity, the project vessel will stop moving, make contact with the other vessel if possible, and wait until it has been confirmed that the course of both vessels will not result in collision or damage to equipment.
- works have to take place outside of periods of festival periods as much as possible,

Cable survey and installation could cause temporary disruption to the flow of recreational sea use.

However, these operations are limited to short periods of time and other activities can generally avoid the work area without significant diversion.

The project will notify the ports authority and others activities, so that vessels in the area would be warned in advance of the ongoing operations through a “Notice to recreational sea users” report transmitted daily

No impacts to marine activities are thus predicted to occur a result of the project activities.

7.5.2.2.2 - Visual – landscape

The onshore facilities will either be buried in the case of beach man holes and therefore little visual impact is envisaged.

Mitigation

Efforts will be made to minimize visual impacts; land disturbed by cable laying will be contoured to its original form as part of overall reinstatement

7.5.2.2.3 - Odor, Heat and Radiation.

The project will not result in any significant increases in odor, heat or radiation conditions.

7.5.2.2.4 - Transport Infrastructure

There are no formal or regularly used transport networks (eg roads, ferries) within the site area and no major shipping routes will be impacted by the development. No impacts to transport networks and their function are predicted to occur as a result of the development.

7.5.2.2.5 - Education

No negative impacts on education levels or educational facilities are predicted to occur as a result of the proposed development.

7.5.2.2.6 - Fishing

Minor interruptions to fishing operations and fish auctioning are expected to occur only during the cables deployment phase. This disturbance is predicted to be localized to the area in which the activities occur and near surrounds only, and will be short term and progressive in its nature as the activities move along the cable route corridor. Any disturbance to fisheries will be temporary.

7.5.2.2.7 - Mining

Minor interruptions to mining operations are expected to occur only during the cables deployment phase. This disturbance is predicted to be localized to the area in which the activities occur and near surrounds only, and will be short term and progressive in its nature as the activities move along the cable route corridor. Any disturbance to mining will be temporary.

Moreover, the cable route cable has been specially rerouted to avoid crossing the mining area (Figure 43).

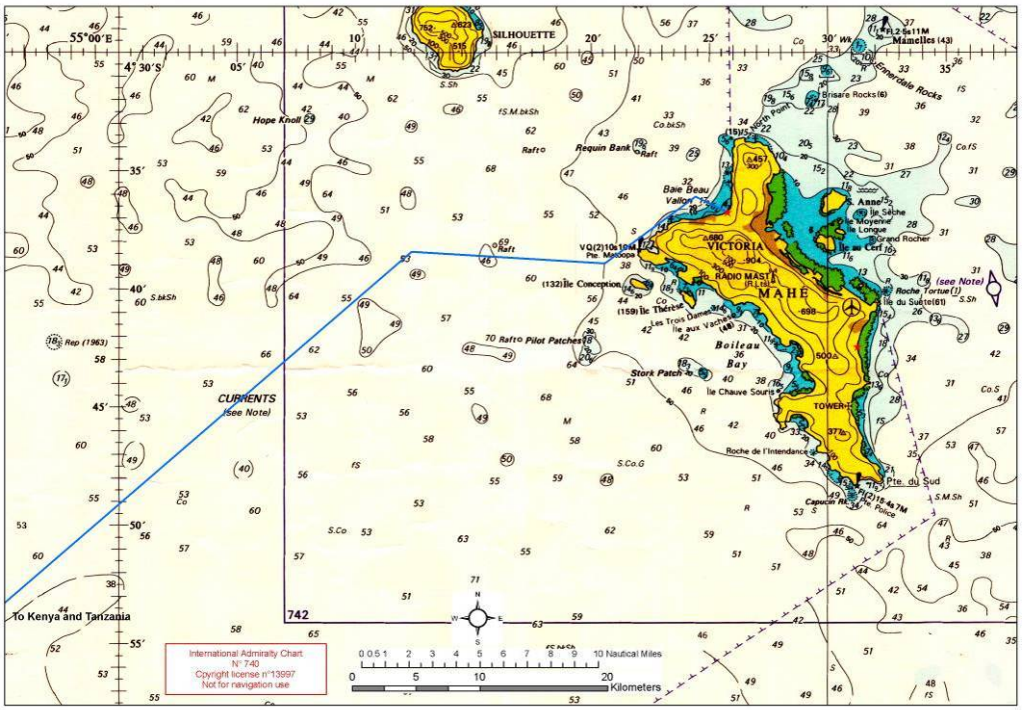


Figure 43. Cable route (rerouted)

7.5.2.2.8 - Cultural Heritage

There are no known sites of significant cultural heritage or archaeological interest in the vicinity of the terrestrial components of the development. The risks to cultural heritage would be to bury resources encountered during excavation on land or by trench ploughing at sea. Coastal wrecks are likely to be the most probable cultural resources within the development area and near vicinity.

7.5.2.2.9 - Landscape and Visual Receptors

There will be small amounts of increased light pollution during the construction period at the BMH as a result of security lighting. There will be no permanent lighting at the beach area.

7.5.2.3 - Potential Cumulative Impacts

The terrestrial areas along the coast are currently under pressure due to development activities. Known development planned or active in the marine environment includes construction of a new hotel between the Coral Strand hotel and restaurant Al mare (in the vicinity of the project).

The impacts associated with the Project are all minor and would not have a significant interaction with the activities associated with the other planned activities in terms of environmental and social impacts.

Positive cumulative impacts on social and economic receptors resulting from the Project and this development are likely to occur during the progressive development of the site facilitated by improved communications infrastructure and broad access.

7.5.3 - Operational Impacts

During operation it is expected that the cable will have no significant negative environmental or social impacts. During the operational phase there will be no routine maintenance of the cable and the cable will have a passive influence on the environment.

7.5.3.1 - Electromagnetic fields

Electromagnetic fields are generated by operational transmission cables. Electric fields increase in strength as voltage increases.

In addition, induced electric fields are generated by the interaction between the magnetic field around a submarine cable and the ambient saltwater.

Magnetic fields are generated by the flow of current and increase in strength as current increases. The strength may reach the multiple of the natural terrestrial magnetic field. In general, HVDC cables produce stronger electromagnetic fields than AC cables.

The World Health Organization has considered the effects on EMF on marine life. It concludes that although all organisms are exposed to the geomagnetic field, marine animals are also exposed to natural electric fields caused by sea currents moving through the geomagnetic field. Electrosensitive fish, such as sharks and rays in oceans, can orient themselves in response to very low electric fields by means of electroreceptive organs.

It acknowledges that some investigators have suggested that human-made Electromagnetic fields from undersea power cables could interfere with the prey sensing or navigational abilities of these animals in the immediate vicinity of the sea cables. However, none of the studies performed, to assess the impact of undersea cables on migratory fish or pelagos and all the relatively immobile fauna inhabiting the sea floor (benthos), have found any substantial behavioural or biological impact.

The potential impact to marine life from electromagnetic fields is considered to be low.

7.5.3.2 - Exposed cables

Cables can become exposed on beaches and in other areas prone to erosion. In addition to the unsightly nature of an exposed cable at low tide, it represents a safety risk to beach users and also substantially increases the risk of cable failure.

For beach crossings the cable is typically installed in flexible steel pipe with an outside diameter in the order of 20 cm and buried in a trench 2 m deep dug previously by equipment such as a backhoe. In the unlikely event of severe erosion resulting in the pipe becoming exposed it will be reburied.

The cable during operations is considered to be minimal and therefore the impact of exposed cables is assessed to be low.

7.5.4 - Decommissioning

It is expected that the cable will be abandoned in place at the end of the Project's lifetime. No impacts are predicted to occur in association with the cable during this stage of the Project.

The cable will continue to have a passive influence on the environment and will be benign, so will not degrade or pollute the environment.

A full decommissioning plan will be developed at the end of the cable's useful life and it will consider best practice at that time. The plan will consider the potential for environmental and social impacts for the decommissioning alternatives.

7.6 - CONCLUSION

The potentials impacts from the project are limited in scope and are mainly associated with the pre-installation and installation phases. Potential impacts during operations and decommissioning are negligible.

This study indicates that there will be no impacts or negligible impacts on the following resources:

- Soils and geology
- Oceanography characteristics
- Hydrology
- Air quality
- Marine biology
- Protected areas
- Landscape and visual receptors
- Noise and vibration receptors
- Traffic
- Social and cultural structure
- Culture heritage

Detailed impact assessment was carried out for three potential impact areas

- Habitats, fauna and flora
- Water quality
- Human activities (recreational, fisheries), health and safety

Table 19. Summary of impacts without mitigation 0 : No impact, 1 : minimal impact, no need for specific mitigation ; 2: low to medium impact, need basic mitigation ; 3 medium to high, need specific mitigation measures and careful monitoring programme to ensure no adverse effects

Potential impact without mitigation			Project stage															
			Onshore				Shallow water						Offshore					
Area of impact	Description	Degree of impact	Construction (BMH)	Cable installation	Operation/Maintenance	Decommisioning	Marine Route Survey (e1cl. vessels)	Route Clearance (e1cl. Vessels)	Submarine cable installation	Vessels (All operations)	Operation/Repairs	Decommissionning	Marine Route Survey (e1cl. vessels)	Route Clearance (e1cl. Vessels)	Submarine cable installation	Vessels (All operations)	Operation/Repairs	Decommissionning
Environment																		
Geology and soils		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrology		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meteorology	Winds, rainfall…	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oceanography	Swell, currents…	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ecology	Terrestrial	Temporary, reversible,direct	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coral reef	Temporary, reversible,indirect	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
	Seagrass bed	Temporary, reversible,indirect	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
	Marine fauna/flora	Temporary, reversible,direct	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
	Marine habitats	Temporary, reversible,direct	0	0	0	0	0	1	1	1	1	0	0	1	1	1	1	0
Protected area/Ramsar		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water quality	Sediment disturbance causing turbidity discharges	Temporary, reversible,indirect	0	0	0	0	0	1	2	1	1	0	0	1	2	1	1	0
	Discharges	Temporary, reversible,indirect	1	1	0	0	0	1	2	1	1	0	0	1	2	1	1	0
	Accidents which cause spills	Temporary, reversible,indirect	0	0	0	0	0	1	2	1	1	0	0	1	2	1	1	0
Waste	Generation of wastes	Temporary, reversible,indirect	1	1	1	0	0	1	1	1	0	0	0	1	1	1	0	0
Air quality (Local)	Dust	Temporary, reversible,indirect	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gazeous emissions	Temporary, reversible,direct	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	0
	Odour	Temporary, reversible,direct	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat/radiation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social																		
Traffic	Impacts on traffic in area	Temporary, reversible,direct	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0
Noise		Temporary, reversible,direct	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Visual Pollution	creation of new building, landsacpe	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cultural and heritage	Impacts to sites of cultural or archeological interest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Human activities	Impacts on fisheries activities	Temporary, reversible,indirect	0	0	0	0	1	1	2	2	1	0	1	1	2	2	1	0
	On tourism - diving sites, recreational activities	Temporary, reversible,indirect	1	1	1	0	1	1	2	2	1	0	1	1	2	2	1	0
	Impact on shipping and anchorage	Temporary, reversible,indirect	0	0	0	0	1	1	2	2	1	0	1	1	2	2	1	0
	Impact on mining activities	Temporary, reversible,indirect	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0
	Impact on dredging/submarine cable/hydrocarbon activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Impact on employment	Positive																

8 - ANALYSIS OF ALTERNATIVES

The analysis of alternatives is a component of the ESIA process. Its purpose is to improve project design, construction and operation decisions based on feasible project alternatives. Early consideration of alternatives during the design phase of a project can result in the avoidance/minimization of impacts without the need for expensive or time consuming mitigation measures at a later stage.

The cable has a small diameter and is designed to be benign in the marine environment. Nevertheless some impacts are likely including:

- Impact to flora and fauna, ecosystems
- Disruption to recreational activities
- Disruption/loss of income to fishing communities
- Construction related nuisance (noise, dust, exclusion areas)
- Environmental and health risks

The impact of others, most notably exclusion areas where fishing and anchoring activity is prohibited, can be minimised if existing corridors (with existing exclusion areas) are used.

During the early stages of Project design an extensive desk top study (DTS) was undertaken to identify a preferred route. Throughout this study environmental issues were considered and potential impacts minimised through selection of the best route. The general philosophy included:

- Use of existing onshore facilities where possible;
- Avoidance of environmental sensitivities (protected areas, sensitive species...);
- Installation of pre fabricated facilities where exiting facilities were unavailable;
- Use of existing corridors (and existing exclusion areas)

For those potential impacts that remain following selection of an optimal route, appropriate mitigation measures are readily available. Where warranted, further consideration of route selection is provided in the country specific EIAs.

9 - ENVIRONMENTAL ENVIRONMENT PLAN AND MONOTORING

In the project impact assessment studies, mitigation measures and best practice have been designed in order to avoid, minimize and reduce negative environmental and social impacts. These measures are reflected in this Environmental Management Plan (EMP) as a set of mitigations measures.

Mitigation measures, when proposed to offset negative impacts are also examined, and whenever necessary, further mitigation is proposed for the efficient protection of environment.

9.1 - PRE-CONSTRUCTION

The phase refers to initial route selection work including the desk top study (DTS) which delineated the cable route, and subsequent onshore/offshore route selection survey work, the marine survey. It therefore includes a number of onshore surveys and the use of vessels and survey equipment. There are no impacts resulting from DTS phase work (selection of the cable route).

9.1.1 - Environmental impacts

Impacts from these survey techniques are all considerate to be low. Impacts and mitigation measures that may results from the operation of survey vessels are described in section.

9.1.2 - Social impact

There no discernible social impact associated with the pre construction phase.

9.2 - CONSTRUCTION

9.2.1 - Environmental impacts

9.2.1.1 - Offshore and shallow water

The pre-laying grapple run

The grapnel will penetrate the seabed to a depth of up to 0.8 meters. Due to the intrusive nature of this operation some negative impact is unavoidable. Impacts include the generation of:

- a small amount of turbidity
- through physical contact mortality or injury to marine organisms, particularly plants and other organisms that have low mobility.

The pre-laying grapple run and cable installation will have some minor physical impact on sea bed geology. This impact will be limited to the area where the cable will be installed only and will vary in intensity depending on the installation method (cable burial in a trench or laying on the seabed).

Cable laying

The laying of cables leads to seabed disturbance and associated impacts of damage, displacement or disturbance of flora and fauna,

- increased turbidity
- release of contaminants
- alteration of sediments.

These effects are mainly restricted to the installation, repair works and/or removal phase and are generally temporary. In addition, their spatial extent is limited to the cable corridor (in the order of 5 m width if the cable has been ploughed into the seabed).

Some mobile benthos is able to avoid disturbance and though sessile species (bivalves, tubeworms etc.) will be impacted.

The cable installation process will only result in short term direct impacts to the subtidal bottom habitats and assemblage present on intertidal area at the Beau Vallon beach landing point. The short term loss of benthic organisms directly along the cable routes is not considerate to represent an unacceptable ecological impact. The rapid natural reinstatement of the seabed will result in the area being available or rapid recolonisation and hence, no permanent impacts are anticipated from cable project.

Raised turbidity and suspended sediment levels can have a number of adverse effects on marine organisms, particularly in areas that would normally have clear waters.

Where suspended sediment concentrations are present for prolonged periods, or are particularly high and widespread, visibility can be reduced affecting the ability of some fish to feed.

Raised turbidity can also reduce light penetration in the water column and reduce photosynthesis/productivity in sea grasses and affecting the coral reef presents in the area (2 fringing reefs).

However the duration, spatial extent and level of suspended sediment associated with route clearance and cable installation in this project are unlikely to cause such problems.

Nevertheless, turbidity levels should be minimized during cable lay operations by minimizing the duration and extent of physical seabed disturbance.

Mitigation

No immediate mitigation known due to temporal nature of impact (less than 24h) would be selected. But this can be achieved using the sea plough burial method in preference to jetting wherever possible. The impact of turbidity generation is assessed as being of low significance.

The Project will implement mitigation measures to reduce the risks of impacts on flora, fauna and marine habitats with particular attention is paid to sensitive marine species including marine mammals and turtles. This will include:

- Marine vessels will be required to adhere to IMO regulations on bilge and ballast water discharge in order to avoid tensional introduction of non-native species to the marine environment

- monitoring for the presence of marine mammals and turtles during marine activities (Contractors will implement a suitable system for spotting marine mammals and turtle whilst pre-installation and installation vessels are at sea. Should these species be observed in the vicinity of the work area, the vessels will execute measures to avoid collision or disturbance. Vessel operators will maintain a distance of 100 m or greater and will travel at 10 knots or less when safety permits until animals are more than 500 m away. Abrupt changes in direction will be avoided

- working with an appropriate environmental organization to develop a notification process;

- Minimizing the impact of lighting at the beach areas.

- Areas of habitat that are temporarily disturbed during cable installation will be restored upon the completion of the installation phase. Areas are disturbed during installation activities will be rehabilitated ASAP after the cable has been installed.

- The Project will ensure that measures are adopted to avoid incursion into areas adjacent to the work site or any secondary effects from pollution, sedimentation, or accidental spills

- The Project will also require that marine vessels have a similarly comprehensive plan for storage and handling of hazardous materials as well as a plan for containment and cleanup of accidental spills into the marine environment

- Vessel crews must report sightings of any injured or dead marine mammals and sea turtles immediately, regardless of whether the injury or death is caused by a Project vessel. The report should include the date and location latitude/longitude) of the animal/strike, the name of the vessel involved, and the species identification or a description of the animal. The report should be made to a designated ecology organisation

- Security lighting will be aimed on the area it is required at an adequate level of illumination only to avoid impacts on sensitive

- fauna. Spillage of illumination outside the direct work area will be avoided.

With appropriate mitigation the significance of impacts on fauna are predicted to be negligible.

Air quality – Vessels operations

Cable laying will require use of dedicated cable lay vessels resulting in a number of general environmental impacts and risks. During normal operational activities vessels emit exhaust gases.

Assuming that the vessels are well maintained, emissions of pollutants will be minimal and within allowable limits.

Mitigation

To minimize air emissions the Project's cable laying vessels will operate in line with the requirements specified under MARPOL 73/78 Annex VI, Prevention of air pollution from ships.

- The Project should require that construction contractors operateonly well maintained engines
- Should considerable dust generation occur during construction, causing plumes of dust in the vicinity of the works and behind
- Construction vehicles, a routine wetting program of all unpaved surfaces including roads and construction areas will be undertaken to ensure sufficient moisture content is maintained to suppress dust generation.
- Construction traffic speed control measures will be enforced on unpaved roads (reduced dust generation levels are often consistent with reduced traffic speeds).
- Operation in line with the requirements specified under MARPOL 73/78 Annex VI

When mitigated by compliance with MARPOL requirements, the impact of vessel operations on air quality is assessed as being of low significance.

The project should require that construction contractors operate only well maintained engines.

Solid waste -Vessels operations

A variety of non hazardous (packaging…) and hazardous (oil wastes, paints…) wastes are typically generated during vessels operations.

Hazardous wastes can clearly have a toxic effect on organisms and can in some circumstances lead to bioaccumulation and ultimately lethal or sub lethal affects if badly managed. In addition, some non hazardous waste types can be equally harmful, particularly non degradable plastics that can remain at sea for many years posing an entanglement risk to sea birds and marine life.

Annex V of MARPOL prohibits the disposal to sea of any plastics whilst restricting the discharge of other non hazardous waste in coastal waters and in designated “Special Areas”.

Hazardous waste should be stored on board the vessel until it can be disposed at a suitably equipped port, respecting the requirements of the Basel Convention on Transboundary Shipment of Hazardous Wastes.

Mitigation

Waste management is required to avoid the risk of harm to the environment and human health.

When mitigated by compliance with MARPOL requirements, the impact of solid waste in vessel operations is assessed as being of low significance.

Aqueous Discharges - Vessels operations

Planned aqueous discharges can include sewage water, grey waters (discharge from showers and sinks) and potentially contaminated drainage from the ship deck. Sewage and grey waters can have high bacteria levels, surfactants and a high Biological Oxygen Demand (BOD5), all which can result in potential human health issues and harm to marine organisms, particularly in sensitive areas or locations with poor mixing and dilution potential.

These wastewaters should therefore be managed in accordance with applicable international regulations and guidance, including the requirements of MARPOL 73/78, Annex IV (sewage).

MARPOL, Annex 1 also addresses discharge of oily waters, for example bilge waters. For ships of 400 gross tonnage and above, for control of oil from machinery spaces, waste water must have an oil concentration below 15ppm without any prior dilution. More specifically:

Within special areas – discharges are prohibited, except when the ship is proceeding en route, and the oil content of the effluent without dilution does not exceed 15 ppm, and the ship has in operation oil filtering equipment with automatic 15 ppm stopping device.

Outside special areas - discharges are prohibited, except when the ship is proceeding en route, the oil content of the processed bilge water (from machinery spaces) effluent is less than 15 ppm, and the ship has in operation an oil discharge monitoring and control systems, oily-water separating or filtering equipment

Mitigation

When mitigated by compliance with MARPOL requirements and the impact of aqueous discharges (excluding ballast waters) in vessel operations is assessed as being of low significance.

Ballast water management - Vessels operations

It is possible that invasive (predominantly non-native) species may be unintentionally introduced. This has a potential impact habitats and fauna and flora if invasive species become highly aggressive, outcompeting native species and altering the structure and community composition of marine ecosystems.

Mitigation

Marine vessels will be required to adhere to International Maritime organization (IMO) regulations on bilge and ballast water discharge in order to avoid unintentional introduction of non-native species to the marine environment.

9.2.1.2 - Onshore

At the landing location there will be a small amount of construction work and environmental impact associated with the cable installation and construction of the onshore facilities. Much of this impact will be typical of general construction activity, resulting in short term waste generation and nuisance impacts (Noise, air quality...).

Cable laying, construction of BMH

In the terrestrial environment small amounts of soil will be disturbed during the excavation of the cable trench and during construction of the BMH.

The extent of the impact is limited to on-site and local. The duration will range from temporary to permanent as some impacts will last only a short while (effects of disturbance during construction) and some will cause a permanent change (habitat removal). Although the habitat type and flora species present are predominantly common and widespread, the magnitude of the change will be low as some natural processes will be affected as a result of small amounts of habitat loss, degradation or disturbance. The impact significance pre-mitigation is minor.

Mitigation

The Project will implement mitigation measures to minimize the extent of the impact to the terrestrial environment and to restore areas that are disturbed. This will include:

- limiting clearing and restoring areas of disturbance;
- using controls to prevent incursion into adjacent areas;
- implementing a hazardous materials management plan;
- to prevent habitat alteration the reinstatement of trench material would be advised. Where possible and appropriate, top soil will be segregated and replaced on other back fill material to promote regeneration of vegetation.

All soil that is disturbed during trench digging will be restored to approximate original depths as the trenches are backfilled.

Waste

Construction wastes will be generated during onshore construction. Overall these are expected to be relatively small quantities although they may include some hazardous waste (oily rags, spent fuel cans, batteries etc.).

If a good waste management plan is planned, the impact of onshore waste is as being of low significance.

Mitigation

Waste management is required to avoid the risk of harm to the environment and human health.

Air quality

The local air quality in the close proximity of onshore construction activities will be affected by emissions from mobile (construction vehicles) and stationary machinery (portable generators).

Mitigation

Assuming that the engines are well maintained, emissions of pollutants will be minimal and within allowable limits.

Dust

There is potential some dust generation during the construction at the shore crossing BMH and ducts. Dust is most likely to be generated during the transportation of materials on unpaved roads and during trench digging and soil movement.

Increased levels of dust in the air have the potential to impact environment (flora, communities) and social resources. However, the construction (BMH and ducts) period will be very short (approximately 3 weeks); any dust would be limited to the construction area, access route and very near surrounds only. Dust related impacts largely reversible within a short timescale. Therefore, no impacts are predicted to occur as a result of increased dust.

Mitigation

Dust suppression techniques, such as increasing the moisture content of excavated materials and roadways by applying water or non toxic chemicals, can be used to reduce the amount of dust in the air, particularly where construction activities are taking place in close proximity to dust sensitive receptors e.g. residential/commercial areas. Other dust management measures include speed restrictions on dust generating vehicles.

Noise

Construction trafic typically consists of large, heavy vehicles which will generate noise and vibration during the transportation of materials for construction of the landing site (BMH and ducts).

Impact to local residences, restaurants, hotel are not predicted to occur as the increase in noise levels associated with the construction of the landing site will only be small, will be limited to short construction period, and because construction will be take place during day-light hours only.

Mitigation

The project will require contractors to use equipment and vehicles that are in good working order, well maintained, and that have all noise suppression equipment intact and in working order

Contractors will be required to implement best driving practices when approaching and leaving the site to minimize noise emissions

Protected area

There are several marine and coastal protected areas within the region including those which are statutorily protected by international and national legislation. One of the several protected areas to the study area is the Baie Ternay marine national park site, which is located 6,5 km south west of Beau Vallon. There are no marine protected areas near the proposed project site.

Ramsar site

There are no Ramsar sites near the proposed project site.

9.2.2 - Social impact

This is Mahé's most popular resort beach with both visitors and locals alike. This sweeping bay of white sand and clear waters on the north-western coast of Mahé offers a very safe swimming area.

With hotels stretched out along its sand, together with water sport and diving centres, this is the beach for those wishing to do something a little more energetic than soaking up the sun.

Beau Vallon is also very safe for children, as there are no strong currents, no rocks or corals underfoot and a lifeguard service is supplied. During the south-eastern trade winds, the sea is extremely calm and the beach is at its absolute best.

Beau Vallon is a very important zone for recreation not only for the tourists but also for the local community

Human health and safety

There is potential for impacts on human health and safety to occur as a result of accidents and unplanned events that may occur during the Project installation activities.

The project activities have the potential to results in a direct and indirect negative impact on human health and safety within the development area and near surrounds.

Extend of the impact is limited to on-site and local. The duration will range from temporary to permanent as some impacts will last only a short while (minor injury) and some may cause a permanent change (mortality related to vehicle or vessel strike).

At particular risk are artisanal fishermen and other vessels (divers, jet ski…) that may move at night-time or in reduced visibility conditions when the Project activities are taking place. Collision of Project vessels with fishing boat and nets or other vessels could results in damage of vessels and equipment, injury or loss of life.

Collision of Project vessels with fishing boats and nets or other vessels could result in damage of vessels and equipment, injury or loss of life. In the terrestrial environment, human health and safety could be impacted through road traffic accidents involving construction vehicles.

In onshore environment, human health and safety could be impacted through road traffic accidents involving construction vehicles. The risk of other injury associated with the construction activities at the landing site will be limited to the work force only (as the site will be secured to avoid public incursion into the active development area), but there is some risk of public injury associated with the installation of the cable between the landing site and CLS as this construction will not be fenced.

Mitigation

All active construction areas will be marked with high-visibility tape to reduce the risk accidents:

- All open trenches and excavated areas will be backfilled as soon as possible after the construction has been completed. Access to open tranches and excavated areas will be secured to prevent pedestrians or vehicle from failing in.
- The project will require all contractors to implement an Environmental, Health and safety plan which will outline procedures for avoiding health and safety incidents and for emergency medical treatment.
- Contractors will be required to wear suitable personnel protective equipment (hard hats, high-visibility vests, safety boots and gloves and life vests)
- All construction and cable repair workers will sufficiently trained in the safe methods of working with fibre optic cables to avoid injury associated with laser lights and fibres.
- While a ship is laying its manoeuvrability is restricted, as such it will display the day signals and lights of a hampered vessel to avoid collision with other vessels at sea.
- Vessels will increase watch when navigating in areas that are kwon to be used by fishermen and other vessels. If other vessels are observed within the near vicinity, the project vessel will stop moving, make contact with the other vessel if possible, and wait until it has been confirmed that the course of both vessels will not result in collision or damage to equipment.
- works have to take place outside of periods of festival periods as much as possible,

Cable survey and installation could cause temporary disruption to the flow of recreational sea use.

However, these operations are limited to short periods of time and other activities can generally avoid the work area without significant diversion.

The project will notify the ports authority and others activities, so that vessels in the area would be warned in advance of the ongoing operations through a “Notice to recreational sea users” report transmitted daily

No impacts to marine activities are thus predicted to occur a result of the project activities.

Visual – landscape

The onshore facilities will either be buried in the case of beach man holes and therefore little visual impact is envisaged.

Mitigation

Efforts will be made to minimize visual impacts; land disturbed by cable laying will be contoured to its original form as part of overall reinstatement

Odor, Heat and Radiation.

The project will not result in any significant increases in odor, heat or radiation conditions.

Mitigation

Not specific mitigation require

Transport Infrastructure

There are no formal or regularly used transport networks (eg roads, ferries) within the site area and no major shipping routes will be impacted by the development. No impacts to transport networks and their function are predicted to occur as a result of the development.

Education

No negative impacts on education levels or educational facilities are predicted to occur as a result of the proposed development.

Mitigation

Not specific mitigation require

Fishing

Minor interruptions to fishing operations and fish auctioning are expected to occur only during the cables deployment phase. This disturbance is predicted to be localized to the area in which the activities occur and near surrounds only, and will be short term and progressive in its nature as the activities move along the cable route corridor. Any disturbance to fisheries will be temporary.

Mining

Minor interruptions to mining operations are expected to occur only during the cables deployment phase. This disturbance is predicted to be localized to the area in which the activities occur and near surrounds only, and will be short term and progressive in its nature as the activities move along the cable route corridor. Any disturbance to mining will be temporary.

Moreover, the cable route cable has been specially rerouted to avoid crossing the mining area (**Figure 42**).

Cultural Heritage

There are no known sites of significant cultural heritage or archaeological interest in the vicinity of the terrestrial components of the development. The risks to cultural heritage would be to bury resources encountered during excavation on land or by trench ploughing at sea. Coastal wrecks are likely to be the most probable cultural resources within the development area and near vicinity.

Landscape and Visual Receptors

There will be small amounts of increased light pollution during the construction period at the BMH as a result of security lighting. There will be no permanent lighting at the beach area.

9.3 - SYNTHESIS

Potential impacts were determined to be moderate or minor (localized short time scale...). Following application or mitigation measures the impacts for these areas was determinate to be negligible (tables 21 and 22).

Table 20. Environnemental management plan actions

Impact	Scope for Mitigation	Monitoring/ Implementation	Responsability
Environment			
Geology, soils, Hydrology, Meterology, Oceanography	not specific mitigation require		Contractors
Terrestrial	Limiting clearing and restoring areas of disturbance Controls to prevent incursion into adjacent areas Top soil will be segregated and laced on other back fill material to promote regeneration of vegetation. All soil that is disturbed during trench digging will be restored to approximate original depths as the trenches are backfilled	Hazardous materials management plan Construction site management plan	Contractors
Marine fauna/flora, Habitats	Marine vessels will be required to adhere to IMO regulations on bilge and ballast water discharge in order to avoid tentional introduction of non-native species to the marine environment Areas of habitat that are temporarily disturbed during cable installation will be restored upon the completion of the installation phase. Areas are disturbed during installation activities will be rehabilitated ASAP after the cable has been installed. The Project will ensure that measures are adopted to avoid incursion into areas adjacent to the work site or any secondary affects from pollution, sedimentation, or accidental spills The Project will also require that marine vessels have a similarly comprehensive plan for storage and handling of hazardous materials as well as a plan for containment and cleanup of accidental spills into the marine environment Contractors will implement a suitable system for spotting marine mammals and turtle whilst pre-installation and installation vessels are at sea. Should these species be observed in the vicinity of the work area, the vessels will execute measures to avoid collision or disturbance. Vessel operators will maintain a distance of 100 m or greater and will travel at 10 knots or less when safety permits until animals are more than 500 m away. Abrupt changes in direction will be avoided Vessel crews must report sightings of any injured or dead marine mammals and sea turtles immediately, regardless of whether the injury or death is caused by a Project vessel. The report should include the date and location latitude/longitude) of the animal/strike, the name of the vessel involved, and the species identification or a description of the animal. The report should be made to a designated ecology organisation Security lighting will be aimed on the area it is required at an adequate level of illumination only to avoid impacts on sensitive fauna. Spillage of illumination outside the direct work area will be avoided.	Construction site management plan Hazardous Materials Management Plan Marine Logistics Plan Waste Management Plan Marine Fauna Protection Procedure Daily fauna observation report Lighting plan	Contractors
Protected area/Ramsar	not specific mitigation require	Construction site management plan	
Water quality	Marine vessels will be required to comply fully with the requirements of the MARPOL Protocol (1978) at all times Marine vessel anchors will not be dragged along the seabed and they will be retrieved vertically to avoid unnecessary sediment disturbance The maximum speed of the cable laying will not exceed 5 knots per hour so that the amount of seabed sediment disturbed anddispersed during the cable laying process can be kept to a minimum	Marine logistic plan	
Waste	Waste management is required to avoid the risk of harm to the environment and human health.	Waste mangement plan	
Air quality (Local)	The Project should require that construction contractors operateonly well maintained engines Should considerable dust generation occur during construction, causing plumes of dust in the vicinity of the works and behind construction vehicles, a routine wetting program of all unpaved surfaces including roads and construction areas will be undertaken to ensure sufficient moisture content is maintained to suppress dust generation. Construction traffic speed control measures will be enforced on unpaved roads (reduced dust generation levels are often consistent with reduced traffic speeds). Operation in line with the requirements specified under MARPOL 73/78 Annex VI	Dust management measures Vehicle maintenance records Placement of traffic signs indicating the speed limit along the route used by construction vehicles Construction Site Management Plan	Contractors
Heat/radiation	not specific mitigation require		

Table 21. Environmental and Social management plan actions

Social			
Traffic	Make contact with the other vessel to avoid collision or damage to equipment Vessels will increase watch when navigating in areas that are kwon to be used by fishermen and other vessels Make contact with the other vessel	Construction Site Management Plan	Contractors
Noise	Use equipment and vehicles in good working order, well maintained The Project will require contractors to use equipment and vehicles that are in good working order, well maintained, and that have all noise suppression equipment (mufflers, noise baffles) intact and in working order	Best driving practices Vehicle maintenance records	Contractors
Visual Pollution	Efforts will be made to minimize visual impacts; land disturbed by cable laying will be contoured to its original form as part of overall reinstatement		
Cultural and heritage	not specific mitigation require		
Human activities (fisheries activities, On tourism - diving sites, recreational activities...)	Contractors will be required to wear suitable Personal Protective Equipment including hard hats, high-visibility vests, safety boots and gloves and life vests as appropriate in accordance with theEHS plan All construction and cable repair workers will be sufficiently trained in the safe methods of working with fiber optic cables to avoid injury associated with laser lights and fibers All open trenches and excavated areas will be backfilled as soon as possible after the construction has been completed. Access to open trenches and excavated areas will be secured to prevent pedestrians or vehicles from falling in Vessels will increase watch when navigating in areas that are known to be used by fishermen and other vessels. If other vessels are observed within the near vicinity, the Project vessel will stop moving, make contact with the other vessel if possible, and wait until it has been confirmed that the course of both vessels will not result in collision or damage to equipment While a ship is laying cable its manoeuvrability is restricted, as such it will display the day signals and lights of a hampered vessel to avoid collision with other vessels at sea. Trenches and excavated areas will be backfilled ASAP Require to wear suitable personnel protective equipment Require day signals and lights of a hampered vessel to avoid collision with other vessels at sea	Environmental, Health and Safety Plan Health and safety training and training records Health and safety incident register Marine Logistics Plan	Contractors

Globally, project activities are expected to have no effect on the environmental or social environment. This is mainly a result of the benign nature of the Project and the associated activities as well as the result of the integration of preventative measures into the project design.

The environmental assessment does indicate some potential for limited environmental and social impacts to habitats and flora; fauna; water quality; and human health and safety. The potential is reduced through the implementation of standard mitigation measures and industry best practices, none of which are excessive in cost.

Given the low potential for negative impacts and the high potential for significant positive benefits (both direct and indirect), the Project would be deemed to have a high level of environmental and social acceptability.

10 - REFERENCES

Alfred Wegener (1924) The Origin of Continents and Oceans, 212 pp., Methuen, New York

Allan, PG. 2001 Hydrographic Information and the Submarine Cable Industry Hydro 2001, Norwich,

Emu Ltd. (2004). Subsea Cable Decommissioning – A Limited Environmental Appraisal. Report commissioned by British Telecommunications plc, Cable & Wireless and AT&T, Report no. 04/J/01/06/0648/0415, available from UKCPC

GAINA C., R. D. MÜLLER, B. J. BROWN, and T. ISHIHARA (2002). Microcontinent formation around Australia. Geological Society of America.

Plummer, P. S., and E. R. Belle (1995), Mesozoic tectono–stratigraphic evolution of the Seychelles microcontinent, Sedimentary Geology, 96, 73–91.

Schlich, R. (1982), The Indian Ocean: aseismic ridges, spreading centres and basins, in The Ocean Basins and Margins, Vol 6. The Indian Ocean, pp. 51–147, Plenum, New York.

Duncan, R. A., and D. G. Pyle (1988), Rapid eruption of the Deccan flood basalts at the Cretaceous/Tertiary boundary, Nature, 333, 841–843.

Alusa, A.L. and Ogallo, L. 1992. Implications of expected climate change in the Eastern African coastal region Ð An overview. UNEP Regional Seas Reports and Studies No. 149. UNEP, Nairobi.

Mathu,E.M. & Davies,T.C. (1996): Geology and the environment in Kenya. Journal of African Earth Sciences

Intergovernmental Oceanographic Commission 1994, Workshop Report No. 96 - Supplement 1 IOC-UNEP-WMO-SAREC Planning Workshop on An Integrated Approach to Coastal Erosion, Sea Level Changes and Their Impacts

Spalding, M. D., Ravilious, C., & Green, E. P., (2001) (eds.) *World atlas of coral reefs*. University of California Press, Berkeley, USA. 424 p.

Stoddart, D. R. (1984). Coral reefs of the Seychelles and adjacent regions. In: *Biogeography and ecology of the Seychelles islands* (ed. D.R. Stoddart), pp. 63-81. The Hague: Dr W Junk.

Obura D.O. (ed) 2002. Proceedin*gs of the International Coral Reef Initiative (ICRI) Regional Workshop for the Indian Ocean, 2001*. ICRI/UNEP/ICRAN/CORDIO. Nunn P.N., 1994, Oceanic islands. Blackwell Publishers, Cambridge, 413 p.

Ochieng, C., Erftemeijer, P.L.A. 2001 The status of seagrass ecosystems in Kenya and Tanzania. Draft paper submitted to the UNEP-WCMC Global Seagrass Workshop, St Pete's Beach, Florida, 5-9 November, 2001. Unpublished.

Ochieng, C.A., Erftemeijer, P.L.A. 2003. Seagrasses of Kenya and Tanzania. *In*: Green, E.P. and Short, F.T. (eds.) *World Atlas of Seagrasses*. WCMC. p. 82-92

Sharkbite on the SL Submarine Lightwave Cable System: history, Causes and Resolution. IEEEE Journal of Oceanic Engineering, Vol 14, No 3 July 1989.

Alusa, A.L.; *Ogallo, L.J.* (1992), Implications of Expected Climate Change in the Eastern African Coastal Region: an Overview , Published in: *UNEP Regional Seas Reports and Studies No. 149, 19 pp.*

Cazes-Duvat, V., 1999. Les littoraux des îles Seychelles. Ed. L'Harmattan, 157 pages.

Cazes-Duvat, V., 2001.Atlas de l'environnement côtier des îles granitiques de l'archipel des Seychelles. ISBN : 2-87614-467-0, 88 pages.

Cutler A. N., and J. C. Swallow, 1984. Surface currents of the Indian Ocean: compiled from historical data achieved by the Meteorological Office, Bracknell, UK, Institute of Oceanic Sciences, report n°187, 8 pages & 36 charts.

Evans, G.S. (1999) Planning for Route Security – The Essential Ingredients, IBC Submarine Communications, Cannes.

Grandcourt, E. M., 1995. Coastal Profile of Beau Vallon. Technical Report of the Seychelles Fishing Authority, 72 pages.

Meteo-France, 1992. Cyclones tropicaux du sud-ouest de l'Océan Indien. Publ. Serv. Meteo. de La Réunion, 479 pages.

Piton B., 1976. Particularités météorologiques et océaniques des parages du Banc des Seychelles (Océan Indien). Cah. ORSTOM, série Océanogr., vol. XIV, n° 4, p. 289-299.

United Nations of Environmental Programme, 2007. *Kenya - State of the Coast Report 2007*, 108 pages.

United Nations of Environmental Programme, 2001. *Eastern Africa Atlas of Coastal Ressources - Tanzania*, 117 pages.

United Nations of Environmental Programme, 1998. *Eastern Africa Atlas of Coastal Ressources - Kenya*, 135 pages.

Wakwabi, E. O., and V. Jaccarini, 1993. The distribution and abundance of planktonic penaid larvae in Tudor creek, Mombasa, Kenya. Hydrobiologia **264**: 185-192.

Seychelles Fishing Authority 2005, Annual reports, 83 p.