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8 Assessment of social and environmental impacts

8.1 Introduction

This section provides an assessment of the social and environmental impacts associated with the proposed coal fired power plant. For each impact, the assessment has been conducted pre-mitigation and post mitigation using the methodology described in Section 7 of this report.

Potential social and environmental impacts identified for the proposed coal fired power plant are listed below. The process of identifying the potential social and environmental impacts included the following:

1. Secondary literature review by each environmental and social specialist that was part of the ESIA team;
2. Field surveys which included collection of baseline information, interviews with the local communities living in and around the project environs;
3. Inputs by various specialists associated with the ESIA Study.

Based on the above, the Consultant identified the following aspects and impacts for assessment:

Table 8-1 Aspects and impacts assessed for the project

Aspect	Impacts assessed
Air quality	• Atmospheric emissions during the construction phase; • Air emissions during the operational phase
Noise	• Noise from construction related activities • Noise from operational phase activities
Thermal effluent	• Discharge of once-through cooling water
Climate change	• Environmental impacts of climate change • Greenhouse gas risks
Waste management	• Construction site waste management • Construction phase off-site waste management • Operational phase waste management
Water resources	• Improper management of wastewater • Contamination of groundwater
Soils and geology	• Soil erosion impacts
Biodiversity	• Impacts on terrestrial flora • Impacts on terrestrial fauna • Impacts on marine ecology
Landscape and visual	• Visual impacts of power plant

Aspect	Impacts assessed
Socio-economic	• Creation of direct, indirect and induced employment • Economic growth • Capacity building • Land acquisition and involuntary resettlement • Disruption and loss of livelihoods • Disruption of the social fabric • Strain on existing infrastructure and social amenities • Change in cultural heritage
Health and safety	• Impact on community health and safety • Occupational health and safety concerns
Cultural heritage	• Impacts associated with WHS OUV • Impacts on archaeology • Loss of plants of cultural value • Impacts on graves

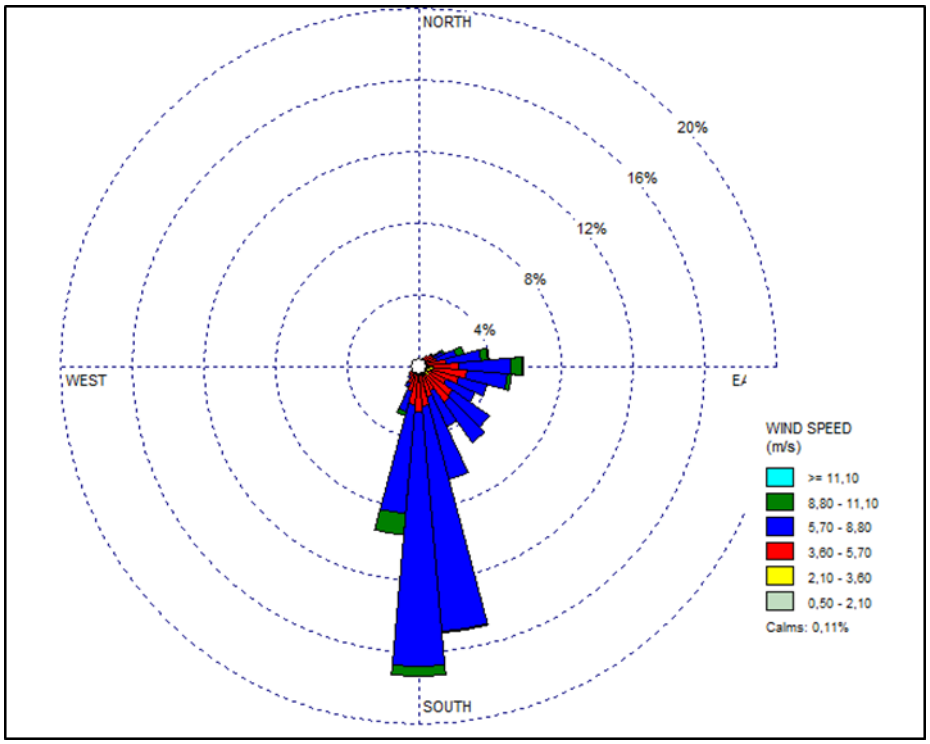
The above impacts are addressed in the remainder of this section.

8.2 Air quality

Section 5.6 of the ESIA Study and tables 5-4 to 5-6 show the results of the ambient air quality survey that was undertaken for the proposed Lamu coal fired power plant. These results were used to undertake a comprehensive air dispersion modeling study for the construction and operational phases of the project. Given in the following sections are the results of the modeling study for the construction and operational phases of the project respectively, potential air quality impacts, mitigation measures and residual impacts.

The prevailing wind directions within the general project area are from the south and easterly regions. Wind directions from the other sectors occur relatively infrequently. The wind rose for the project site is presented in figure 8-1 below.

Figure 8-1 : Wind Rose for the Project Site (2009-2013)



8.2.1 Atmospheric emissions during the construction phase

Without mitigation measures, the construction of the proposed coal power plant may have potential negative impacts on the ambient air quality of the local area.

It is anticipated that the most significant components of such emissions, from an environmental perspective, will be combustion (exhaust) gases and particulate matter associated with site clearance and the operation of earth moving equipment.

The following equipment or activities will lead to atmospheric emissions during construction:

a) Earthmoving operations (associated with land clearing and site preparation);

b) Construction and delivery vehicle emissions (diesel powered equipment, cranes, excavators, barges and ships);

c) Cement batching operations; and

d) Power generation at the worker camps, laydown areas and the Project site.

The effect of early construction activities such as ground breaking, earth moving, levelling, excavation, foundation work, using sand and cement for building, movement of vehicles and trucks, is considered temporary and adverse.

Similarly, the impacts of emissions from traffic related to construction activities are considered temporary and negative.

The effect of emissions from volatile hazardous materials (oils, solvents) stored on site is also considered temporary and adverse, because the quantities of such materials are relatively small.

Given the absence of paved roads on the proposed site, emissions from vehicles transporting materials onto the site during construction phase have temporary and negative effects.

Table 8-2 summarises the estimated emissions from construction plant and vehicles involved the construction phase activities of the Project.

Table 8-2 Estimated emission quantities fro mconstruction plant and equipment

Pollutant	Emission Quantity (tons)/Peak Year
CO	356
CO_2	109,305
NO_x	764
SO_2	78
PM_{10}	716

The impact significance for the construction phase is assessed based on dust and gaseous emissions from the construction plant and equipment.

Table 8-3: Impact significance for air emissions from construction activities-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Moderate	Probable
	2	2	6	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should develop and implement a Construction Environment Management Plan (with reference to the management of air quality during the construction phase) once detailed information relating to the construction methodology and schedule is available (prior to commencement); • The EPC contractor should compact access roads from the entrance to the site and spray with water to minimize the dust generated from the vehicles and trucks; • The EPC contractor should ensure that deliveries of equipment/plant to the site are efficiently managed to reduce the number of trips; • The EPC contractor should consider minimization of ground-works when high winds are present; • The EPC contractor should undertake land grading, improvement or moving of materials during periods of low winds. • Large sand piles should be avoided where possible, with dust suppression sprays being utilized on any piles during periods where the wind speed exceeds 15km/h.			

	• A visual assessment of dust emissions should be undertaken by the EPC contractor on a regular basis. • Designated roads should be made clear to the drivers and signs for the directions and speed limit will be placed all along the roads. • Where sand and other dusty material (e.g. cement) is transported to the site, trucks will not be overloaded and will be appropriately covered / sheeted to eliminate the contamination to the air. • Sand and other materials will be stored in specific designated areas and will be properly stored at the site and will be water-sprayed or covered. • Exhaust fumes and particulates emitted from trucks and vehicles should be minimised by assuring the use of good condition vehicles. These will be tested to ensure the compliance with local standards. • Lorries and trucks engines should be turned off while waiting on site to minimise the exhaust emissions. • Dusty materials stockpiles and dusty activities such as stone cutting and grinding to be sited away from the site boundaries and/or effectively screened. • Fires and material burning will not be allowed on the Project site. • Hazardous materials stored and used on site with potential gas emissions (e.g. VOCs) will be located in well-ventilated secure areas away from major transport routes.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			

8.2.2 Atmospheric emissions during the operational phase

Key emission sources during the operational phase of the project include the SO_x, NO_x, PM_{10} and $PM_{2.5}$ emanating from stationary and mobile sources. The stationary sources include the main boilers, auxiliary boiler and black-start generators; the mobile sources include fugitive emissions from (i) materials handling and transfer, (ii) heavy duty vehicles, (iii) stockpile loading and unloading, (iv) wind erosion, (v) paved roads, and (vi) unpaved roads.

The air quality impacts of the proposed coal power plant have been assessed using baseline information gathered through desk and field studies, analysis of the information provided by the EPC contractor and advanced air modelling using preliminary design and technical information. The stack heights have been determined based on Good International Industry Practice to avoid excessive ground level concentrations and minimize impacts.

The specifications of the coal that can be utilized in the proposed Lamu coal fired power plant are given in Table 8-4 below.

Table 8-4: Coal fuel specifications

Parameter	Imported Coal (S. Africa)		Kenyan Coal
	Eskom	New Vaal	
Calorific Value (MJ/kg) Lower Heating Value	21	16	18
Total Organic Carbon (%)	44	36	55
Sulphur Content (%)	1	0.5	2.4
Plant Coal Consumption (tonnes / day)	10,685	14,248	12,600

During the operation of the power plant, a number of activities and plant equipment will result in air emissions which have the potential to impact upon the ambient air quality within the coal power plant and surrounding areas. In order to adequately assess the potential impacts to the air environment during the operational phase of the proposed plant, it is therefore necessary to undertake predictive air dispersion modelling. The following aspects are considered:

- Emission characteristics from the power plant; the air dispersion model is run to estimate the stack emission impact. The purpose is to determine the permissible environmental limits to satisfy at source environmental and ground concentration.
- This study determines the requirements for the sea water scrubbing FGD system with SO_X removal capacity from coal having a sulfur content of 0.5 – 1%.

In order to estimate ground level concentrations for each study pollutant, an atmospheric dispersion modelling study was undertaken using the US EPA preferred CALPUFF and AERMOD dispersion models. Four scenarios were defined for purposes of modelling as shown below.

Table 8-5: Air dispersion modeling scenarios

Scenario	Description	Normal or Abnormal Operation	Duration	US EPA Model Used	Pollutants Considered
Scenario 1	Normal Operations of the Lamu Power Station including the three main boilers operating at 100% load	Normal	Continuous	CALPUFF	NO_2, SO_2, PM_{10}, $PM_{2.5}$, mercury
Scenario 2	Fugitive dust from coal and ash handling and storage activities including dust mitigation controls (including emissions from three main boilers)	Normal	Continuous	AERMOD	PM_{10} and $PM_{2.5}$*

Scenario	Description	Normal or Abnormal Operation	Duration	US EPA Model Used	Pollutants Considered
Scenario 3	Total suspended particulates (TSP) fallout for selected metals as a result of fugitive dust from ash operations	Normal	Continuous	AERMOD	Selected metals (arsenic, cadmium, nickel, lead and mercury)
Scenario 4	Black Start of Power Station	Emergency	Less than 5% of the year	CALPUFF	NO_2 and SO_2

During operation of power plant, the main source of air pollution comes from combustion of coal in the boilers. In the proposed project, imported coal will be used as primary fuel to generate electricity, however the generating units are designed to be able to use coal from a variety of sources including Kenya; additionally, light distillate oil (LDO) will be used for start-up or emergency purposes if Kenya Power is unable to supply the power needed for start-up.

The air emission impacts associated with the operation of the power plant are permanent and of adverse significance without any mitigation measures. These effects are associated with SO_2, NO_x and PM emissions in absence or failure of adequate pollution control equipment.

Table 8-6: Impact significance for air emissions from power plant-operational phase

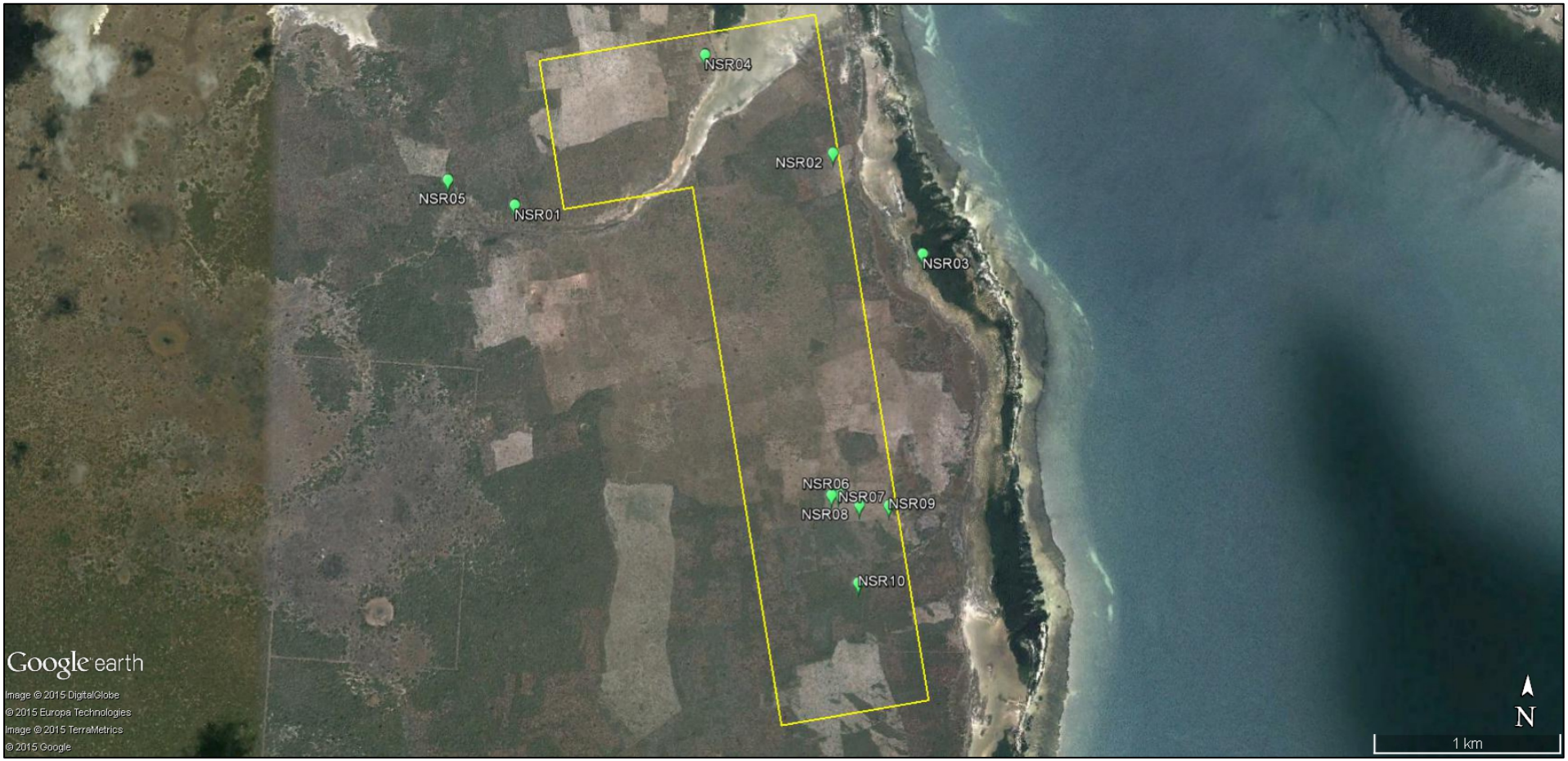
Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Long term	Moderate	Highly probable
	3	4	6	4
	Result: (-52) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor shall install a wet flue gas desulfurization (FGD) system to remove sulfur dioxide from the flue gas before the flue gas is emitted to the environment. One FGD plant of the seawater type shall be installed for each unit. The FGD system shall be designed to meet the SO_2 emission limits recommended by the International Finance Corporation (IFC) EHS Guidelines for Thermal Power Plants of 2008. • The EPC contractor shall use low NO_x burners to reduce the nitrous oxide emissions before the flue gas is discharged to the atmosphere. The nitrous oxide emissions will be required to meet the limits recommended under the IFC EHS Guidelines for Thermal Power Plants of 2008. • The EPC contractor shall design and install an electrostatic precipitator (ESP) for the power plant. The ESP shall be installed upstream of the FGD/chimney and downstream of the air heaters in			

	order to meet the environmental emission limits regulated by IFC EHS Guidelines for Thermal Power Plants of 2008. • The EPC contractor shall install a continuous emission monitoring system (CEMS) mounted within the stack. The CEMS will be capable of continuously monitoring the NO_x, SO_x, CO_2, and PM_{10}, emissions to ensure compliant conditions are maintained through appropriate process controls. In addition, the monitoring of other stack parameters such as oxygen, carbon monoxide and temperature will also ensure that the plant is operated efficiently to maintain compliance with the specified air emission standards and ambient air quality standards; • The O&M Company will ensure compliance with the requirements of air quality in accordance with L.N. 34: Air Quality Regulations, 2014 and project air quality standards • Stack monitoring data collected during commissioning and the subsequent 25-year operation period will be reported to NEMA on an annual basis as part of the statutory environmental audit and will be subject to inspection by external environmental auditors to verify the performance and compliance status; • Fugitive emissions from the coal power plant site during operation will be controlled by an inspection and maintenance program that will be detailed in alignment with an Environmental Management System (equivalent to ISO 14001) that will be developed at the start of operations and maintained throughout the 25 year plant operational period. • Regular maintenance of plant at the proposed facility will also be carried out in order to optimize and minimize emissions.				
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**	
With mitigation	Regional	Long term	Minor	Improbable	
	3	4	2	2	
	Result: (-18) Low negative				

8.3 Noise

Noise sensitive receptors were identified during the screening and scoping phase of this ESIA Study. A total of 10 noise sensitive receptors (NSRs) were identified for the construction and operational phase noise assessment. NSRs 1 – 5 are existing receptors within the project area and its immediate environs; NSRs 6 – 10 are new receptors all located within the power plant project footprint area. The location of the 10 NSRs is shown in Figure 8-2.

Figure 8-2: Location of noise sensitive receptors used used for predicitng noise impacts



8.3.1 Noise from construction related activities

During the construction phase, noise will be generated by construction plant and equipment; this will be the predominant noise and is evaluated in this section. Precise details of the construction schedule or equipment requirements are not yet finalized; however, the assessment was conducted based on assumed impact durations and equipment numbers for the construction of the project facilities. Given below is the assumed inventory of construction equipment that will be used for development of the power plant.

Table 8-7 Assumed construcion equipment inventory

Plant/Activity	Number of units	Lp @ 10m	Reference [1]
I. Earth Work Equipment			
Backhoe Excavator	6	78	C.2 No. 3
Dozer	4	79	C.2 No. 11
Loader	10	68	C.2 No. 8
II. Transportation Equipment			
Autodumper (Large)	20	76	C.4 No. 4
Autodumper (Small)	10	78	C.4 No. 7
Water Tank Truck	4	76	C.4 No. 76
III. Concrete and mortar Equipment			
Concrete Mixing Plant	2	80	C.4 No. 20
Concrete batching machine	2	N/A	N/A
Material loader (a)	4	68	C.2 No. 8
Material loader (b)	2	68	C.2 No. 8
Concrete mixing transportation cart	10	76	C.4 No. 22
Concrete pump truck	2	77	C.4 No.21
Concrete transport pump	4	67	C.4 No. 24
Mortar mixer	8	61	C.4 No. 23
IV. Lifting Equipment			
Track type crane (a)	1	67	C.3 No. 28
Track type crane (b)	1	67	C.4 No. 46
Truck crane	2	70	C.4 No. 43
V. Special Equipment			
Piling machine	10	82	C.3 No. 15
Construction elevator	1	66	C.4 No. 62
Diesel generator	2	74	C.4 No. 84
Water purification equipment	3	N/A	N/A
VI. Other Equipment			

Plant/Activity	Number of units	Lp @ 10m	Reference [1]
Steel processing equipment	6	N/A	N/A
Woodwork equipment	4	N/A	N/A
Electric slag pressure welding machine	6	73	C.3 No. 31
Flash butt-welding machine	4	73	C.3 No. 31
Electric welder	10	73	C.3 No. 31
Electric winch (a)	4	N/A	N/A
Electric winch (b)	4	N/A	N/A
Impact hammer	6	82	C.3 No. 15
Hand drill	10	76	CONCAWE CNP 064 [6]
Sand-wheel grinder	6	75	C.4 No. 94
Angle abrader	10	75	C.4 No. 94
Bench grinder	4	80	C.4 No. 93
Electrohydraulic pipe bender	2	N/A	N/A
Pneumatic drill(including hammer)	20	82	C.3 No. 15
Submerged pump	20	62	C.8 No. 23
Sewage pump	8	68	C.4 No.88
Vertical tamping machine	2	82	C.3 No. 15
Frog hammer	6	82	C.3 No. 15

Noise emissions from construction activities have been estimated for the 6 groupings (I to VI) of equipment items outlined in table 8-7 in accordance using the methodology presented in BS5228:2008: Noise and Vibration Control on Construction and Open Sites.

The IFC General EHS Guidelines state that the day time noise levels (LAeq 1-hour) at residential, institutional or educational type receptors should not exceed 55dB(A). Due to the temporary and transient nature of construction noise, a Project threshold value has been set at 10 dB higher than the IFC limit. Therefore 65 dB(A) has been applied for the assessment of construction noise impacts and those levels higher than 65dB(A) are highlighted in orange in Table 8-8.

Table 8-8: Construction noise levels (project in isolation)

Distance (m)	Construction Noise Level (dB(A))					
	I	II	III	IV	V	VI
10	81.7	81.5	81.8	73.0	82.7	89.5
20	75.7	75.5	75.8	67.0	76.7	83.5
30	72.2	72.0	72.3	63.5	73.2	80.0
40	69.7	69.5	69.8	61.0	70.7	77.5
50	62.7	62.6	62.9	54.0	63.8	70.6
75	59.2	59.0	59.3	50.5	60.2	67.0

Distance (m)	Construction Noise Level (dB(A))					
	I	II	III	IV	V	VI
100	56.7	56.5	56.8	48.0	57.7	64.5
150	53.2	53.0	53.3	44.5	54.2	61.0
200	50.7	50.5	50.8	42.0	51.7	58.5
300	47.2	47.0	47.3	38.5	48.2	55.0

From the above table, the construction noise limit of 65 dB(A) is expected to be exceeded for the six types of construction plant and equipment when the project is considered in isolation. It should be noted however, that in all cases, the exceedance of the limit is expected to be limited to within a radius of approximately 50 - 75 m from the edge of the construction site. Given below is the impact significance of the construction related noisy activities.

Table 8-9: Impact significance for noise related activities-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	National	Short	Moderate	Probable
	4	2	6	3
	Result: (-36) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should prioritize building the perimeter walls around the facility • The EPC contractor should endeavor to reduce operations or other noisy tasks through off-site fabrication whenever practicable • The EPC contractor should ensure minimum compliance with the environmental noise standards stipulated in L.N. 61: Noise and Excessive Vibration Pollution Regulations, 2009 and occupational noise limits stipulated in and L.N. 25: Noise Prevention and Control Rules, 2005 • The EPC contractor should maximize the offset distance between noisy equipment items and residential receptors; • Material stockpiles and mobile equipment staging, parking, and maintenance areas shall be located as far as practicable from noise-sensitive receptors • The EPC contractor should ensure that all equipment and its mufflers is regularly serviced, and immediately serviced/replaced if damaged. • Acoustic covers on all machine engines that generate excessive noise levels are to remain closed at all times. • The EPC contractor should limit operation times of noisy equipment, vehicles and activities, where possible; • Community liaison would form a critical element in the management of the noise impacts. If provided with adequate warning, affected sensitive receptors are sometimes willing to accept excessive noise for a short period of time. Designation of a community liaison officer			

	who will be able to deal with the concerns of residents and establishment of a noise complaint response program can enable the identification and resolution of any noise related concerns at an early stage • The EPC contractor should conduct regular inspection and spot checks of all noise generating equipment.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	National	Short	Minor	Improbable
	4	2	2	2
	Result: (-16) Low negative			

8.3.2 Noise from operational phase activities

During the operational phase, the principal sources of noise in power plants include turbine generators and auxiliaries; boilers and auxiliaries, such as coal pulverizers; reciprocating engines; fans and ductwork; pumps; compressors; condensers; precipitators, including rappers and plate vibrators; piping and valves; motors; transformers; and circuit breakers.

In order to predict the operational noise levels from the above sources and their impacts on sensitive receptors, a noise modeling study was conducted using the internationally recognized SoundPLAN version 7.3 software.

The propagation methodology adopted within the SoundPLAN model was the International Organization for Standardization (ISO) 9613 'Acoustics – Attenuation of Sound during Propagation Outdoors' (ISO, 1996).

In the absence of detailed design data, equipment has been integrated into the noise model as either a point, area or block source, depending on the size and function of the item of equipment. In the absence of vendor noise data, all equipment has been modelled at the occupational noise threshold sound pressure level (Lp) of 85 dB(A) at a distance of 1m from any equipment façade. The sound power level data has been estimated based on the sound pressure level data and approximate equipment sizes estimated from data provided by the project engineers or based on approximate dimensions illustrated on Project plot plans and facility layout drawings.

Under normal operating conditions, the modeled sound levels at the boundaries of the plot are shown in Table 8-10. The IFC General EHS Guidelines provide a maximum value of 70dB(A) at the fence line as community noise limits.

Table 8-10 : Predicted Project Site Boundary Noise Levels – Normal Operation

Boundary	Maximum Cumulative Boundary Noise Level under Normal Operating Conditions (dB(A))	Boundary Noise Limit: IFC Guidelines	
North	45.3	70	70
East	55.5	70	70
West	54.4	70	70
South	48.9	70	70

Noise emissions from normal and emergency operational activities have been estimated for the five existing NSRs. According to the IFC standards, the daytime and night time noise limits at the residential NSRs are 55 dB(A) during the day and 45 dB(A) at night respectively.

The noise levels at NSRs due to normal operation of the Project in isolation at the five sensitive receptors are detailed in table 8-11 and assessed against the IFC daytime and night time noise standards.

Table 8-11: Assessment of Noise Levels at Existing NSRs under Normal Operating Conditions

Receptor	Project noise contribution at receptor (dB(A))	Baseline Noise level at receptor (dB(A))	Cumulative noise level at Receptor (dB(A))	Change in noise level at receptor (dB(A))	Applicable IFC Noise Limit (dB(A))	
					Day	Night
NSR1	40.7	53.0	53.2	0.2	55	45
NSR2	44.3	47.3	49.1	1.8	55	45
NSR3	47.4	43.8	49.0	5.2	55	45
NSR4	40.7	49.4	49.9	0.5	55	45
NSR5	38.6	44.1	45.2	1.1	55	45

As shown in table 8-11, the cumulative noise levels (Project noise contribution with ambient noise) have been compared against the IFC noise limits for daytime and night time periods. The results indicate no exceedances of daytime noise limits for any of the NSRs, however all five NSRs are expected to experience exceedances of the night time limit of 45 dB(A).

It should be noted that it is arguable that the noise limits are conservative with regards to the existing ambient noise levels, as most ambient noise levels already exceed the applicable night time limit.

In terms of contextualizing background noise levels in excess of the standards, the IFC Guidelines states that the contribution of operational noise should not result in an increase of background noise levels by more than 3 dB(A). Based on this requirement, the cumulative noise level should not be 3 dB(A) greater than the ambient noise level. Under this consideration, NSR 3 is expected to experience a cumulative noise level which is more than 3 dB(A) above the existing ambient noise level.

It should be noted at this point that the Project contribution to this exceedance is below the daytime noise limit and only 2.5 dB(A) above the night time IFC limit.

The noise levels at NSRs due to normal operation of the Project in isolation at the five sensitive receptors are detailed in table 8-12 and assessed against the IFC daytime and night time noise standards.

Table 8-12: Assessment of Noise Levels at New NSRs under Normal Operating Conditions

Receptor	Project Noise Level at Receptor (dB(A))	Applicable IFC Noise Limit (dB(A))		Applicable IFC Noise Limit (dB(A))	
		Day	Night	Day	Night
NSR6	65.5	55	45	55	45

Receptor	Project Noise Level at Receptor (dB(A))	Applicable IFC Noise Limit (dB(A))		Applicable IFC Noise Limit (dB(A))	
		Day	Night	Day	Night
NSR7	64.1	55	45	55	45
NSR8	60.2	55	45	55	45
NSR9	52.1	55	45	55	45
NSR10	53.2	55	45	55	45

As shown in table 8-12, the Project noise levels have been compared against the IFC noise limits for daytime and night time periods. The results indicate exceedances of daytime noise limits for NSR 6, 7 and 8; while all five NSRs are expected to experience exceedances of the night time limit of 45 dB(A).

It should be noted that it is arguable that the noise limits are conservative with regards to the fact that the classification of the NSRs is technically an industrial area; however, given that these areas are designed to accommodate workers, it was considered more conservative to assess the noise levels at these locations against the residential standards.

The impact assessment table for noise during the operational phase is provided below.

Table 8-13: Impact significance for noise related activities-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	National	Short	Moderate	Probable
	4	2	6	3
	Result: (-36) Medium negative			
Mitigation measures	**Comments/Mitigation:** • According to Legal Notice 25: Noise Prevention and Control Regulations 2005 (under the OSHA 2007), the EPC contractor will ensure that continuous noise characteristics of all equipment do not exceed 85dB(A). • For the new NSRs 6 and 7, the EPC contractor's design for the worker's colony windows should include secondary glazing (4 mm single glazed window) as defined in the Building Research Establishment (BRE) Digest 379 (1993). For NSRs 8 – 10, the EPC contractor's design for the worker's colony windows should contain thermal glazing (Thermal 6-12-6 mm in a PVC-U frame) as defined in the Building Research Establishment (BRE) Digest 379 (1993). • The O&M Company shall always comply with the latest environmental and occupational noise regulations promulgated under the EMCA or OSHA and their respective subsidiary legislation. In the absence of Kenyan standards on noise, the developer will comply with the requirements of the latest IFC Noise Guidelines for similar types of power plants. • The O&M Company should endeavor to reduce operations or other noisy tasks through off-site fabrication whenever practicable.			

	• The O&M Company should ensure that all equipment and its mufflers is regularly serviced, and immediately serviced/replaced if damaged. • Acoustic covers on all machine engines that generate excessive noise levels are to remain closed at all times. • The O&M Company should limit operation times of noisy equipment such as vehicles and activities, where possible; • The O&M Company should conduct regular inspection and spot checks of all noise generating equipment.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	National	Short	Minor	Improbable
	4	2	4	2
	Result: (-20) Low negative			

8.4 Thermal effluent

8.4.1 Discharge of once-through cooling water

The proposed coal power plant will utilize a once-through cooling water system for the condenser. A once-through cooling system carries off waste heat from the power plant by means of water flowing through the condenser and discharges it to the natural water body. There, waste heat is transferred to the atmosphere which is the ultimate heat sink.

The Lamu coal power plant will require about 42,000m^3/hour of seawater to cool the combustion systems. Water for cooling the systems will be obtained directly from the sea, used for cooling then released back into the sea; at the discharge point, the temperature differential of the ambient and discharged water will be about 9°C. Without adequate mitigation measures, waters with such elevated temperature differentials can potentially be harmful to sensitive habitats such as coral species. For instance, the 1997–1998 El Niño weather phenomenon in East Africa resulted in a sea temperature rise of 1–2°C in March–April 1998, resulting in widespread coral bleaching and mortality in the region (Obura 2001).

According to the current World Bank Group (WBG) EHS Guidelines for Thermal Power Plants, thermal discharges should be designed to ensure that discharge water temperature does not result in exceeding relevant ambient water quality temperature standards outside a scientifically established mixing zone. Further, the WBG General EHS Guidelines state that the temperature of wastewater prior to discharge should not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations.

The effects of thermal discharges on the marine environment can be sub-divided into direct effects (those organisms directly affected by changes in the temperature regime) and secondary effects (those arising in the ecosystem as a result of the changes in the organisms directly affected).

Direct effects

The direct effects of thermal discharges on the marine environment include:

- Change to the temperature regime of the water column and perhaps the sediment of the receiving environment over a small area;
- Lethal and sub-lethal responses of marine organisms to the change in temperature regime;
- Stimulation in productivity in a range of organisms.
- Minor reduction in the dissolved oxygen saturation. Changes to dissolved oxygen saturation potentially arise as a result of the reduction in solubility of oxygen in sea water with increasing temperature and as a consequence of the increased productivity of microbial communities in particular

Indirect effects

The indirect effects of thermal discharges on the marine environment include:

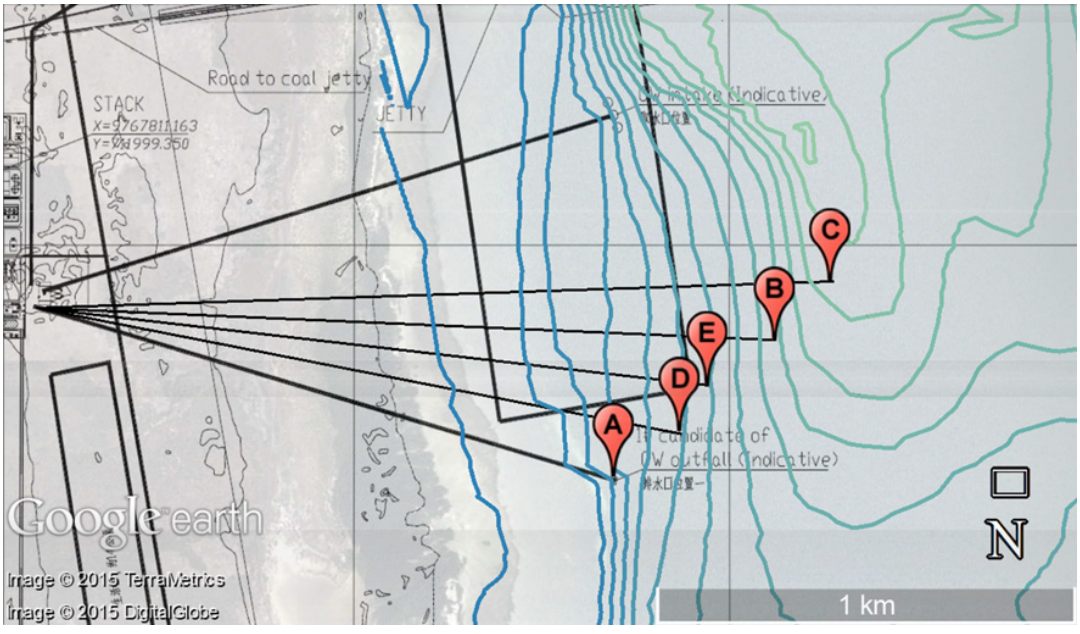
- Changes in the distribution and composition of communities of marine organisms comprising marine sites (particularly estuaries);
- Localized changes in bird distributions usually in response to increased macroinvertebrate or fish food supplies close to thermal discharges.

A thermal plume modeling study was undertaken using the US EPA endorsed Cornell Mixing Zone Expert Model (CORMIX) which is primarily used for the assessment of regulatory mixing zones resulting from continuous point source discharges.

Mixing behavior can be assessed from a range of discharge designs within bounded channels (e.g. rivers, estuaries or industrial discharge channels) and unbounded channels (e.g. coastline or lakes). The mixing behavior is modelled based on discharge characteristics and ambient conditions such as current speed, buoyancy of the effluent, stratification of the ambient fluid, effluent flow rate and port diameter/design. CORMIX is particularly effective at determining **near field** mixing characteristics based on outfall design and the ambient conditions at the point of discharge.

Figure 8-3 shows the screening locations for the circulating water discharge using CORMIX.

Figure 8-3: Circulating water discharge locations for screening purposes



Water depths and current speeds at each of the locations were determined by interrogating the modelling results of the 3D tidal simulations of the Lamu estuary. Tidal simulations were conducted for a 1-year period, and assessments within the near field were assessed at water heights and current velocities at mean high tide (MHT) and mean low tide (MLT).The ambient parameters at the locations are shown in Table 8-14 below.

Table 8-14: Ambient Parameters at Location Options

Ref.	Latitude	Longitude	Average Depth (m)	Depth at MHT (m)	Depth at MLT (m)	Current Speed at MHT (m/s)	Current Speed at MLT (m/s)
A	-2.105363	40.921075	3.5	4.56	2.44	0.12	0.07
B	-2.102450	40.924537	7	8.06	5.93	0.11	0.07
C	-2.101193	40.925731	10	11.06	8.93	0.09	0.07
D	-2.103403	40.923148	4	5.06	2.94	0.12	0.07
E	-2.104468	40.922537	5	6.06	3.94	0.12	0.07

Various types of diffuser designs were used to carry out the screening assessment as shown below.

Figure 8-4: Uni-directional Perpendicular Diffuser

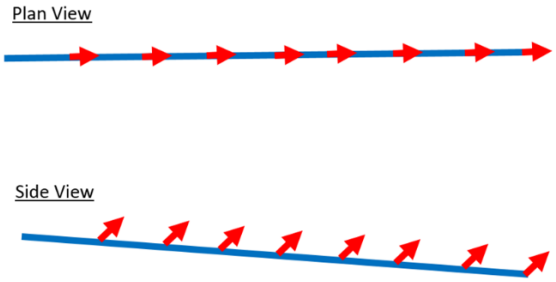


Figure 8-5: Staged Perpendicular Diffuser

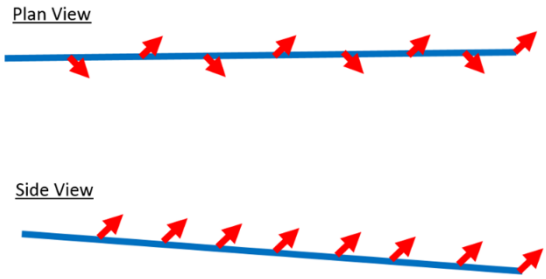


Figure 8-6: Uni-directional Parallel T Diffuser

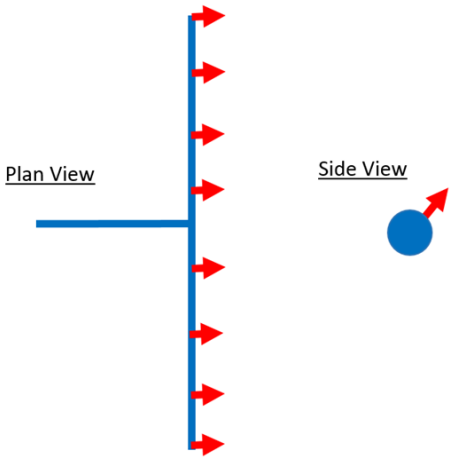
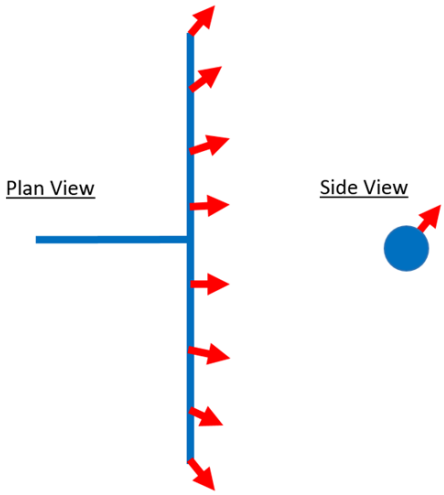


Figure 8-7: Fanned Parallel T Diffuser



All four outfall designs were assessed at locations A, B and C to determine mixing behavior at variable distances within the plume centerline, with the exception of the 'Staged Perpendicular Diffuser'. It was not possible to assess this design within the near-field due to the instability of the plume, and therefore unreliable nature of dilution predictions. This instability is likely caused by the forced separation of the plume by the variable discharge direction, results can only be reliably predicted once the multiple plumes are re-joined downstream into a single plume.

An additional two diffuser designs were assessed, based on the favorable results of the planned designs within the assessment, and in an attempt to introduce diffuser designs that may be more technically and financially feasible to the Client. The designs were variations to the 'Uni-directional perpendicular diffuser' design with reduced lengths and number of ports.

A summary of the designs assessed is provided within Table 8-15.

Table 8-15: Design Screening Options Parameters

Ref.	Description	Port Diameter (m)	Diffuser Length (m)	Port Number	Horizontal Discharge Angle (°)
a	Single Port	4	N/A	1	60
b	Uni-Directional Perpendicular Diffuser	0.44	100	35	45
c	Staged Perpendicular Diffuser	0.44	100	35	45
d	Parallel T Diffuser Uni-Directional	0.44	100	35	60
e	Parallel T Diffuser Fanned	0.44	100	35	60
f	Uni-Directional Perpendicular Diffuser	0.58	50	20	45
g	Uni-Directional Perpendicular Diffuser	0.82	25	10	45

The results of the screening assessment using CORMIX modeling software is given in tbale 8-16.

Table 8-16: CORMIX screening results for various thermal plume modeling scenarios and diffuser options

Scenario Ref.	Discharge Type	Diameter (m)	Port Number	Discharge Angle (°)	Tidal Conditions	Depth at Discharge (m)	Distance from Shore (m)	Current Velocity (m/s)	Temperature (Δ°C) at Distance (m)							Δ3°C within 100 m?	Δ3°C within near-field?
									1	2	5	10	20	50	100		
Db	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MHT	5.06	590	0.12	1.85	1.85	1.85	1.85	1.85	1.85	1.56	Yes	Yes
Db	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MLT	2.94	590	0.07	2.42	2.42	2.42	2.42	2.42	2.42	2.03	Yes	Yes
Df	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MHT	5.06	590	0.11	3.24	3.21	3.10	2.94	2.70	2.19	1.74	Yes	Yes
Df	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MLT	2.94	590	0.07	3.54	3.50	3.41	3.41	3.41	2.86	2.29	Yes	Yes
Dg	Uni-Directional Perpendicular Diffuser (g)	0.82	10	45	MHT	5.06	590	0.11	4.36	4.28	4.07	3.79	3.29	2.44	1.87	Yes	Yes
Dg	Uni-Directional Perpendicular Diffuser (g)	0.82	10	45	MLT	2.94	590	0.07	5.50	5.42	5.22	4.94	4.38	3.19	2.45	Yes	Yes
Eb	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MHT	6.06	600	0.12	1.81	1.79	1.75	1.69	1.69	1.69	1.42	Yes	Yes
Eb	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MLT	3.94	600	0.07	2.09	2.09	2.09	2.09	2.09	2.09	1.77	Yes	Yes
Ef	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MHT	6.06	600	0.11	2.99	2.95	2.85	2.70	2.47	2.01	1.59	Yes	Yes
Ef	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MLT	3.94	600	0.07	3.37	3.33	3.22	3.07	2.95	2.48	1.97	Yes	Yes
Eg	Uni-Directional Perpendicular Diffuser (g)	0.82	10	45	MHT	6.06	600	0.11	4.03	3.95	3.74	3.47	2.99	2.26	1.72	Yes	Yes
Eg	Uni-Directional Perpendicular Diffuser (g)	0.82	10	45	MLT	3.94	600	0.07	4.86	4.78	4.57	4.29	3.72	2.79	2.11	Yes	Yes
Ba	Single Port (a)	2.6	1	45	MHT	8.06	770	0.12	9.00	9.00	9.00	8.20	5.63	2.87	1.41	Yes	No
Ba	Single Port (a)	2.6	1	45	MLT	7.8	770	0.07	9.00	9.00	9.00	8.21	5.64	2.90	1.44	Yes	No

Scenario Ref.	Discharge Type	Diameter (m)	Port Number	Discharge Angle (°)	Tidal Conditions	Depth at Discharge (m)	Distance from Shore (m)	Current Velocity (m/s)	Temperature (Δ°C) at Distance (m)							Δ3°C within 100 m?	Δ3°C within near-field?
									1	2	5	10	20	50	100		
Bb	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MHT	8.06	770	0.11	1.76	1.75	1.71	1.65	1.55	1.46	1.24	Yes	Yes
Bb	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MLT	5.93	770	0.07	1.81	1.80	1.76	1.71	1.71	1.71	1.44	Yes	Yes
Bc	Staged Perpendicular Diffuser (c)	0.44	35	45	MHT	8.06	770	0.11	-	-	-	-	-	-	-	?	?
Bc	Staged Perpendicular Diffuser (c)	0.44	35	45	MLT	5.93	770	0.07	-	-	-	-	-	-	-	?	?
Bd	Parallel T Diffuser Uni-Directional (d)	0.44	35	60	MHT	8.06	770	0.11	5.50	4.73	3.71	2.98	2.34	1.63	1.50	Yes	Yes
Bd	Parallel T Diffuser Uni-Directional (d)	0.44	35	60	MLT	5.93	770	0.07	5.69	4.93	3.91	3.17	2.50	1.76	1.60	Yes	Yes
Be	Parallel T Diffuser Fanned (e)	0.44	35	60	MHT	8.06	770	0.11	5.20	4.43	3.42	2.72	2.11	1.46	1.13	Yes	Yes
Be	Parallel T Diffuser Fanned (e)	0.44	35	60	MLT	5.93	770	0.07	5.44	4.67	3.65	2.93	2.29	1.60	1.45	Yes	Yes
Bf	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MHT	8.06	770	0.12	2.63	2.59	2.49	2.36	2.15	1.74	1.39	Yes	Yes
Bf	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MLT	5.93	770	0.07	3.02	2.98	2.88	2.73	2.50	2.03	1.61	Yes	Yes
Ca	Single Port (a)	2.6	1	45	MHT	11.06	930	0.12	9.00	9.00	9.00	6.66	3.40	2.04	1.49	Yes	No
Ca	Single Port (a)	2.6	1	45	MLT	8.93	930	0.07	9.00	9.00	9.00	8.22	5.64	2.90	1.37	Yes	No
Cb	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MHT	11.06	930	0.09	1.66	1.64	1.61	1.55	1.45	1.25	1.06	Yes	Yes
Cb	Uni-Directional Perpendicular Diffuser (b)	0.44	35	45	MLT	8.93	930	0.07	1.75	1.74	1.70	1.64	1.54	1.39	1.17	Yes	Yes

Scenario Ref.	Discharge Type	Diameter (m)	Port Number	Discharge Angle (°)	Tidal Conditions	Depth at Discharge (m)	Distance from Shore (m)	Current Velocity (m/s)	Temperature (Δ°C) at Distance (m)							Δ3°C within 100 m?	Δ3°C within near-field?
									1	2	5	10	20	50	100		
Cc	Staged Perpendicular Diffuser (c)	0.44	35	45	MHT	11.06	930	0.09	-	-	-	-	-	-	-	?	?
Cc	Staged Perpendicular Diffuser (c)	0.44	35	45	MLT	8.93	930	0.07	-	-	-	-	-	-	-	?	?
Cd	Parallel T Diffuser Uni-Directional (d)	0.44	35	60	MHT	11.06	930	0.09	5.02	4.24	3.25	2.57	1.98	1.36	1.25	Yes	Yes
Cd	Parallel T Diffuser Uni-Directional (d)	0.44	35	60	MLT	8.93	930	0.07	5.19	4.41	3.41	2.71	2.10	1.45	1.33	Yes	Yes
Ce	Parallel T Diffuser Fanned (e)	0.44	35	60	MHT	11.06	930	0.09	4.77	3.99	3.02	2.37	1.81	1.24	0.95	Yes	Yes
Ce	Parallel T Diffuser Fanned (e)	0.44	35	60	MLT	8.93	930	0.07	4.94	4.16	3.17	2.50	1.92	1.32	1.21	Yes	Yes
Cf	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MHT	11.06	930	0.09	2.27	2.24	2.15	2.03	1.84	1.48	1.19	Yes	Yes
Cf	Uni-Directional Perpendicular Diffuser (f)	0.58	20	45	MLT	8.93	930	0.07	2.50	2.47	2.38	2.25	2.04	1.65	1.32	Yes	Yes

The results of the screening assessments indicate that the diffuser designs at all locations meet the project requirement of Δ3°C within the near-field mixing zone (or area of initial dilution). As all designs meet the project requirements within the near field mixing zone, cconsideration of direct impacts of outfall construction will be considered within the assessment (i.e. longer outfall pipes are likely to cause greater direct destruction of habitat and generation of turbidity plumes during construction).

The preferred design option was further modelled for the 'far-field' behavior of the thermal plume using a 3D Plume Discharge Model (PLUME3D). PLUME3D modeled the cooling water dispersion over a full year period to statistically determine the temperature rise within the receiving environment. The results of PLUME3D are spatially and temporally accurate and will be utilized to determine potential impacts on environmentally sensitive habitats within the estuary. The results of the PLUME 3D modeling indicated that the selected discharge design, a uni-directional perpendicular diffuser, is anticipated to meet IFC requirements within the near-field mixing zone, and therefore a significant increase in temperature of greater than 3°C is not anticipated to extend beyond the effluent jet issuing from the diffuser openings. Therefore, the selected outfall design and location are anticipated to comply with the strictest definition of IFC requirements.

Given below is the impact assessment of thermal discharge of once through cooling water.

Table 8-17: Impact significance for thermal discharge of cooling water into the estuary-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Very high	Highly probable
	2	4	10	4
	Result: (-64) High negative			
Mitigation measures	**Comments/Mitigation:** • A cost benefit analysis should be undertaken to determine the optimal design of the submerged diffuser design. Consideration should be given to utilize the shortest length of the diffuser and CW discharge in order to minimize construction related impacts on the marine ecology. • The Proponent should consider installation of CW intake technologies such as seasonal barrier nets or mesh/wire screens to reduce impingement and entrainment of fish, jellyfish, etc. The reduced intake flow rate also reduces the potential for entrainment of marine species. • During the initial testing at the plant and cooling water systems commissioning, it should be ensured the initial effluent and cooling water discharges fully comply with the AfDB and/or IFC standards on thermal discharge. • Over-chlorination of the condensed water will be prevented and should be achieved through process monitoring • Water quality monitoring should be provided on all lines feeding the outfall. If process standards are accidentally exceeded, there should be an option of diverting the stream into a holding pond;			

	• The O&M company should periodically monitor flow and quality on the main outfall using alarms if standards are exceeded; • The O&M Company should conduct reef inspection and water quality monitoring at specified locations (in collaboration with an NMK marine ecologist) and at appropriate time intervals according to the environmental monitoring plan and report reef status and water quality data after each survey.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Long term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

8.5 Climate change

As part of the ESIA Study, a desktop climate change impact assessment was undertaken for the proposed 1,050MW coal fired power plant comprising two distinct parts namely:

- A climate risk assessment (CRA); and
- A greenhouse gas (GHG) assessment.

This Climate Change Specialist Study was undertaken with the following objectives:

- Undertake a high level assessment of the physical risks facing the development, such as high temperatures, floods, strong winds, monsoons etc. and identify adaptation measures that could reduce the risk or take advantage of opportunities; and
- Estimate the operational carbon footprint of the proposed 1,050MW Coal Fired Power Plant, Lamu County, identify high level opportunities for minimizing the carbon footprint, and understand exposure to applicable regulation.

The climate change impact assessment was also undertaken in accordance with the requirements of the African Development Bank's integrated safeguard system which requires an assessment of climate change for coal fired power plants. Additionally, the IFC Performance Standards require that all new projects undertaken after January 1, 2012, need to undertake an assessment of climate change impacts associated with a project.

There are a number of key drivers for conducting a CRA and GHG assessment alongside an ESIA for a new development and include:

- Climate change impacts (as identified through the CRA) may have implications on the environmental performance of the project; for example, if changes in extreme weather events result in damage to facilities that lead to environmental impacts (e.g. from leaks or damage to equipment and storage facilities).
- Integrating CRA into ESIA's can help to improve the climate resilience of projects and can help to avoid the maladaptation of projects to climate change. Projects failing to consider climate change risks at the planning stages could face severe financial, safety and operational impacts in the future if climate change impacts bring about the damage or disruption to operations, assets, infrastructure and energy supply.

- Projects conducting a CRA and GHG assessment as part of the ESIA process are likely to be identified by stakeholders as being forward looking and responsible, bringing about reputational benefits.

Please note that this impact assessment for climate risk does not follow the standard format used in the rest of the Impact Assessment Chapter. This is owing to uncertainties that exist with regard to the accuracy of simulated climate change predictions, specifically due to the early stage of project design and that (in many cases) available information was insufficient to determine significant change to the baseline risk profile. As such, a conservative approach has been adopted and estimated values are considered to reflect worst-case scenarios.

The CRA was conducted by reviewing historic data on climate and weather events in the project region and surrounding towns, and overlaying the findings with peer-reviewed scientific projections of climate change in order to assess and identify future climate risk and opportunities for the project. Key interactions between project components and climate risk sources were subsequently analyzed and prioritized.

8.5.1 Climate change induced-risks on the project

In terms of the climate change impact assessment, the project area is envisaged to have the following characteristics:

- The climate around the project area is typically hot & dry with low precipitation throughout the year;
- Extreme weather events are not characteristic of the region and the project site in particular and those that have taken place do not appear to have had a significant impact apart from droughts impacting fresh water supply;
- Temperatures across Africa are projected to increase over the 21st Century (across all seasons) and the warming is anticipated to exceed the global mean annual temperature increase, which is projected to be approximately 3.4°C by 2100. In Kenya, warming is expected to be greater over the Northern and Central parts and lower along the coast (within which the project area falls);
- Overall, it is envisaged that the project area is likely to get hotter and drier with increasingly variable precipitation as a result of climate change. Additionally, storm surges along the coast may become more common given projected increases in severe weather events specially the El Niño Southern Oscillation (ENSO), La Niña and Inter-Tropical Convergence Zone (ITCZ).

Based on the experience of the climate change specialist, given below are the potential climate change impacts on the proposed project.

Table 8-18 : Potential climate change risks and consequences to the project

Weather variable	Risk to project	Potential consequence
High Temperature (air/oceans)	• Health risk to workforce and community • Equipment efficiency • Sea temperature increase	• Reduce workforce efficiency • Potential community unrest • Downtime and delays due to reduced productivity and problems with equipment • Downtime in ability to cool due to marine life damage

Weather variable	Risk to project	Potential consequence
Flooding	• Very low with only some localized pooling	• No major consequences
Drought	• Reduced water availability (e.g. water restrictions as water prioritized for community) • Increased need of water for dust suppression (during construction) • Evaporation of ponds/dams/water supply • Evaporation causing vegetation loss and erosion • Drying up of natural local fresh water supply in sand dunes	• Reduced production • Delays • Community stress and unrest • Livestock loses • Shut downs due to cooling discharge water heating marine area and impacting marine life beyond best practice levels.
Sea Level Rise	• Limited due to site elevation of between 6 & 12 m above sea level. • Storm surges could have some impact on the lower areas of the project site	• Disruption to the generation plant will be limited but flood defense barriers to be considered.

Those impacts that emerged as being of moderate significance to the project under future predicted climate change conditions were:

High Temperature

- Affecting staff health and potentially productivity;
- Physically affecting nearby communities, which may lead to community unrest;
- Reducing access to water and affecting subsistence agriculture in nearby community, which may lead to community unrest;
- Reducing the efficiency of equipment, which may compromise productivity;
- Low rainfall comporting water availability within region, which may result in reduced productivity;
- Increased sea water temperature which could lead to productivity issues, as cooling system may need to be stopped due to discharge water into sea increasing beyond best practise levels, which could damage marine life; and
- Increase risk of more severe stores over the warmer seas.

Rainfall and Flooding

- Flooding will be minor and limited to surface water build up with severe weather events, but run off to the ocean will limit this impact;
- Maintenance could be impacted if parts are shipped in or trucked in from areas within the flood prone zones within Kenya. Delays could have a minor impact on operation efficiencies;

- Construction could be impacted by high temperatures causing worker fatigue and equipment in-efficiencies and failure due to excessive heat;
- Wetting the coal supplier in storage rendering it un usable till dried; and
- Access of supplier from areas within the high flood risk zone in Kenya.

Sea Level Increase

- Damage from storm surges to plant, infrastructure and erosion,
- Sea water egress into plant and damaging equipment, and
- Port access for supplies of coal could be delayed due to severe storm events.

Based on the more significant types of impacts, it is advisable that the project developer invests in a mitigation measures that will act to reduce the influences of hotter temperatures on the plant, it's staff and the nearby communities as well as appropriate flood and sea level control measures.

8.5.2 Adaptation measures for climate change

Based on the potential climate change risks on the proposed project, it is recommended that the adaptation measures listed in the table below be implemented.

Table 8-19: Proposed adaptation measures for coal power plant

Climate Variable/ Event	Potential Impact on Power Generation and Associated Activities	Phase of Power Plant Affected	Project Component Impacted	Possible Adaptation Measure(s)
Change in disease distribution	Increase incidence of dengue, diarrhea, bartonellosia, malaria and other vector-borne diseases (given increased high temperatures) will impact the health of workforce and surrounding community putting strain on health facilities	Construction & Operational	Health	Rollout community health programs as part of community based adaptation Establish a health support program for staff including training on the avoidance of diseases and infections as well as distribution of prevention materials (i.e. mosquito nets etc.) Clear unwanted water bodies to prevent breeding grounds for Mosquitos
Cyclone/High Winds	Increase dust, blow the Fly ash being blown around	Construction & Operational	Community Support and Health/ Safety	Improve dust suppression mechanisms under high wind conditions
Human adaptation/mitigation and increased competition for land	Changes in climate impacting agricultural (subsistence) and food security could lead to	Construction & Operational	Community Support	Roll out community-based adaptation program considering improving food security under climate change conditions.

Climate Variable/ Event	Potential Impact on Power Generation and Associated Activities	Phase of Power Plant Affected	Project Component Impacted	Possible Adaptation Measure(s)
	conflict with local communities			
Pluvial/Fluvial flooding	Disrupted access to facility due to flooding leading to interruption to supply of inputs such as diesel, materials. Diesel in particular during construction phase, material supply throughout life of project.	Operational	Supply Chain	Implement appropriate flood control measures Implement appropriate stock control system
Storm Events	Increased delay to construction, docking of coal ships, as well as increased maintenance costs and possible business delays during operations Storm surges.	Construction & Operational	Power Plant and Harbour Infrastructure and facilities	Undertake more regular maintenance of infrastructure Implement flood control measures and controls
Temperature	Power Plant staff may experience health impacts as a result of temperature e.g. heat stress, which may result in delays	Construction & Operational	Health	Prevent working under very hot temperatures Ensure availability of cool drinking water for all on-site staff Change working hours to avoided hot working parts of the day
Temperature	Reducing efficiency of equipment due to hotter operating temperatures resulting in increased operational costs (trips/premature failures etc.)	Operational	Power Plant infrastructure and facilities	Review and adjust if possible the operational temperatures for equipment Increase maintenance schedule to prevent slow/shut downs

8.5.3 Impact of Project GHG Emissions on Kenya's National Emissions

This section provides an assessment of the potential impacts associated with the Project's contribution to climate change through 'greenhouse gas' (GHG) emissions. To determine this, the operational phase carbon footprint of the Project has been estimated in a Climate Change Specialist Study.

The Amu Power Company carbon footprint has been estimated in accordance with the *GHG Protocol: Corporate Accounting & Reporting Standard* developed by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). The *GHG Protocol* provides comprehensive guidance on accounting and reporting corporate GHG emissions. It is the most widely used standard for mandatory and voluntary GHG programmes and makes use of the Intergovernmental Panel on Climate Change (IPCC) GHG Inventory guidelines for specific heating values, carbon content, densities and emission factors. In the absence of data available from the project developer, the following sources of information were used to calculate the GHG emissions:

- Intergovernmental Panel on Climate Change (IPCC) 2006 GHG Inventory guidelines and 2013 supplement where and when applicable;
- Department for Environmental, Food and Rural Affairs (Defra) 2014 GHG Conversion Factors for Company Reporting Guidelines;
- Kenya's intended National Determination Contribution (INDC) (23 July 2015);
- National Climate Response Strategy (NCCRS 2010);
- National Climate Change Action Plan (NCCAP 2013); and
- National Adaptation Plan.

The greenhouse effect occurs on a global basis and the point source of emissions is irrelevant when considering the future impact on the climate. It is not possible to link emissions from a single source – such as the Lamu Power Plant facility - to particular impacts in the broader study area.

Subsequently, this specialist study does not consider the physical impacts of climate change resulting from increasing GHG emissions, but rather the impact of the project on Kenya's National GHG Inventory and the implications of this.

The impact of the estimated operational emissions for the Lamu Coal Power Plant has been compared with a national emissions trajectory of Kenya from 2016 to 2040 which has been determined based on historic and projected economic growth and development pathways. The last official GHG emissions inventory for Kenya was completed for the year 1994 and used in the First National Communication, in 2002. Since then Kenya's GHG emissions from 2000 to 2010 have historically been calculated using the Intergovernmental Panel on Climate Change (IPCC) 2006 guidelines for GHG emissions inventories.

For a detailed overview of the methodology and approach used in calculating the Projects carbon footprint please refer to the Climate Change Specialist report. The table below summarises the key emission sources occurring on site and indicates those which are included in the carbon footprint.

Table 8-20: Summary of key emission sources (all Scope 1)

Emission Scope	Emission Source
Mobile combustion	Fuel used in freight carriers
	Fuel used in terrestrial vehicles including cars, utility vehicles, buses etc.
	Fuel used in airplanes for business travel
Stationary combustion	Diesel used for power generation (black start and during construction phase)
Waste emissions	Coal fired boiler
	Methane emissions from waste water (sewage) treatment
Refrigerants	Leakage/use of refrigerant gases in air conditioning units in vehicles and offices/accommodation
Fugitives	Methane escaping from coal storage yards
Lubricants	Use of lubricant oils and greases in machinery
Land clearance	Clearance of vegetated land (at the start of the project)

Kenya's national emissions were estimated to be 73 million tCO_2e in 2010[1] and the vast majority of these arose from land use, land use change and forestry and agriculture (75%). The energy sector accounted for 11.37% of emissions in 2010.

Based on the calculations in the climate change specialist study, the operational phase carbon footprint for the proposed project, is estimated to be approximately ~8.8 million tons CO_2e per year from 2020 onwards when all three boiler unit become fully operational. This calculation is based on the design parameters of the equipment to be employed, the estimated annual coal quality and feed rate.

Emissions from transport related activities account for approximately 284.22tCO_2e (0.00003%) of the total operational emissions from Lamu Power Plant's activities in the area.

Emissions from waste water (sewage) treatment estimated to account for 3 290tCO2e per annum (<0.04%) of the operational carbon footprint. However, due to the significantly higher number of people on site during construction (up to 3 000), waste water treatment contributes a higher proportion of emissions during the initial stages (construction) of the project.

During the construction phase of the project, electricity will be provided by diesel generators until the Lamu Coal Power Plant is up and running. Based on similar types of activities and the climate change specialist's experiences elsewhere, it is estimated that approximately 20MW of electricity would be needed to power the camps and construction of the facility. Based on a diesel consumption of 15.8 million litres per year, the emissions associated with the diesel combusted are 42,873tCO_2e.

The greenhouse effect occurs on a global basis and the point source of emissions is irrelevant when considering the future impact on the climate. It is not possible to link emissions from a single source – such as the Lamu Power Plant – to particular impacts in the broader study area. This specialist study, therefore, looks at the impact of the project on Kenya's National GHG Inventory and the implications of this rather than the physical impacts of climate change.

[1] Kenya's Intended National Determination Contribution – 23 July 2015

An indirect impact of Lamu Power Plant's activities in Kenya is the effect on global greenhouse gas emissions. In 2013, global emissions of greenhouse gases from anthropogenic activities excluding land use change and deforestation came to 36 Giga tons (Gt) CO_2e[2], this is 61% higher than 1990 (the Kyoto Protocol reference year) and 2.3% higher than 2012.

Current generation from the Lamu Power Plant Facility is anticipated to be approximately 1,050 MW of electricity per year (~8.8 GWh) using 3 600 000 tonnes of coal per annum. It must be noted that all but the parasitic load[3] will be distributed via national grid to local electricity demand. Excluding the emissions from transport of coal, transmission losses and downstream combustion of this electricity will result in the emission of approximately ~ 8.8$MtCO_2e$ per year – a 0.024% increase in global emissions (World Total: 36 131 $MtCO_2$).

Given the growth in national emissions over time, by 2030 (143$MtCO_2e$)[4], Lamu Power Plant could account for around 6 – 10% of the Kenyan national emissions. The emission projection is based on GDP growth and projected emissions by 2030 which assumes a ~3.4% increase in emissions annually[5]. This is based on the emissions growing from the 2010 level of 73$MtCO_2e$ to 143$MtCO_2e$ in 2030. Since there is no actual data upon which to base this assumption, it is not possible to assess whether this figure is an over or under estimate of future emissions. Assuming that emissions will increase by 6% per year, the addition of the Lamu Power Plant facility will increase Kenya's emissions by an equivalent amount during the first few years of operation, reducing each year as national emissions rise.

Based on above assessment that the impact magnitude of the proposed project on Kenya's national emissions during the operational phase could be medium to high and the definite likelihood of the impact occurring, the significance is rated as major. It must be noted that the impact is based on the effect the operation will have on the national GHG emissions level which are low on a global context and therefore the impact on that basis is considered major.

Given its global nature, mitigation of the impact of climate change takes the form of reducing the concentration of greenhouse gases in the atmosphere. Subsequently, the developer should consider the following mitigation measures:

- Consider options for implementing waste heat recovery in order to improve the thermal efficiency of the plant;
- Consider the development of a man-made mangrove for the treatment of sewerage in order to sequester carbon[6];
- Optimise transport logistics;
- Incorporate 'green building' features in the design of offices and accommodation; and
- Explore options for providing local communities with electricity to offset deforestation.

[2] From http://co2now.org/Current-CO2/CO2-Now/global-carbon-emissions.html
[3] Represents the power consumed when the power plant is not generating electricity for the grid and/or self-generated load required to provide generation to grid i.e. it operational power.
[4] Kenya's Intended Nationally Determined Contribution (INDC) 23 July 2015
[5] Based on the Intended National Determined Contibution (INDC) 23 July 2015
[6] Asia-Pacific Conference on Science and Management of Coastal Environment (1997-01-01) 123: 49-59, January 01, 1997 By Wong, Y. S.; Tam, N. F. Y.; Lan, C. Y.

8.6 Waste management

The proposed power plant project is expected to generate a variety of wastes during the construction and operational phases of the project respectively. Given in Table 8-21 are the estimated quantities of wastes that may be generated by the proposed power plant during the construction and operational phases of the project.

Waste steam	Origin/Source	Estimated Quantities		Preferred treatment/ disposal options
		Construction (tons)	Operation (tons/year)	
Waste water	Concrete placing	1,500		Re-used after sediment removal
Construction waste	Building/ Architecture construction	400		Carted away for disposal by NEMA licensed transporter
Wood/iron sheets	Equipment package	500		Reused, and a little unusable waste will be carted away for disposal
Concentrate water	Concentrated water from water treatment equipment	110,000		Discharged into Manda Bay
Cooling water	Once-through cooling water system		9.42×10^8	Discharged into Manda Bay
Fly ash	coal burning		2.5×10^5	Stored in ash yard
Bottom ash	coal burning		2.7×10^4	Stored in ash yard
Gypsum	Wet Flue Gas Desulfurization		6.9×10^4	Stored in ash yard
Sanitary sewage	Colony		1.4×10^4	Treated through effluent treatment plant and used for dust suppression
Household refuse	Temporary colony and Colony	600	150	Carted away for disposal by NEMA licensed transporter

8.6.1 Construction phase waste assessment

Raw material waste from the construction of buildings and plant infrastructure may require offsite disposal. Some of the waste streams are likely to be generated during the excavations for building foundations and the construction of the building frame, internal fittings, electrical installations and external works and include the following waste streams:

- Hazardous wastes such as solvents, thinners, cleaners, cutting oils, paints, contaminated rags, packaging and containers, adhesives, light bulbs and batteries;

- Non-hazardous wastes such as food and canteen waste, scrap metal waste, waste paper, wood, cardboard packaging; and,
- Other wastes such as glass, uncontaminated soil and rubble, plastics and rubber.

The improper management of the above wastes may have potential adverse impacts on the environment in the absence of appropriate mitigation measures given that there are minimal waste disposal facilities within Lamu County.

Table 8-21 : Impact significance for waste-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Low	Highly probable
	2	2	4	4
	Result: (-32) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should endeavor to design out waste through the initial project planning phase, consider the types of materials used, the methods of transportation and how the materials are handled, stored and disposed of in-situ, particularly any excavated material from building foundations and retention of excavated materials on site. • In alignment with the IFC principles of waste avoidance and utilization, the EPC contractor should encourage their suppliers to minimize waste generation. This may involve suppliers committing to reduce surplus packaging associated with and construction raw materials such as plastics, cardboard and wooden pallets • The EPC contractor should construct a salvage yard which includes areas for segregating general and hazardous wastes. The waste storage facilities must include linings, bunds and roofing. • A hazardous chemical and waste storage facility should include a low permeability surface, preferably concrete, that is protected from the ingress of storm water from surrounding areas to ensure that accidental spillage does not pollute local soil or water resources. • All storage areas must also be properly demarcated and, if the material is hazardous, there should be adequate labelling and security at the facility. • A facility must be provided for separate storage of incompatible chemicals or wastes, e.g. acids and bases, flammable materials, etc. • The EPC contractor should emphasize the minimization and reuse aspect during the construction process through awareness among construction workers of waste minimization and recycling initiatives. Wastes should be segregated at source and kept in segregated stockpiles. • The EPC contractor should provide clearly labeled skips for separation of specific types of wastes such as metals, wood, card board. The skips should be located in a centralized area on an impermeable hardstanding surface.				

	• All waste oils and chemicals should be stored in drums or tanks in a bunded compound situated on an impermeable surface in order to prevent potential spillage.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Duration	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			

8.6.2 Construction phase off-site waste management

The potential impact from the offsite disposal of waste to an appropriate waste disposal site may result in increased traffic movements from the site. This could be a significant impact as Lamu County lacks any dump sites or engineered landfills. If no minimization issues are implemented at the site this is likely to result in the increase of offsite waste truck movements (noise and dust generation) and the amount of waste disposed of to landfill sites resulting in a potential negative impact.

Table 8-22: Impact significance for off-site disposal of waste-construction phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Regional	Short	Low	Highly probable
	3	2	4	4
	Result: (-36) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The Construction Environment Management Plan (CEMP) should identify appropriate approved waste disposal facilities in Lamu, Kilifi, Kwale or Mombasa Counties respectively for off-site disposal of construction wastes. • In order to reduce the off-site disposal of waste, it is recommended that the EPC contractor carry out an on-site waste audit at each stage of the construction process and implement appropriate on-site waste targets and program of monitoring at the site such as: ✓ Quantifying raw material storage; ✓ Quantifying the generation of each waste stream; ✓ Any improvements in current working practices; ✓ Methods of handling and storage of waste streams; and ✓ Quantifying the material disposed off-site. • The EPC contractor will ensure that the waste disposal transporter selected to dispose of any residual waste streams off site is registered with NEMA and will have a duty to ensure that waste is disposed of in a safe and correct manner			

	• The EPC contractor will ensure that all records of paperwork relating to the disposal of both hazardous and non–hazardous waste streams are retained as part of the CEMP and monitoring maybe required to ensure that the movement of waste off site is undertaken in accordance with the Kenyan Waste Management Regulations 2006 (L.N. 121)

Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Regional	Short	Minor	Improbable
	3	2	2	2
	Result: (-14) Low negative			

8.6.3 Operational phase waste management

Without any beneficial use, fly ash, bottom ash and wet FGD gypsum are classified as wastes. According to the Technical Proposal submitted during the tender submission in April 2014, the annual ash and gypsum reject load for each unit is ~592,900m^3. Over a period of 15 years the total ash and gypsum volume is envisaged to be about 26,740,000m^3. Fly ash, bottom ash and wet FGD gypsum will be disposed of in the on-site ash yard. The lack of a properly designed ash yard could potentially lead to sub-surface and groundwater contamination. A further potential impact associated with generation of fly ash, concerns the release of fly ash material into the environment. Due to its low density and fine particulate size, it has the potential to travel relatively large distances.

Table 8-23: Impact significance for operational waste management

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Medium	Moderate	Probable
	3	3	6	3
	Result: (-36) Medium negative			
Mitigation measures	**Comments/Mitigation:** • An ash yard will be designed and constructed in accordance with the Chinese Standard GB 18599-2001: Standards for pollution control on the storage and disposal site for general industrial solid wastes. GB 18599-2001 states that if the coefficient of permeability is greater than 1.0×10^{-7}cm/s, there should be natural or artificial material to build an impermeable layer the thickness of which should produce an anti-seepage capacity which is equal to that of the clay layer of 1.0×10^{-7}cm/s permeability coefficient and of 1.5m thickness. • Based on the above standard, the proposed power plant ash yard design should incorporate at least three layers of protection namely (i) a 1.5m thick in-situ compacted layer of clay, (ii) an appropriately designed HDPE layer around the ash yard whose permeability coefficient is less than 1.0×10^{-7}cm/s, (iii) a 200mm thick layer of sand on top of the HDPE layer for protection, and (iv) a network of perforated pipes to collect leachate for subsequent treatement.			

	• The HDPE liner should be inspected for uniformity, damage and imperfections during construction and installation. • A leachate collection system should be incorporated in the ash yard design and provided at the lowest point(s) of the ash yard. The leachate and runoff should be collected from the coal ash pile and diverted it into a leachate storage or treatment system. • A groundwater monitoring system made up of wells should be installed and operated around the ash yard capable of verifying whether coal ash or leachate has penetrated the pad or HDPE liner. • Stormwater canals will be constructed along the perimeter of the ash dump. The leachate from the canals will be collected and treated in the ash treatment pool with the treated water used in the ash yard through a sprinkler system for dust suppression • A 7m wide road should be constructed around the perimeter of the ash yard complete with drains for access purposes • The O&M Company will develop and implement a waste management plan for the operational phase of the project • Based on the specific situation(s) at the time, the O&M Company should take suitable measures to prevent erosion of the ash pile during the monsoon season in Lamu or a failure of part of the ash pile • Employees should be trained in the proper handling and disposal of the fly ash, bottom ash and wet FGD gypsum to minimize their risk of exposure in accordance with the O&M Company's operational health and safety procedures. Employees should be provided with appropriate personal protective equipment (PPE) for handling the ash. Proper handling and disposal by employees would minimize exposure or health-related issues to the public.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**	
With mitigation	Study area	Long term	Minor	Improbable	
	2	3	2	2	
	Result: (-14) Low negative				

8.7 Water resources

Impacts associated with water resources include stormwater events and sanitary waste generated by construction activities at the project site. As the freshwater in Lamu is scarce, a desalination plant will be incorporated into the project. The desalination plant will provide fresh water for firefighting, service water, demineralized water and potable water for the colony. The impacts associated with water resources mainly include those associated with the sanitary waste as described below.

8.7.1 Improper management of wastewater-construction phase

During construction, the primary wastewater issues relate to storm water events and sanitary wastewater generated by construction activities on site.

Storm water has the potential to run off into areas containing hazardous materials and either leach these into the soil or carry these off the site, potentially contaminating other areas, groundwater, or coastal waters. Storm events can potentially have adverse impacts on water resources resulting in large amounts of silt laden run-off.

For the sanitary sewage, it is anticipated that about 3000 workers will be on site during the peak period of construction. At an average water use by one person of 0.1m^3/day, it is estimated that 300m^3/day of sanitary wastewater will be generated for treatment and disposal. This is a significant amount of sanitary wastewater that without proper treatment and disposal methods, could be discharged off-site with detrimental impacts on the environment.

Table 8-24: Impact significance for contaminated stormwater run-off into the estuary-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Moderate	Probable
	2	2	6	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor will avoid silt laden run-off into the estuary throughout the construction phase by limiting the amount of exposed soil stockpiles left unprotected • The EPC contractor should store all hazardous materials and wastes on site in bunded areas lined with impermeable surfaces such as reinforced concrete • Any spills that occur from hazardous substances should be cleaned up immediately to prevent them being carried into the stormwater runoff			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Very short	Minor	Improbable
	2	1	2	2
	Result: (-10) Low negative			

Table 8-25: Impact significance for improper management of sanitary waste-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Moderate	Probable
	2	2	6	3

	Result: (-30) Medium negative
Mitigation measures	**Comments/Mitigation:** • The EPC Contractor will design and build an appropriately sized Effluent Treatment Plant (ETP) for managing sanitary sewage that will be generated during the construction phase. The design of the ETP must include biodigesters for solid sewage and ensure that it will be able to meet as a minimum, the effluent discharge standards stipulated under Kenya's L.N. 120: Environment Management and Coordination (Water Quality) Regulations, 2006. Treated wastewater will be reused for ablution water in the cisterns or for landscaping or dust suppression purposes. • If septic tanks are constructed, the EPC Contractor will procure a new honeysucker vacuum truck for exhausting the septic tanks/latrines • Sludge generated from the sewage treatment plant that cannot be used as compost will be disposed off-site by a NEMA licensed transporter. The EPC Contractor to keep records of all sludges generated and disposed off-site • The EPC contractor to undertake weekly site inspections to ensure that all wastewater generated is managed properly and no leakages or spills occur within the site area • The EPC contractor will train their employees including sub-contractors at the site to minimize water consumption for ablutions and to ensure an understanding of wastewater issues • The EPC contractor shall develop procedures for the demobilization of the sewage treatment plant once the site construction phase ended to ensure that appropriate procedures/methods would be employed and no contamination to the site area occurs during this demobilization period.

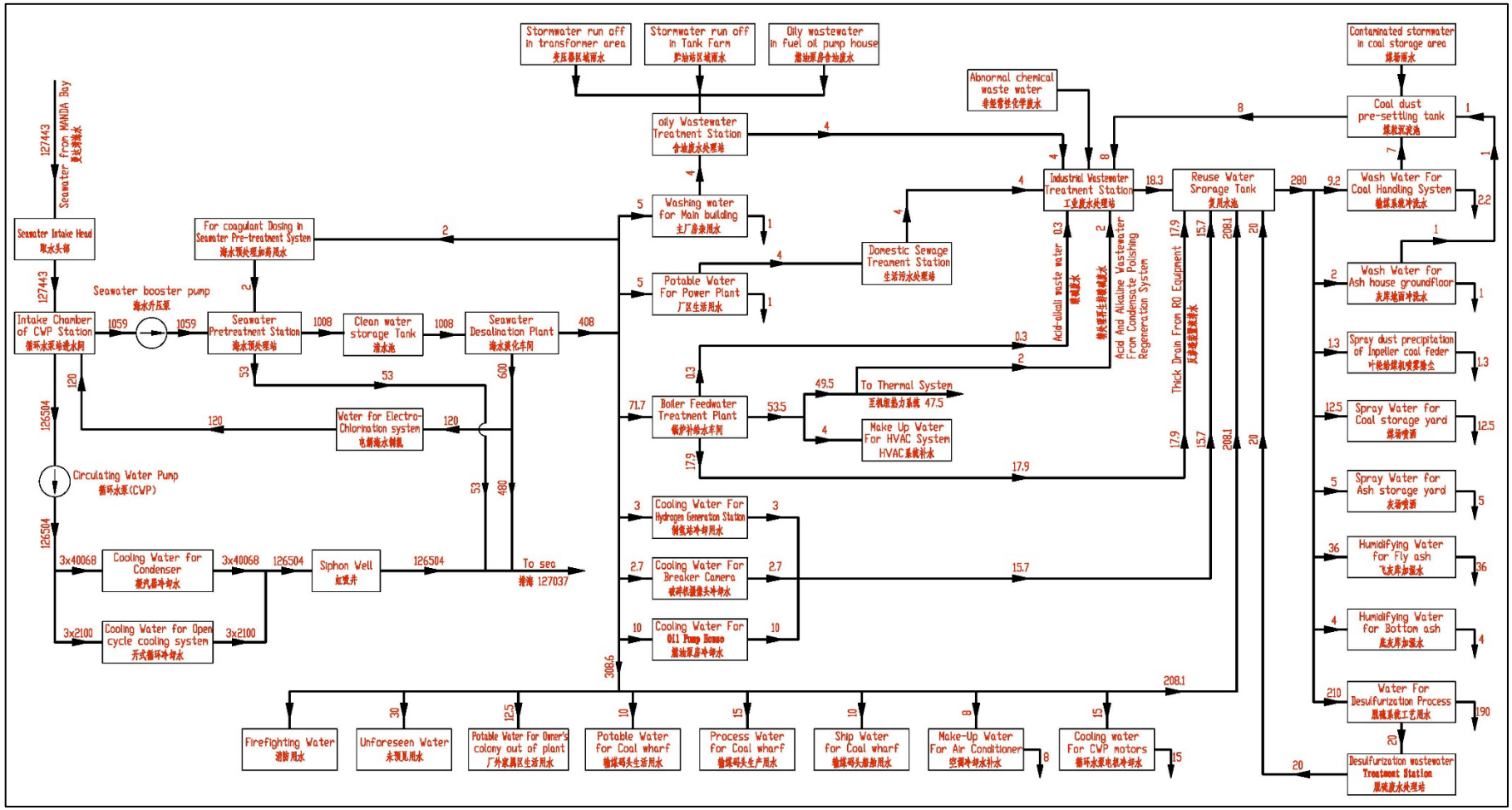
Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Study area	Very short	Minor	Improbable
	2	1	2	2
	Result: (-10) Low negative			

8.7.2 Improper management of wastewater-operational phase

The main issues related to wastewater during the operational phase of the proposed coal power plant include domestic (including sanitary) wastewater, oil-contaminated and/or chemical containing wastewater and storm water run-off. The potential impacts that may result from these is described below.

The EPC Contractor has prepared a Water Balance diagram as shown in Figure 8-8.

Figure 8-8 : Water Balance DIagram for water management-Operational phase



Unit of water flow = m^3/h ↴ means consumption Volumes shown are for 3x350MW

Water consumption for daily activity used in the administration office and the colony (accommodations for workers onsite) during plant operation is pegged at approximately 0.2m^3 per person per day. If approximately 500 workers are present on site, this will generate a daily sewage effluent volume of about 100m^3 for treatment. Improper design of the sewage treatment plant and/or noncompliance with the water quality regulations of 2006 could have detrimental effects on surface water quality.

The industrial process of the power plant facilities will generate wastewater from various streams e.g. workshops, process areas and vehicle parking yards. Some of these streams may contain hazardous components such as oily water and/or wastewater containing chemicals. If managed improperly, such wastewaters can potentially cause pollution of the estuary.

Table 8-26: Impact significance for contaminated wastewater discharge-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Moderate	Probable
	2	2	6	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The Operations and Maintenance (O&M) company should ensure that all hazardous materials and wastes on site are properly stored in closed systems in bunded areas • Process wastewater (e.g. oil-contaminated wastewater) will be treated separately from non-process run-off. Oil separator(s) will be utilized to provide primary treatment of the oily wastewater. Used oil removed from the wastewater will be stored in 210 liter drums and transported to a NEMA licensed waste disposal facility in Malindi or Mombasa by a NEMA licensed specialist operator. • Wastewater containing chemicals resulting from various streams (e.g. chemical storage, boiler blow-down water, chemical cleaning effluents) will be pre-treated by neutralization and/or detoxification prior to being collected and treated at the wastewater treatment plant on site. This will ensure the treatment process will function properly and the effluent discharges comply with the discharge limits stipulated under Legal Notice 120 titled Environment Management and Coordination (Water Quality) Regulations, 2006 (LN 120). • All wastewater is envisaged to be treated in the wastewater collection systems/treatment facilities will when in compliance with effluent discharge parameters, be re-used in the coal ash yard for dust suppression purposes. • If any wastewater is envisaged to be discharged into the environment or aquatic environment, the O&M company will acquire an Effluent Discharge License (EDL) from NEMA.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
	Study area	Very short	Minor	Improbable

With mitigation	2	1	2	2
	Result: (-10) Low negative			

Table 8-27: Impact significance for improper management of sanitary waste-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Moderate	Probable
	2	2	6	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Domestic and sanitary wastewater will be collected and treated in a sewage treatment plant which will be provided by the EPC contractor for the proposed coal power plant. The discharge limits stipulated under Legal Notice 120 titled Environment Management and Coordination (Water Quality) Regulations, 2006 (LN 120) shall always be complied with for water quality discharge limits. The O&M Company will acquire an EDL for the sewage disposed off-site from NEMA.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Very short	Minor	Improbable
	2	1	2	2
	Result: (-10) Low negative			

8.7.3 Contamination of groundwater

During the operational phase, the proposed coal power plant will discharge fly ash, bottom ash and wet gypsum in an ash yard which is located about 200m from the intertidal zone on the eastern boundary. If the design of the ash yard does not include impermeable layers of protection, leachate from the ash yard could percolate into the sub-surface and potentially contaminate the groundwater. The inferred groundwater flow is eastwards towards the Manda Bay and any leachate in the groundwater would have adverse impacts on the hydrology.

A geophysical survey was undertaken in which 28 vertical electrical soundings (VES) of the project area were carried out at a grid size of 500m x 1000m to determine the surficial geology characteristics found in the project area. The results of these soundings indicate that the subsurface geological formations are permeable and the sedimentary formations are intercalated with weathered coral zones, clays and shales. These zones are likely to be old land surfaces (OLS) which formed in between different episodes of depositional history.

These zones are likely to be old land surfaces (OLS) which formed in between different episodes of depositional history. The curves have similar shape except VES_6 and VES_22. This implies that the project area is homogenous and comprises of Sand dunes, Raised Coral reef and Marine sands & clays of the Magarini sands in that stratigraphic succession.

The interpreted geophysical data indicates that the general area in which the coal power project is going to be constructed has the following characteristics:

- The subsurface geological formations are highly weathered and most of the layers have true resistivity of less than 980 Ohm-metre.
- There are shallow aquifers of between 3 and 5 metres below ground level and deeper aquifers of between 10 and 35 metres below ground level.
- The upper sub-surface geology is vulnerable to the infiltration of pollutants from coal ash yard and hydro-carbon pollutants in the event of leakage of petroleum hydrocarbons from heavy vehicles operating in the project area during construction which could lead to the local aquifer systems potentially being contaminated.
- The formation strength is composed of unconsolidated sands, clays and coral limestone weathering, sands and shales.

Based on the above, the impact significance for contamination of ground water during the construction and operational phases is given below.

Table 8-28 : Impact significance for for groundwater contamination-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	International	Long term	Moderate	Probable
	5	4	6	3
	Result: (-45) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The design of the coal stock yard and ash yard should include a sufficient number of groundwater monitoring wells. These groundwater monitoring wells should be checked regularly by sampling and analyzing water from them for compliance with Kenya's L.N. 120: Environment Management and Coordination (Water Quality) Regulations, 2006. • The discharge limits stipulated under Legal Notice 120 titled Environment Management and Coordination (Water Quality) Regulations, 2006 (LN 120) shall always be complied with for water quality discharge limits. The O&M Company will acquire an EDL for the sewage disposed off-site from NEMA.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Very short	Minor	Improbable
	2	1	2	2
	Result: (-10) Low negative			

8.8 Soils and geology

The project area is overlain by relatively shallow mainly black cotton soils which in some areas grade into more grayish colored loamy soils. The soils of the Kwasasi sub-location in Lamu area are classified as below. (Speck, 1978, Sombroek et al, 1982).

At several locations within the project footprint area, the surface soil samples were excavated up to a depth of 1.5m in order to determine the soil texture and observe the colors of the various horizons. The results of the soil survey are given below and it gives the baseline soil conditions within the project area.

Reddish-brown to gray fine loose sandy or clayey sandy soils vary from 5 to over 10m and are overlain by fine loose and/or compact sandy soils that are relatively deep and vary in depth between 0.3 and 1.5 metres in most places. The soils are mainly a product of the weathering and deposition of sand dunes, coral limestones, hence giving them the light color and high quartz content. Loamy and dark clayey soils are also widespread in the area.

The geological data based on secondary literature reviews indicates that the area in which the Lamu Coal Power Plant will be built, has the following characteristics:

- The first 4m of the ground contain fine loose soil at the top and compact sandy soil of low fertility but is useful for agricultural practice and farming activities.
- The lithology up to 10m is generally permeable and therefore in the event of construction of coal power facilities, care should be taken to construct strong foundations, hard standing and proper underground supporting systems.
- Highly weathered coral limestones are encountered after 3-8 metres below which saline water is encountered.
- The upper sub-surface geology is vulnerable to the infiltration in the event of the spillage of contaminants and that in the event of leakage and of seepage; the surface and groundwater is likely to be contaminated.

8.8.1 Soil erosion impacts

During the construction phase, the project footprint areas will be stripped of the topsoil and excavation done to receive reinforced concrete foundations for the power plant infrastructure.

There is the potential for the loss of soil and other excavated material through erosion caused by run off during rainy weather or from wind during the dry period in the construction phase of the proposed development. This is considered a negative and minor impact in the absence of suitable mitigation measures. The nature of the construction activities will involve the stripping and stockpiling of soil and other excavated material until it is reinstated, when required.

The continuous use of heavy machinery and other vehicles on unsealed areas of ground has the potential to adversely impact the soil structure, which is considered a direct impact. This is considered a negative and moderate impact in the absence of suitable mitigation measures.

Table 8-29: Impact significance for soil erosion-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Low	Probable
	2	2	4	3
	Result: (-24) Low negative			
Mitigation measures	**Comments/Mitigation:** • The site Engineer will ensure that silt control measures are implemented such as silt fences and silt traps to check occasional runoff. • The site Engineer will ensure that stockpiles of excavated materials stored appropriately in designated areas and at a minimum distance of 30m from any nearby watercourses or drains. Measures should also be taken to avoid direct rainfall on stockpile materials or exposed areas of ground that may result in slippage and washout of sediments into nearby drainage channels. • The site Engineer will ensure that long term stockpiles will be sealed at a suitable gradient and grass planted as part of rehabilitation plan. • The site Engineer will ensure that the stripped topsoil and tailings from the screening process will be used to progressively backfill the dugout trenches immediately behind the abandoned quarry site.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			

Table 8-30: Impact significance of soil structure destruction by heavy vehicles-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Short	Moderate	Probable
	3	2	6	3
	Result: (-33) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The site Engineer will ensure that vehicles and other heavy equipment use approved tracks as access routes. • The site Engineer will ensure that well paved tracks (stone and laterite/murram) are used as access tracks to protect underlying soil. This should be well compacted in order to carry the weight of the expected heavy vehicles. The tracks should be constructed in such a way as to allow for easy drainage of surface run-off on either side of the track. In sloped areas the drainage channels on the sides of the tracks should have concrete barriers at intervals of 30 to 50 metres			

	(depending on the slope) to check erosion and cutting into the drainage channel.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Regional	Short	Low	Improbable
	3	2	4	2
	Result: (-18) Low negative			

8.9 Marine ecological impacts

8.9.1 Impacts due to dredging

While the present assessment does not take in consideration a specific design of intake and discharge structures at the site, potential marine environment impacts from the proposed coal power plant include:

(1) Impacts of construction activities of marine structures; and

(2) Impacts during operation

(a) Impingement and entrainment of organisms due to the intake of large quantities of seawater;

(b) Localized rise of sea water temperature due to cooling water discharge; and

(c) Impacts on water quality.

Construction of intake and discharge structures at the coal power plant site may include offshore dredging (by floating equipment) and onshore dredging/excavation (by land equipment).

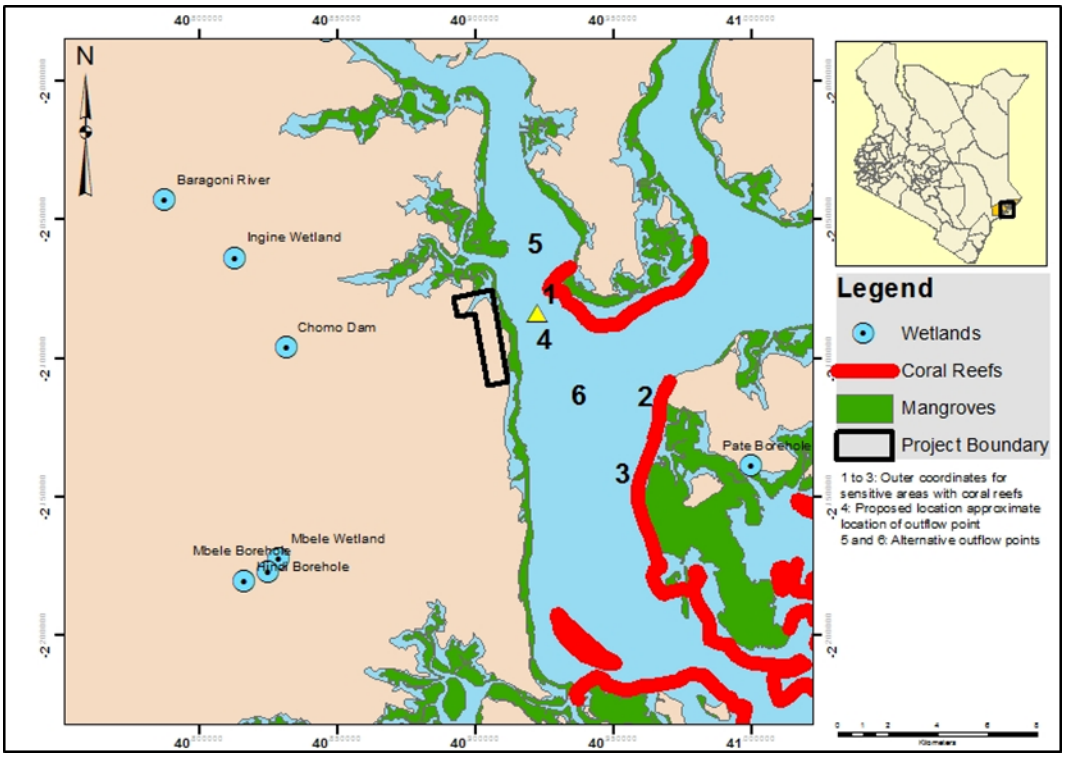
The project site is situated on the landward side of a shallow (water depths typically less than 10m) coastal estuary, which is fringed by a coral reef (Figure 8-9). Beside a small section of the coral reef itself, other materials to be dredged may include sand, silt and eventually clay. The total volume of material to be dredged may be on the order of several hundred thousand m^3. The main receptors for impacts during dredging are coral reef ecosystem comprising corals, flora and fauna, and benthic communities.

The recovery of the disturbed habitats following dredging ultimately depends upon the nature of the new sediment at the dredge site, sources and types of re-colonizing animals, and the extent of the disturbance. Recovery periods depend on habitat types and are in the order of few months to several years. Since the habitat type in this project is mostly sandy, it is anticipated that a full recovery of the benthic community will be established within 1 -2 years after dredging.

Reduced water quality and increase in turbidity and oxygen depletion due to suspension of sediments is a major negative impact, especially as the fine fraction plume can travel over significant distances. Settlement of these suspended sediments can result in the smothering or blanketing of sub-tidal communities and/or adjacent intertidal communities.

During project construction activities, there is a possibility of re-suspension of sediments increasing the turbidity and reduced dissolved oxygen in stormwater runoff. Wilkinson (2004) noted that activities associated with human disturbances such as increased coastal development, poor land-use and watershed management and sewage discharges lead to sedimentation, nutrient loading and eutrophication in marine habitats. These environmental problems adversely affect mangroves, sea grasses and coral reefs, more so their delicate and complex ecological interactions that makes them areas of high biodiversity. Specifically, coral reefs are sensitive and vulnerable to sedimentation; persistent sedimentation initially causes bleaching of corals followed by death (Obura et al. 2004). As such impacts associated with increased pollution and turbidity in the marine systems are regarded as significant.

Figure 8-9: Sensitivity map showing areas prone to degradation



Change of concentration and availability of nutrients during dredging can affect the marine life and is considered an impact of moderate significance.

Dispersion of contaminants during dredging and disposal affects marine life. This is a moderate impact of major negative significance.

Significant areas of Manda Bay are under mangroves, sea grass beds and coral reefs; depending on the location of the power plant infrastructure, some of these resources may be permanently lost while other will die due to impacts associated with dredging. For instance, during construction of Mokowe jetty in Lamu, about 100ha of mangrove forest was killed by sediment deposited from dredging activities (Abuodha & Kairo, 2001). Dredging activities during the construction phase are projected to cause significant and serious damage to the neighboring mangroves, sea grasses and coral reefs habitats.

The noise impacts (surface/underwater) from equipment used for dredging in the marine habitat can be considered minor. Similar minor impact is expected due to over-spill from the barge that handles dredged material.

Noise impact on construction workers during dredging is a typical workplace noise hazard. Workers will have access to personal protective equipment hence, sensitivity is assessed as minor.

Oil or fuel spillages from marine equipment, while unlikely, would have serious consequences for local marine life depending on the size of spill. The delivery of fuels, oils and chemicals should be avoided by sea route and instead delivered by road and stored away from the shoreline in a secure compound.

Since there are no designated marine protected areas next to the site, it is considered that there will be no impact on marine protected species of the Manda Bay such as dugongs and sea turtles; at least so far, these species have not been sighted anywhere near the coal power plant site area.

During the operational phase, the coal power plant may generate storm water during heavy downpour that is likely to flow directly into the sea. Other accompanying developments such as residential areas, schools, hospitals and other amenities are projected to add more contaminated waste water into the sea without adequate mitigation measures. Domestic effluents and storm water are sources of water pollutants in the form of sediments and nutrients. Nutrient enrichment leads to eutrophic systems that favor algae blooms, trigger incidents of anoxic conditions in the water column and subsequently degradation and loss of habitats and, elimination of vulnerable species. Fabricius (2005) and (Veron et al. 2009) reported that coral reefs and coral communities are highly sensitive to water quality changes, that are largely a product of sediment loads (which affects light penetration), nutrients and environmental contaminants. Terrestrial runoff from urban development, agriculture and deforestation are the principal causes of diminished water quality. Indeed runoff impacts have become such a worldwide phenomenon, that only reefs well removed from highly populated landmasses have escaped degradation of some sort. The analysis results of a sample of water collected in the bay adjacent to Lamu Town during the marine ecological assessment study showed elevated levels of total nitrogen and coliform bacteria counts.

The Lamu coal power plant is major development initiative and without adequate mitigation, might add wastes into the sea capable of causing significant adverse effects if they reach vulnerable environments. Therefore environmental impacts associated with waste discharges into the sea are rated as significant.

8.9.2 Impingement and entrainment of organisms

During the operational phase, there may be impacts associated with the cooling water system associated with the seawater intake and outfall locations.

A potential impact associated with the sea water intake is impingement and entrainment of organisms. Impingement occurs when marine organisms are trapped against intake screens by the velocity and force of water flowing through them. The fate of impinged organisms differs between intake designs and among marine life species, age, and water conditions. Some hardy species may be able to survive impingement and be returned to the sea, but the 24-hour survival rate of less robust species and/or juvenile fish may be less than 15%.

Entrainment occurs when smaller organisms pass through an intake screen and into the process equipment. Organisms entrained into process equipment are generally considered to have a mortality rate of 100%.

The number of affected organisms will vary considerably with the volume and velocity of feed water and the use of mitigation measures developed to minimize their impact. If intake velocities are sufficiently low, fish may be able swim away to avoid impingement or entrainment. The swimming performance for different species of fish can predict the types and ages most vulnerable, however, even large fish are frequently caught on intake screens, indicating that swimming ability is not the only factor in impingement. Cold temperatures or seasonal variations in age-selective migrations or growth are also factors.

Table 8-31: Impact significance of dredging for circulating water intake and discharge structures-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	High	Definite
	2	2	8	5
	Result: (-60) Medium negative			
Mitigation measures	**Comments/Mitigation:** • As part of the detailed design, the EPC contractor should reduce the loss of coral reef habitat (say by at least 10%) and the provision of outer wall structures which will facilitate the re-colonization of corals in the future • The EPC contractor should consider the timing of the dredging and disposal operations in order to avoid and reduce adverse impacts on marine sensitive habitats. This can be done based on knowledge of the local hydrodynamics to minimize sediment dispersion and the marine ecology around the power plant site location to avoid sensitive periods • Dredging should be undertaken at the most favorable points in the tidal cycle in order to reduce the movement of suspended sediment from the dredged area. • The EPC contractor should identify an access route for the dredger and barges to avoid physical damage to adjacent coral reef communities, particularly at low tide. • In order to avoid carryover of silt plume from the dredging and disposal operation, the EPC contractor should use silt curtains to minimize spreading of silt plume, and limit the volume of offshore disposal. Any spreading of dredged materials on adjacent coral reefs must be avoided. • The EPC contractor should load dredged material onto barges and dispose at sites away from the coral reef in deeper waters (say 50m). • The EPC contractor should reduce the impact of turbidity on water quality by avoiding sensitive areas, use of silt curtain, proper planning and scheduling of the dredging and disposal to avoid strong wind, current and tides that will further add to widen the effect of spreading of sediments, testing and analyzing the water column at upstream and downstream from dredging activities • To prevent noise impacts, the EPC contractor should apply a high standard for maintenance of equipment, installation of noise				

	suppressors in all equipment, provision of silencer and muffler, limiting the hours of operation. • There should be no refueling of the dredger or barge while working on site. All land based fuels should be stored away from the shoreline on hard standing to avoid accidental spillage. Spill kits and oil booms should be available for immediate use in the unlikely event of an accident.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Low	Improbable
	2	2	4	2
	Result: (-16) Low negative			

8.9.2.1 Impacts on sea water quality

Beside cooling water, the process waste water streams listed below may potentially impact groundwater or sea water, if not handled correctly or discharged accidentally. Given the hydraulic connection between groundwater and sea water in the coastal area, any accidental spill into groundwater onshore can be transferred to the sea water and may affect the marine environment in the same manner as effluents directly discharged to the sea.

Water treatment plant effluent

The plant will include a desalination plant for provision of service waters. The water discharged by the plant will have increased salinity and will be returned via the circulating water discharge pipe. The higher salinity of this water will have minimal impact once this water is mixed with the returning cooling water.

Boiler blow-down

During operation, small quantities of boiler water (boiler blow-down) will be discharged to avoid the build-up of impurities. This effluent will be virtually pure water, containing very small quantities of various chemicals that are used to prevent corrosion and scaling in the boiler.

The water discharged from the cycle must therefore be replaced with make-up water, which must be of high purity. Water from the desalination plant will therefore have additional treatment in a demineralized water treatment plant.

Miscellaneous minor process effluents

During commissioning and at infrequent intervals during the life of the plant, it will be necessary to chemically clean the water side of the boiler tubes. All solid effluents will be disposed offsite by a NEMA licensed contractor for treatment and disposal at an appropriately licensed disposal facility.

During maintenance it may be necessary to drain down the boiler, the closed circuit cooling water system or parts of these systems. All such wastes will be discharged to the sea water outfall after treatment. The boiler water will be identical to boiler blow-down and will be high purity water containing traces of ammonia, phosphate and suspended solids. The closed circuit cooling water will be high purity water containing small amounts of corrosion inhibitor.

During the detailed engineering of the plant, consideration will be given to the storage, recovery and re-use of these effluents.

Table 8-32: impact significance of incorrectly handled or discharged process waste water steams-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Moderate	Highly probable
	2	4	6	4
	Result: (-48) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor will provide a performance guarantee of the effluent treatment plant equipment which should include compliance with physicochemical parameters, pollutants, microbiological and mixing zone standards • The Operations and Maintenance (O&M) company should ensure that all process systems are controlled to ensure that the effluent quality standards in Kenya are met as a minimum. • The O&M Company will comply with all requirements of Kenya's L.N. 120: Environment Management and Coordination (Water Quality) Regulations, 2006 on Effluent Discharge License (EDL) requirements • The O&M company should have an adequate supply of oil booms and similar equipment on site to deal with accidental oil spills offshore • The O&M Company should not over-chlorinate the cooling water; • Water quality monitoring should be provided on all lines feeding the circulating water discharge. If process standards are accidentally exceeded, there should be an option of diverting the stream into a holding pond; • The O&M company should undertake continuous flow and quality monitoring on the main outfall with alarms if standards are exceeded; • The O&M Company should conduct reef inspection and water quality monitoring at specified locations and at appropriate time intervals according to the environmental monitoring plan and report reef status and water quality data after each survey.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Long term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

8.10 Terrestrial ecological impacts

This sub-section analyzes the potential ecological impacts on terrestrial ecology. The analysis has been conducted for:

- Loss of ecosystem services;
- Impacts on plants;
- Impacts on birds;
- Impacts on herpetofauna;
- Impacts on invertebrate fauna; and
- Impacts on mammals.

8.10.1 Loss of Ecosystem Services

Currently, the local community benefits from a wide range of provisioning, regulating and supporting ecosystem services such as fishing, abstraction of water for various purposes, medicinal plants, etc. some of which are key sources of income. With the construction and operation of the proposed coal power plant, some of these services may be eliminated or reduced.

Table 8-33: Impact significance of ecosystems services from the construction and operation of the power plant-construction and operational phases

Mitigation Status	Extent	Duration	Magnitude	Probability
Without Mitigation	Regional	Permanent	High	Probable
Scores	3	5	8	3
	Results: (-48) Medium negative			
Mitigation Measures	**Comments/Mitigation** • The O&M Company should consider supporting capacity building initiatives to create alternative sources of livelihoods for the communities within and around the project area, e.g., alternative sources of building materials and medicine (promote agro forestry), protein (bee-keeping for honey, empower fishermen to start fishing in deep waters, practice fish farming), etc. • The County Government of Lamu and other Central Government lead agencies should enforce fishery laws to control overexploitation, disallowing fishing in non-designated/protected areas using destructive fishing methods.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With Mitigation	Regional	Permanent	Minor	Improbable
Scores	3	5	2	2

	Results: (-20) Low negative

8.10.2 Impacts on Plants

8.10.2.1 Loss of biodiversity

As the construction activities involve vegetation clearance, terrain shaping and soil excavation, several plant species may be lost in the process among them being threatened species such as *Dalbergia melanoxylon*, *Dialium orientale*, and *Haplocoelum inopleum*, as well as mangroves. Although most of the other species likely to be lost might not be threatened, their destruction will reduce the vegetation cover for area. The community may also lose the ecosystem services such as herbal medicine, wood fuel and aesthetics value.

8.10.2.2 Habitat loss/size reduction, modification or fragmentation

Some habitats such as aquatic ecosystems are more critical to species' survival than others. Microhabitats within the project site are likely to be lost to pave way for construction activities. Small water pans, ponds, wetlands or dams may be reclaimed or reduced especially where access roads and perimeter walls are built across them or other construction work occupies part of these habitats. Increased demand for fresh water by the surging human population may further affect the diversity of aquatic vegetation.

This alteration of habitats may affect plant pollination and seed dispersal patterns especially where the mechanisms involves insects and animals.

8.10.2.3 Soil erosion and contamination

Soils play a fundamental role in biodiversity conservation thus changes to the structure and chemical composition can have subsequent effects on vegetation structure and composition as well as altering water courses.

Specific activities that will have a negative impact to soils which can be directly relevant to the functional capacity, sensitivity, vulnerability and general condition of soils include excavation activities, fuel tanks, waste management facilities, and waste treatment facilities. The impacts of these activities on soil properties and processes can include: erosion, pollution, e.g. from oil spills, heavy metals, organic compounds, industrial wastes, pesticides, changes in pH, loss of organic matter, compaction, structural deterioration, physical and chemical changes associated with topsoil stripping, storage changes associated with land restoration, decline in fertility, changes to soil water regime and removal or alteration of parent material. Clearing of vegetation may lead to changes in surface runoff flow direction and quantity in the area. This will potentially cause wind and water erosion. Solid wastes, oil leakage and waste oils will emanate from the project's activities due to the high influx of personnel and activities in the area. Solid waste materials expected include cans, wrappings, paper, and plastics waste, among others. Petroleum, oil leakage and waste oils may spill on the ground and ultimately into the soil or water systems and degrade the ecosystem.

8.10.2.4 Dust and other air pollutants

Destruction of ecosystems can also be caused indirectly if emissions from a coal-power plant reduce productivity of vegetation. Dust for instance will affect plants growth by interrupting physiological processes like transpiration when lodged on leaf surfaces thereby blocking their stomata. Stack emissions such as Sulphur dioxide, nitrogen oxides, carbon monoxide and heavy metals (such as mercury) may contribute to acid rain, which in turn pollute and affect plants growth by corrosion of their surfaces and causes acidification of aquatic ecosystems.

8.10.2.5 Increased anthropogenic activities

Human activities are responsible for most of the loss in biodiversity throughout the world and with the proposed coal power plant, activities such as construction of access roads and an upwelling of human population is expected in the area as project staff, suppliers, opportunistic job-seekers and new settlements due to opening up of the area. This may impact negatively on the biodiversity of the area due to increased pressure on ecosystem services. Of particular concern is the unsustainable harvesting of *D. melanoxylon* which is targeted for its hardwood timber and in the carving industry. Overexploitation of medicinal plants and wild fruit trees such as *Dialium orientale, Tamarindus indica* and *Adansonia digitata* may also occur. Clearing of vegetation for settlements and expansion of farmlands will further lead to loss of important plant species.

Elevated demand for fresh water for domestic use may affect the aquatic flora and convert the permanent swamps into seasonal ones. Excessive collection of fuelwood by workers during construction or operation can also lead to deforestation as well as increased charcoal burning.

Increased domestic waste production, sewage and non-biodegradable material may cause environmental pollution. Using chemical fertilizers, insecticides and herbicides to increase food production may lead to emission of toxic chemicals in the air, soil and water.

8.10.2.6 Invasive species

With the expected habitat disturbance during the implementation of the coal power plant, invasive species may take advantage of the situation and increase in the area. Clearing of natural vegetation opens up gaps that are immediately occupied by opportunist invasive and weedy species when conditions become favorable. Movement of trucks and soil from one point to another might spread seeds of these species along the communication and travel paths that under persistence disturbances. Exotic species might also be introduced in the area either passively as people dispose of fruit seeds in the environment or by design during landscaping activities.

Table 8-34: Impact significance for Biodiversity loss-Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Long term	Moderate	Highly probable
	2	4	6	4
	Result: (-48) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should undertake a pre-excavation identification of land within the project site for relocation and			

	conservation of threatened species that may be destroyed by the construction footprint. • The EPC contractor with the assistance of a National Museums of Kenya (NMK) botanist should where possible, relocate any endangered species to less disturbed environs within the project site or community lands • The EPC contractor should consider undertaking a reference voucher specimen collection within the project footprint for storage at the East African Herbarium (the national/regional repository for botanical collections) should be done for future scientific research as representative collections from the area • A wet season survey and collection of annual plants missed during the dry season should be done to avoid loss of the ephemeral species. • The EPC contractor should avoid clearing vegetation where it is not necessary to do so.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short	Low	Improbable
	2	2	4	2
	Result: (-16) Medium negative			

Table 8-35: Impact significance for soil erosion and contamination- Construction phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Study Area	Medium term	Low	Probable
	2	3	4	3
	Result: (-33) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Topsoil should be removed and stored for use in restoration and rehabilitation • Roadside trenches should not be channeled on bare soils without existing vegetation, especially where water flow would be expected to be high such as in culverts exits. • Where possible, earth-moving activities should not be done in days with heavy rainfall • Grass should be planted on bare areas to help stabilize the soil. • Any spillages (e.g. of oils and greases) should be cleaned immediately before spreading to other areas by runoff water			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Medium Term	Minor	Probable
	2	3	2	3
	Result: (-21) Low negative			

Table 8-36: Impact significance for dust and air pollutants-Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Short term	Low	Definite
	2	2	4	5
	Result: (-40) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should restrict excavation to the project footprint areas • The EPC contractor should use site traffic control measures with well labelled low speed limit signs • Equipment, machines and vehicles should be in good condition to minimize smoke emissions • The EPC contractor should undertake wetting/sprinkling to avoid nuisance dust emissions • The EPC contractor should plant vegetation as part of the rehabilitation plan			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short term	Minor	Improbable
	2	2	2	3
	Result: (-18) Low negative			

Table 8-37: Impact significance for alien invasive plant species-Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Long term	High	Probable
	3	4	8	3
	Result: (-45) Medium negative			
Mitigation measures	**Comments/Mitigation:** • All earthmoving and excavation equipment and transport vehicles should be inspected and cleaned of any extraneous soil and debris that may harbor invasive species propagules. This should be done in designated areas using preferably high-pressure washing machines • Construction materials such as sand and gravel should be obtained from weed-free sites • Only seed collected from indigenous plants in the vicinity of the project should be used for re-vegetation programs. Exotic species should be avoided			

	• Cultivated fruit seeds should be properly disposed to avoid finding their way into natural vegetation areas. • Minimize unnecessary soil and vegetation disturbance • Monitoring of the invasive species coverage to be done			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Regional	Long term	Low	Improbable
	3	4	4	2
	Result: (-22) Low negative			

Table 8-38: Impact significance for biodiversity loss-Operational phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Study Area	Long term	Low	Probable
	2	4	4	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The O&M Company should implement an afforestation programme to include the threatened species in areas such as near the power plant, the buffer zone, adjacent community lands and unused site land. This should involve stakeholders working with community groups to establish plant nurseries for the programme • A wet season survey and collection of annual plants missed during the dry season should be done to avoid loss of the ephemeral species. • The O&M company should create awareness on importance of conservation for their staff members			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Long term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

Table 8-39: impact significance for increased anthropogenic activities-Construction and operational phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Localized	Short term	Low	Highly probable
	1	2	4	4
	Result: (-28) Low negative			

Mitigation measures	**Comments/Mitigation:** • The EPC contractor and O&M company should develop and implement awareness programs on the importance of conservation of provisioning services and other natural resources • The EPC contractor and O&M company should encourage their staff members in raising plant nurseries and subsequent tree planting activities • The EPC contractor and O&M company should practice waste reduction initiatives in order to relieve the pressure on the ecosystem			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short Term	Minor	Improbable
	1	2	2	2
	Result: (-10) Low negative			

8.10.3 Impacts on Birds

8.10.3.1 Nature of impacts

Birds are highly mobile and therefore are likely to move out of the area once developed. However due to the presence of species of conservation concern (IUCN red list species and migratory species), the cumulative impact on conservation obligations is present.

Recent advances in technology mean that modern coal power plants are cleaner and more efficient, with up to efficiencies of up to 50% achievable. The Lamu coal power plant will use supercritical coal power plant technology with a state of the art 210m tall smoke stack. The smoke stack will use a three stage treatment system ensuring that approximately 95% of exhaust gases and particulates are removed including sulphur dioxide, carbon dioxide, and mercury and nitrogen oxides. Emissions will be largely water vapour.

Noise and vibration may be an issue during the construction phase. The contractor has not given levels of noise and vibration of the machines they will use during the construction phase. During the operation phase the plant will produce less than the permitted levels of noise recommended by NEMA (table 6.32) and vibrations of no more than the recommended 0.5cm/s at 30m from a source.

[7]Table 8-40: Maximum permissible noise levels for constructions sites

Type of receptor	Day L_{eq} (dB(A))	Night L_{eq} (dB(A))
a) Health facilities, educational institutions, homes for disabled, etc.	60	35
b) Residential	60	35
c) Areas other than those prescribed in (i) and (ii)	75	65

[7] Source: L.N.61 of 2009: Environment Management and Coordination (Noise Pollution and Excessive Vibration Control) Regulations

8.10.3.2 Construction phase

During this phase, the project is expected to attract a large workforce (c2000) on the site. Access roads will be built, traffic to the site will increase and associated waste disposal challenges. Impacts on the avifauna are likely to be:

i). **Loss of habitat and displacement-** the current habitat on the site will be cleared to give way to construction of the site. Avifauna on the site will be displaced. Opportunistic species, e.g. scavenging birds will replace them. Already during the recent visit there was evidence of people clearing and burning the habitat (Figure 8-10) in anticipation of compensation by the project. Species of conservation concern such as Coastal Black Boubou and Eurasian Curlew, are likely to be displaced and their numbers reduced.

Figure 8-10: Ongoing habitat clearance at the project site

ii). **Invasive species-** the increase in human population and associated activities e.g. waste disposal is likely to attract and increase populations of scavenging and invasive birds species e.g. Marabou Storks and Indian House Crows. This will have direct effect on populations of indigenous species through mainly predation as well as risk to public health

iii). **Waste and sewage disposal-** There may be up to 2000 people at the site during construction. This will likely create waste and sewage disposal problems.

iv). **Noise and Vibration**-The Lamu coal power plant proposes a 24-hour construction schedule. A NEMA permit may be required for infrequent high noise level activities which may exceed the permissible levels.

8.10.3.3 Operation phase

i). **Loss of ecosystem services provided by birds**- Birds serve several roles in the ecosystem including seed dispersal, weed and pest control, pollination and waste disposal service (scavenging)**.** With displacement, these functions will be lost. They also have an aesthetic value.

Figure 8-11: Flock of shorebirds/waders feeding on a mudflat near the project site

ii). **Loss of feeding habitat-** The Lamu coal power plant is next to sandy beaches and mud flats used regularly by shorebirds and waders for feeding (Figure 6-2). These beaches and mudflats are likely to be destroyed and/or polluted by activities of the PLCPP.

iii). **Heavy metal poisoning**- Residue ash may contain heavy metals including mercury, arsenic and lead (e.g. see *http://www.sourcewatch.org/index.php/TVA_Kingston_Fossil_Plant_coal_ash_spill*). Entry of the heavy metals in the food chain impacts on avifauna through lesser egg production and survival rates and mortality of adult birds (Fry 1995). Birds at the top of the food chain are usually the most severely affected via bioaccumulation and bio-magnifications of the toxicants discharged. Though the Lamu coal power plant will use modern technology and a three stage emission treatment system, the residue ash and the planned ash dumpsite still pose a threat of seepage and ash spill contaminating the environment. It is noted that the ash dumpsite will be located in a tidal zone. The amount of residues will depend on geological origin of the coal, combustion conditions and efficiency of particulate removal.

iv). **Collision risks-** There is a risk that low flying birds will collide with the smoke stack at the coal power plant. For migrating birds, a combination of bad weather and operation lights will attract them to the site. This is more of a factor especially during bad weather and at night for flocks of migrating birds.

v). **Cumulative impacts on Kenya's conservation obligations-**Kenya is signatory to several international conservation treaties. Most relevant for the Lamu coal power plant is the Convention on the conservation of Migratory Species of Wild Animals. Lack of adherence to the applicable requirements of this convention will be a negative impact.

Table 8-41: Impact significance on loss of habitat and displacement on avifauna-construction and operation phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Medium term	Low	Probable
	2	3	4	3
	Result: (-27) Low negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should excavate those areas where the project footprint will be constructed. Further the EPC contractor should undertake restoration and rehabilitation of disturbed areas to as near original conditions as possible • Amu Power should undertake a re-afforestation program to compensate areas destroyed by the construction activities			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Medium Term	Minor	Improbable
	2	3	2	2
	Result: (-14) Low negative			

Table 8-42: Impact significance of invasive species on avifauna abundance and diversity-construction and operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Medium term	Low	Probable
	2	3	4	4
	Result: (-36) Low negative			
Mitigation measures	**Comments/Mitigation:** • All earthmoving and excavation equipment and transport vehicles should be inspected and cleaned of any extraneous soil and debris that may harbor invasive species propagules. This should be done in designated areas using preferably high-pressure washing machines • Construction materials such as sand and gravel should be obtained from weed-free sites • Only seed collected from indigenous plants in the vicinity of the project should be used for re-vegetation programs. Exotic species should be avoided • Cultivated fruit seeds should be properly disposed to avoid finding their way into natural vegetation areas. • Minimize unnecessary soil and vegetation disturbance • Monitoring of the invasive species coverage to be done			

Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Study Area	Medium Term	Minor	Probable
	2	3	2	2
	Result: (-14) Low negative			

Table 8-43: Impact significance for noise and vibration on avifauna abundance and density-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Low	Probable
	2	4	4	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should install equipment that meets the environmental noise limits stipulated by Kenyan environmental noise regulations. • The installed equipment should comply with the requirements of the occupational noise limits specified in the occupational noise regulations			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Long Term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

Table 8-44: Impact significance of heavy metal poisoning on the avifauna abundance and density-operation phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Moderate	Probable
	2	4	6	3
	Result: (-36) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The ash yard should be designed and constructed in accordance with international standards to prevent leaching into the subsurface. • In order to prevent leakage from the ash yard, an impermeable liner should be placed before receiving fly ash from the boiler. The ash yard must have a properly designed and impermeable bund wall around the ash yard.			

Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Study area	Long Term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

Table 8-45: Impact significance for loss of feeding habitat on the avifaunal abundance and density-operation phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Moderate	Probable
	2	4	6	3
	Result: (-36) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The O&M company should limit cutting down trees and grass areas to the construction footprint areas • The O&M company should develop and implement a tree planting program for the lifetime of the project			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Long Term	Low	Improbable
	2	4	4	2
	Result: (-20) Low negative			

Table 8-46: Impact significance for conservation obligations on cumulative impacts-operation phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	National	Long term	Minor	Probable
	4	4	2	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • APCL should adhere to the applicable requirements of the Convention on Migratory Species (CMS) and specifically resolution 7.5			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	National	Long Term	Minor	Probable
	4	4	2	2
	Result: (-20) low negative			

8.10.4 Impacts on Herpetofauna

8.10.4.1 Herpetofauna loss due to habitat modification and alteration

Herpetofauna loss is likely to occur during the site preparation and construction. There will be three activities involved in this i.e. construction of the plant, construction and improvement of the access road and the transmission line. This process will lead to:

a) *Loss of habitat*: This will happen during the initial clearing to remove vegetation. This will clear all the herpetofauna habitats on the ground like trees, dead tree trunks, grasses which are home to amphibians and reptiles. It will also remove the source of food which are insects which are eaten by lizards who are in turn eaten by snakes thereby interfering with the food chain.

b) *Excavation and landscaping*: Construction phase will involve landscaping which will involve excavation, compacting flattening of some areas. Wells, loose top soils and burrows will be covered or removed. This will take away the breeding site, which are mostly the soft and loose top soil. Amphibians congregate on wetlands which in the actual plant building location will be the water wells dug by the community for drinking water that during excavation and landscaping might be destroyed.

c) *Exposure of herpetofauna to predation and road deaths*

Cleared vegetation will expose herpetofauna to their predators when closing the roads and in open spaces created to accommodate transmission line. The animals will be prone to being crushed on the road by vehicles. This is especially during the wet season when the animals have more movement in search of mates for breeding. Reptile forms a diet for the local people with clearance of their habitats the reptiles will be more exposed

Figure 8-12: A Nile monitor Lizard (Varanus niloticus)

8.10.4.2 Invasive species and human-wildlife conflict

During the clearing of the project site, animals such as snakes and lizards may move to other areas. However, due to the sudden change of environment, there is likely aggression from animals such as agitated snakes trying to escape. Further, snakes will move to other sites that are near the area. The concentration of snakes and lizards like Nile monitor lizards may rise thus leading to competition for available resources near homes and feeding on domesticated animals. Increased snake bites and snake encounters may occur to workers and the surrounding general population. A construction camp is going to be established holding about 2000 workers. Waste and new habitats formed will attract lizards and rodents which in turn attract snakes this might cause human-wildlife conflicts as well as wildlife-wildlife conflicts.

8.10.4.3 Spillages of chemicals and oils

Oils and fuels from machines, generators and vehicles plus other chemicals used during construction and in the operation may accidentally spill on the site. These include chemicals used in the cleaning, treating and reducing the toxic gases in the operations of the plant. This spillages if collected by rain water will eventually accumulate and if not well disposed on the land will end-up in the ocean or in other habitats. This will contaminate water and soils and affect especially amphibians more because they rely on their skin for respiration. This will lead to death and low reproduction due to the eggs and larval stages not getting enough air thus leading to population changes (Mahaney, 1994, Akani et al. 2004). This can also have adverse effects if it lands in the ocean where turtles live, feed and bask.

8.10.4.4 Trace elements from the fly ash

The fly ash from coal combustion may contain residual trace elements such as arsenic, selenium, cadmium, chromium and mercury which are heavy metals. These chemicals are known to modify hormonal responses of amphibians and reptiles thereby affecting breeding. In turtles, these chemicals accumulate in embryos leading to deformations of the young (Hopkins et al. 2013). This trace elements accumulation in tissues also affects other reptiles and amphibians leading to poor and stunted growth. For instance in amphibians, the swimming ability of tadpoles is impaired if the trace elements are in water (Metts *et al*. 2013, Todd *et. al*. 2012, Wanda *et al*. 2011). This is because they cause deformation on juveniles that affects their activities such as breeding, avoiding predators and feeding.

8.10.4.5 Dust and exhaust particles pollution

During construction there will be exhaust fumes from vehicles and also dust during excavation which may affect breathing systems of herpetofauna. Amphibians which breathe through their skin and need to keep their skins moist for this purpose will be mostly affected. This will also include dust from the fly ash dump as it dries relatively fast and so can be blown by wind.

8.10.4.6 Alteration of marine environment

Cooling water for the power plant will be obtained from the Manda Bay. This will pose the danger to marine turtles which may get entrained in the moving screens, thus leading to death in the process. Another area of concern is the release of thermal water from the plant with elevated higher temperatures that may affect turtles, which are dependent on their environments temperature as they cannot thermo-regulate. The green turtle is endangered because its eggs and mature individual are harvested by humans for food. The green turtle prefer nesting areas on clean sandy beaches where it lays its eggs which might

be destroyed by clearing mangroves and dredging activities with pollution and sedimentation. Also spillages of oils and chemicals, raw sewerage, fly ash trace elements can lead to decline in their food sources which are mainly sea weed, algae and sea grass (IUCN 2010, Spawls *et al*. 2004).

Table 8-47: Impact significance for herpetofauna loss due to habitat modification and alteration- construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Long Term	High	Highly probable
	2	4	8	4
	Result: (-56) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Before the onset of the construction, a reforestation program should be initiated in conjunction with the local community • The excavation should start on one end preferably from the ocean side heading inland to allow animals to escape • Areas that will not be put to immediate use to be left intact. • If possible, avoid excavation during the rainy (wet) season when animals are breeding • Top soil to be kept aside for use in replanting and landscaping • Together with experts, relocate animals found in the site that move slowly during clearing and excavation • Re-establish original habitat patterns to improve surface water runoffs			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short	Low	Improbable
	2	2	4	2
	Result: (-16) Low negative			

Table 8-48: Impact significance for invasive species and human-wildlife conflict-Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Medium Term	Moderate	Probable
	2	3	6	3
	Result: (-33) Medium negative			
Mitigation measures	**Comments/Mitigation:** • All workers be equipped with appropriate personal protective equipment which must be worn during working hours			

	• Educate local people of dangers from snake bites and how to prevent them • Equip local hospitals with anti-venom readily available from centres such as Bio-ken situated in Malindi. • Train doctors to identify types of bites and how to treat them • Dispose all solid waste according to Kenya's waste management Regulations 2006 as a minimum • Trap and rid the site of any rodents or vermin which attract snakes			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short	Low	Improbable
	2	2	4	2
	Result: (-16) Low negative			

Table 8-49: Impact significance for spillage of chemicals and oils- Construction phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Study Area	Short	Moderate	Probable
	2	2	6	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • A log of all dangerous chemicals be kept, how to be used, transported stored and disposed • Keep all dangerous chemicals, oils, greases, solvents, and residues in a well secured receptacles. • Have a standard operating procedure on how to deal with chemical spills if they occur and how to prevent them • Have a spill response team readily available to respond to such incidents • Train workers on spill preparedness and response • Have a containment and disposal plan for all hazardous materials • All used oils and hazardous wastes should be disposed of according to NEMA waste management regulations 2006			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Very short	Minor	Improbable
	2	1	2	2
	Result: (-10) Low negative			

Table 8-50: Impact significance for alteration of marine environment-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Long Term	High	Highly probable
	2	4	8	4
	Result: (-56) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Recycle water used in the plant to minimize uptakes • Use barrier nets around the intake area to prevent entrainment of animals • Use the IFC recommended uptake velocities of 0.5ft/s • Use multiport diffusers when releasing water into the sea • Treat all waste water and runoff water before coming to contact with the ocean • All used oils, hazardous wastes and effluent to be disposed of according to NEMA waste management regulations 2006			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Long term	Low	Improbable
	2	4	4	2
	Result: (-20) Low negative			

Table 8-51: Impact significance for invasive species and human-wildlife conflict-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Long Term	Low	Probable
	2	4	4	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The project on-site medical center should be equipped to provide anti-venom if a trained doctor will be available full-time • Equip local hospitals with anti-venom readily available in Bio-ken Malindi. • Train doctors to identify types of bites and how to treat • Dispose all solid waste according to NEMA waste management regulations 2006 and EMCA act 1999 • Trap and rid-off the site of any rodents which attract snakes			

Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Study Area	Long Term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

Table 8-52: Impact significance for spillage of chemicals and oils and release of trace heavy metals from ash yard-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Short	Moderate	Probable
	2	2	4	3
	Result: (-24) Low negative			
Mitigation measures	**Comments/Mitigation:** • A log of all dangerous chemicals be kept, how to be used, transported stored and disposed • Keep all dangerous chemicals, oils, greases, solvents, and residues in a secure room. • Have a standard operating procedure on how to deal with spills • Have a spill response team readily available to respond • Train worker on spills and how to deal with them • Have a containment and disposal plan for all hazardous material (where to dispose) • Collect and separate all water from rain from different areas like roof and ground surface run-off then store and treat separately • All oils and hazardous materials to be disposed of according to NEMA waste management regulations 2006 and EMCA act 1999			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			

Table 8-53: Impact significance for dust and exhaust particles pollution-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Low	Probable
	2	2	4	3
	Result: (-24) Low negative			

Mitigation measures	**Comments/Mitigation:** • Water sprinklers should be used to reduce dust where activities will generate it • Vehicle speed should be set at 30 to 40 KPH to reduce dust emissions • It is recommended that low sulphur diesel is used for construction plant and equipment			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short	Low	Improbable
	2	2	4	2
	Result: (-16) Low negative			

8.10.5 Impacts on Invertebrate fauna

8.10.5.1 Destruction and loss of habitat

The excavation of land for construction of the coal plant, ash yards, coal stock pile areas, housing estate and access roads will lead to loss of habitats especially for the ground dwelling species. Natural vegetation will be cleared affecting the species that depend on it for food and shelter. There will therefore be loss of breeding and nesting areas. This loss is not projected to be significant for invertebrates since only a fraction of the larger area will be excavated and the study did not identify a species that has a very restricted habitat that was within the areas to be cleared.

8.10.5.2 Possible effects of gaseous emissions and dust

Air contaminants accumulate in insects tissues by ingestion, respiration or penetration through the cuticle. There are known interactions between sulfur compounds from coal plants and insects which show changes in population dynamics induced by sulfur compound pollution stress (Eric and Robert, 1977). Sulfur and nitrogenous gases emitted from the combustion of fossil fuels contributes to the formation of acidic rains that may lead to the following:

- Interference with phytophagous (plant feeding) invertebrates: The loss of vegetation cover due to acidic rains together with the covering of vegetation with soot which might contain heavy metals will in turn affect a variety of leaf feeding invertebrates such as grasshoppers and leaf beetles;
- Decline of pollinators: Contamination with various pollutants emanating from a coal power plant has been shown to affect the abundance social bees such as the African honey bee even at very low concentrations (Gary and Orie, 1980). Decline of these major pollinators will result in reduced pollination which in turn will affect the agricultural productivity of the farming communities bordering the project area;
- Decline of natural predators and parasitoids: Parasitic wasps have been shown to suffer from coal plant emissions (Gary and Orie, 1980). Decline of these predators and parasitic groups have been shown to lead to a rapid increase of several plant feeding insects (Gary and Orie, 1980);
- Effects on ground beetles (Carabidae): A number of insect groups with a strong sensory system such as predacious beetles e.g. ground beetles have been shown to reduce in

abundance due to pollutants emanating from coal (Gary and Orie, 1980). These beetles live in very close association with the soils and detritus.

8.10.5.3 Effects of increased vehicular activities on invertebrates

There is likely to be increased emissions and dust from vehicles to and from the construction site which will no doubt soil the leaves of plants adjacent to the access roads used for the project. These are likely to affect the vegetation which in turn will have some effects on invertebrates that depend on them. This may however not be widespread but localized in the immediate areas next to the access road.

8.10.5.4 Potential effects of ash yards

Different ground dwelling invertebrate groups require different pH conditions of the soil. The dispersal of ash from the ash yard to neighboring locations is likely to increase the pH of the soils in the surrounding areas. This will have an effect on those species that require neutral or acidic soil conditions for survival.

8.10.5.5 Likely effects of desalination on marine invertebrates

The project will have a desalination plant to provide water for various uses. Desalination of sea or ocean water is a widespread technology used in many countries in the world to solve the problem of water quality. It is quite common in the North Africa, Middle East, (Pantell, 1993) and fast growing in United States of America (Jenkins and Wasyl, 2005). If not well mitigated, desalination might have potential effects on marine invertebrates both during the uptake and release of the resultant brine back into the sea. These impacts of sea water desalination can be attributed to operational aspects below.

- Impingement where large marine invertebrates such as crabs and lobsters are trapped on the intake screen, resulting in their injury or death;
- High concentration of brine: It has been estimated that salinity levels of the discharge brine is approximately double that of the intake sea water which equals to 64-70 ppt (part per thousands) (Rashad, 2007). The average salinity of the sea water is approximately 30-37 ppt (Millero and Sohn, 1992); in the Lamu area, the salinity is usually less than 34% (Kitheka, 1997);
- Increased alkalinity in the discharge water due to basic/alkaline chemicals used during desalination (calcium carbonate and calcium sulfate);

8.10.5.6 Light pollution from lighting during and post construction

A lot of artificial light is expected in the evenings all through the construction phase as well as from security lights in the housing estate during the operational phase. An expected effect this is that it will attract large amounts of both nocturnal and diurnal invertebrates mainly insects. Some of the groups highly attracted to light are moths, beetles, midges, crane flies, mayflies, ant lions, bush crickets, and the water bugs (Eisenbeis, & Hassel, 2000). Many types of marine invertebrates, such as late-stage crab larvae, are also attracted to artificial light (Porter et al, 2008) It is estimated that about a third of all insects attracted to street lighting die (Eisenbeis, 2006). In a study carried out in Finland, it was found that even light as little as that of a light trap can lead to extinction of some moth that have very small populations (Väisänen & Hublin, 1983). Most of these attracted invertebrates do not find their way into the natural habitats but rather rest on the ground where they are either trampled or predated on. Artificial lighting also repels some species that operate under the cover of darkness. These include earwigs, cockroaches, woodlice,

earthworms and scorpion (Camp & Gaffin, 1999). This affects their feeding and breeding patterns and it is highly probable that it threatens their survival prospects.

8.10.5.7 Expected effects of developments such as housing estates

These developments are likely to cause a proliferation of undesirable species. The influx of many workers in the area and mushrooming of residential estates to accommodate them will result in the generation of tonnes of garbage and sewerage. This will in turn attract a few undesirable invertebrate species such as house flies (*Musca domestica*) and blow flies (*Chrysomya spp*). Production of sewage and forming of other organically enriched water pools from these residential estates will create conducive breeding habitat *Culex quinquefascitus* for mosquitoes. This is an urban mosquito that thrives in organically contaminated waters. Besides being a source of great biting nuisance, it is the main vector of elephantiasis in urban areas. This was found in large populations in Lamu Island and Mokowe during the study period. The housing estates together with the expected urban development will most certainly bring with it the two nuisance cockroach species *Blatella germanica* and *Periplaneta americana* and to a smaller extent the Psychodid moth flies.

8.10.5.8 Impacts of pooling of storm waters from paved areas and road construction

Run-off water from the paved area and roadside pool resulting from access road construction will create breeding grounds for *Anopheles gambiae* and *An. funestus* mosquitoes. These two are the principle vectors of malaria in Africa.

8.10.5.9 Impact of harvesting construction material locally

Locally sourced construction materials such as sand from nearby rivers will distort the ecosystems from which they are sourced. Sand harvesting from rivers particularly affects the dragonflies in the family *Gomphidae* that specifically breed in sandy substrates in rivers and streams.

Table 8-54: Impact significance for destruction and loss of habitat – Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Short	Low	Definite
	2	2	4	5
	Result: (-40) Medium negative			
Mitigation measures	**Comments/Mitigation:** • If possible, creation of new access roads should be avoided. Improve and use existing roads to the site • No burning should be employed to clear vegetation. Employ alternative methods such as clearing by machines. This will allow as many species as possible in the affected areas to migrate to the non-affected areas.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
	Localized	Short	Minor	Improbable

With mitigation	1	2	2	2
	Result: (-10) Low negative			

Table 8-55: Impact significance for gaseous emissions and dust – Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Localized	Very short	Minor	Probable
	1	1	2	3
	Result: (-12) Low negative			
Mitigation measures	**Comments/Mitigation:** • Earth moving should be planned to coincide with rains or during the time of the day when it is calm with low invertebrate activity			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Very short	Small	Highly improbable
	1	1	0	1
	Result: (-2) Low negative			

Table 8-56: Impact significance for increased vehicular activities– Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Short	Minor	Highly probable
	2	2	2	4
	Result: (-24) Low negative			
Mitigation measures	**Comments/Mitigation:** • If possible creation of new access roads should be avoided. Improve and use existing roads to the site • No burning should be employed to clear vegetation. Employ alternative methods such as clearing by machines. This will allow as many species as possible in the affected areas to migrate to the non-affected areas. • Use regular watering of access roads as a dust suppression technique			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Small	Improbable
	2	2	0	2

	Result: (-8) Low negative

Table 8-57: Impact significance for effects of ash yards –construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Localized	Short	Minor	Probable
	1	2	2	3
	Result: (-15) Low negative			
Mitigation measures	**Comments/Mitigation:** • Restrict the excavation area to only that demarcated for the ash yard • Ensure that the ash yard is properly bunded with an impermeable layer beneath it			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Short	Small	Improbable
	1	2	0	2
	Result: (-6) Low negative			

Table 8-58: Impact significance for pooling of storm waters from paved areas and road construction – Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Localized	Short term	Low	Probable
	1	2	4	3
	Result: (-21) Low negative			
Mitigation measures	**Comments/Mitigation:** • Proper drainage of storm waters should be taken into account right from the design phase of paved areas and access roads to avoid storm water retention.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Short term	Minor	Improbable
	1	2	2	2
	Result: (-10) Low negative			

Table 8-59: Impact significance for harvesting construction material locally – Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Short term	Moderate	Probable
	3	2	6	3
	Result: (-33) Medium negative			
Mitigation measures	**Comments/Mitigation:** • If possible, the EPC contractor should source all construction materials from existing borrow pits			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Regional	Short term	Low	Improbable
	3	2	2	2
	Result: (-14) Low negative			

Table 8-60: Impact significance associated with development of housing estates – Construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Localized	Short term	Minor	Improbable
	1	2	2	2
	Result: (-10) Low negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should institute proper garbage and sewerage management for the temporary workers' accommodation area to prevent garbage breeding flies such as house flies and filth flies.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Short	Small	Highly improbable
	1	2	0	1
	Result: (-3) Low negative			

Table 8-61: Impact significance for desalination water effects on marine life – operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
	Study area	Long term	Low	Probable

Without mitigation	2	4	4	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Locate the circulating water inlet and outlets in areas of the sea with lesser biodiversity or fewer sensitive species such as corals			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			

Table 8-62: Impact significance for light pollution– operational phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Study Area	Long term	Minor	Probable
	2	4	2	3
	Result: (-24) Low negative			
Mitigation measures	**Comments/Mitigation:** • Minimize the impacts of lighting by using the minimum number of bulbs. • The O&M Company should use low pressure sodium vapor lamps, also known as sodium oxide lamps. • Floodlights at the edges of the project site should be positioned to face away from the adjacent areas. • When not needed, the floodlights should be switched off			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Long term	Small	Improbable
	2	4	0	2
	Result: (-12) Low negative			

Table 8-63: Effects of developments such as housing estates – Operational phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Localized	Long term	Minor	Improbable
	1	4	2	2
	Result: (-14) Low negative			

Mitigation measures	**Comments/Mitigation:** • The O&M Company should use proper garbage and sewerage management to keep garbage breeding flies such as house flies and filth flies in check. • All residential house should have screened windows			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Long term	Small	Highly Improbable
	1	4	0	1
	Result: (-5) Low negative			

8.10.6 Impacts on mammals

8.10.6.1 Habitat Alteration

Clearing of vegetation, soil excavation and construction of facilities may alter the habitat for mammals in the area. The population of trees and other plant species will also be reduced through clearing of vegetation to pave way for the power plant structures. It is expected that vegetation will be stripped in some of the areas leading to loss of ecological functional areas such as woodlands and bushes. As a result wildlife ranging, foraging and roosting areas may be adversely affected.

8.10.6.2 Displacement of mammals from project site

Spatial occupation of the area by project facilities and people will displace mammals that currently forage in the project area and could create a barrier effect, which may alter their dispersal patterns. Displacement may lead to human-wildlife conflict in other locations as animals could move to human-occupied areas in the vicinity of the project site looking for foraging grounds.

8.10.6.3 Alteration of mammal movements and behaviors

Mammals' species including bats are sensitive to human occupation. Disturbances include flood lights, vehicle lights and noise from machinery and vehicles. This will affect movement of mammal species across the landscape, and may result in occasional road kills. Occupation of the area by project facilities will render the site inaccessible to mammals. This will reduce faunal foraging options by barring the site as a foraging ground. Noise and vibrations from the heavy machinery may interfere with foraging, ranging, breeding and nesting behavior of mammals in the ecosystem within the project site and those in the larger ecosystem.

8.10.6.4 Collision impact on bats

Bats may collide with the emissions stack of the coal power plant. This is expected to be more intense during hours of heightened bat activity (typically 1800hrs to 2359hrs).

Table 8-64: Impact significance for habitat alteration for mammals-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Short Term	Moderate	Probable
	2	2	6	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • As part of the rehabilitation plan, the O&M company should consider a re-afforestation program for mammals; • Areas devoid of human activities should be left intact or rehabilitated and allowed to regenerate.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Very short	Low	Improbable
	2	1	4	2
	Result: (-14) Low negative			

Table 8-65: Impact Significance on Mammal Displacement-Construction Phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study Area	Short term	Moderate	Probable
	2	2	6	3
	Result: (-30) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should engage the Kenya Wildlife Service (KWS) to translocate large mammals from the project area to the nearest conservation area. • The EPC contractor should engage the KWS during the construction period to monitor the movements of translocated mammals to ensure they remain within the conservation area			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study Area	Short term	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			

Table 8-66: Impact significance for bat collision with emission stack-operation phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Low	Improbable
	2	4	4	2
	Result: (-20) Low negative			
Mitigation measures	**Comments/Mitigation:** • The O&M Company should consider using radar techniques to deter bats from venturing close to the stack.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Long Term	Minor	Probable
	2	4	2	2
	Result: (-16) Low negative			

8.11 Socio-economical-cultural environment

8.11.1 Increased affordability, reliability and stability of electricity supply

The proposed project is envisioned to inject about 981.5MW of electricity into the national grid, currently standing at 2173MW as at December 2014, as part of the Government of Kenya's Least Cost Development Plan for power generation to bring down the cost of power via a more stable, cheaper, reliable platform. Once complete, the Project will constitute approximately 36% of the new combined grid capacity as well as bring down the average cost of generation for Kenya Power and Light Company ("KPLC"). This is expected to:

a) Increase KPLC's outreach and connectivity with emphasis on rural electrification, educational institutions, health institutions and micro-enterprises;

b) Significantly reduce the cost of electricity;

c) Address the current power shedding outages experienced nationally and;

d) Address the current uncertainty of power generation from hydropower

Table 8-67: Impact significance for increased affordability, reliability and stability of electricity supply - Operational phase

Enhancement Status	Extent	Duration	Magnitude	Probability
Without enhancement	National	Medium term	High	Definite
	4	3	4	4
	Result: (+44) Medium positive			

Enhancement measures	• The O&M Company should minimize, to the extent possible, operational cost that may subsequently result in an increase in consumer tariffs • O&M Company should employ appropriate technologies to increase efficiency and stability of power generation			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	National	Medium term	High	Definite
	4	3	8	5
	Result: (+75) High positive			

8.11.2 Creation of direct, indirect and induced employment

The proposed project is envisioned to generate direct and indirect employment opportunities for both skilled and unskilled workers. Direct employment includes jobs at the power plant during the construction and operational phases. Indirect employment will be realized through increased business opportunities and spurred economic growth both at the County and national levels. APCL is committed to build the capacity and capability of local people and businesses to benefit from the project.

Creation of employment opportunities was perceived to be the most important benefit of the project by the communities in Lamu. This was mainly expected to benefit the unemployed people living within and around the proposed project site. The unemployment levels are generally high in the region and expectations on job opportunities are high among the people of the area. APCL will also ensure gender balance during employment to help empower women in the community. APLC envisions building the capacity of 1000 local youth through the National Youth Service with an aim of absorbing them into the project during the construction phase.

During the construction phase, it is projected that the workforce will peak at approximately 2,978 personnel with 59% of these being Kenyan workers and 41% Chinese workers. These will mainly be semi-skilled and unskilled jobs. A large fraction of the construction-based jobs will be under civil works which will include but not limited to carpentry, steel-works, water-works, concrete-works and masonry. The operational phase of the project is anticipated to peak at approximately 320 workers at commissioning (with at least 50% of these being Kenyan personnel) with a projected growth to about 500 jobs. These will mainly be skilled positions.

It is anticipated that the proposed project will result in a marked increase in individual income nationally and specifically for the Lamu community. This will be attributed by the increased purchases from local and national businesses, employment generated by project activities, and a general spur of economic activities stimulated by the project.

The Energy (Local Content) Regulations (2014) provides guiding principles that will ensure the local communities and Kenyans benefit from the proposed project. The regulations place an obligation on APCL and its contactors to:

a) Ensure that local content is a component of their operational energy activities

b) Establish a local office, where procurement, project management and implementation decision making are to take place, to the satisfaction of the Commission.

c) Give Kenyan citizens the first consideration for employment and training in any operations executed in energy activities

d) Give first consideration to services provided from within Kenya, to goods manufactured in Kenya, to locally available goods and Kenyans citizens

e) Submit a Local Content plan to the Commission demonstrating compliance with the Kenyan Local Content requirements. The Local Content plan should detail how the proponent and its contractors shall ensure:

- First consideration to services provided within the country and goods manufactured in the country where the goods meet the specifications of the energy sector as established by-the Kenya Bureau of Standards or by other internationally acceptable standards
- Qualified Kenyans are given first consideration with respect to employment
- Adequate provision is made for the training of Kenyans on the job

While Part two of the first schedule on minimum local content in goods and services under the Local Content regulations will guide the specific local content to be achieved, part one provides a premise for the assumption that the proposed project will dedicate at least 30% - 40% of the total project budget to local content. Based on this assumption, at least KES 5.4 billon of the KES 18 billion project budget will be expended on local content resulting in a significant increase in individual income nationally.

Table 8-68: Impact significance on creation of direct, indirect and induced employment - construction phase

Enhancement Status	Extent	Duration	Magnitude	Probability
Without enhancement	Localized	Short term	Low	Probable
	1	2	4	3
	Result: (+21) Low positive			
Enhancement measures	• APCL and its contractors must endeavor to prioritize the local community in the allocation of job opportunities, prioritizing from the residents immediately neighboring and/or displaced by the project, to the larger Lamu County • APCL should also ensure opportunities for capacity building are afforded to the local communities to enable them to benefit from the available employment opportunities. This includes training in skills set required during the construction and operational phases of the project • Job advertisements should be made through mediums that are easily accessible to the local community such as Chief's noticeboards, CLO's, local radios, etc. • Where possible, expertise should be sourced locally then nationally before resorting to engagement of international experts • The recruitment selection process should seek to promote gender equality and the employment of women where possible. • Management and enhancement measures for local employment should be included in the company's labor and human resources plan.			

	• Where possible, Lamu County administration should be consulted when recruiting local workers • APCL should make a conscious effort to promote local businesspeople in the procurement of goods and services to assist in providing more economic and employment opportunities for the local community			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	Regional	Short term	Moderate	Definite
	3	2	8	5
	Result: (+65) High positive			

Table 8-69: Impact significance on creation of direct, indirect and induced employment - operational phase

Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Localized	Short term	Low	Probable
	1	3	4	3
	Result: (+24) Low positive			
Enhancement measures	• APCL and its contractors must endeavor to provide the local community for any job opportunities, prioritizing from the residents immediately neighboring and/or displaced by the project, to the larger Lamu County • The O&M Company should ensure opportunities for capacity building is afforded to the local communities to enable them to benefit from the available employment opportunities. This includes training in skills set required during the construction and operational phases of the project • Expertise should be sourced locally then nationally before resorting to engagement of international experts • Job advertisements should be made through mediums that are easily accessible to the local community such as Chief's noticeboards, CLO's, local radios, etc. • The recruitment selection process should seek to promote gender equality and the employment of women where possible. • Management and enhancement measures for local employment should be included in the company's labor and human resources plan. • Where feasible, Lamu County administration should be consulted when recruiting local workers • Promotion and prioritization of employment opportunities for the local community • APCL should make a conscious effort to promote local businesspeople in the procurement of goods and services to assist			

	in providing more economic and employment opportunities for the local community			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	National	Short term	High	Definite
	4	3	6	5
	Result: (+65) High positive			

8.11.3 Economic growth

The proposed 1,050MW coal power project is of such a magnitude that will impact the economy of the whole country and by extension the East Africa region. Implementation of the proposed project is anticipated to stimulate economic growth through:

- Elevation of Lamu County's profile with subsequent infrastructural development, increased revenue and investment in the county
- Access to affordable and reliable power by industries and micro-enterprises nationally. This will promote the emergence of new enterprises and boost business and economic opportunities both in the informal and informal sectors. This is also expected to increase productivity of all sectors through mechanization of sectors such as agriculture, enhanced industrialization and adoption of ICT.
- Enhanced availability of markets for local products. Both goods and services such as food supplies, catering services and construction materials will be required during construction as well as operations. As rightly perceived by the local communities, this will lead to secondary employment and creation of small supporting businesses.
- Increased tax revenue through VAT, withholding tax on imported services and PAYE on project employee salaries

Table 8-70: Impact significance of economic growth - construction phase

Enhancement Status	Extent	Duration	Magnitude	Probability
Without enhancement	Regional	Short term	Low	Probable
	3	2	4	3
	Result: (+27) Low positive			

Enhancement measures	• The Government, in partnership with APCL, should provide financial literacy training to individuals compensated during the RAP to ensure prudent investment and utilization of the funds • Ensure that economic opportunities are available or are created for the local community and that proper capacity building is afforded to the local communities to enable them to benefit from the available economic opportunities • Communication and information programs should be used to manage expectations and target local service providers • APCL and its contractors should, to the extent possible, make deliberate efforts to source for all required supplies from local providers, prioritizing from Lamu County to the rest of the Country, before resorting to importation • Tender documents should include guidelines for the involvement of local entrepreneurs, businesses and SMEs from the local sector			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	National	Short term	High	High
	4	2	8	4
	Result: (+56) Medium positive			

Table 8-71: Impact significance of economic growth - operational phase

Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Regional	Short term	Low	Probable
	3	2	4	3
	Result: (+27) Low positive			
Enhancement measures	• Ensure that economic opportunities are available or are created for the local community and that proper capacity building is afforded to the local communities to enable them to benefit from the available economic opportunities • Communication and information programs should be used to manage expectations and target local service providers • The O&M Company should, to the extent possible, make deliberate efforts to source for all required supplies from local providers, prioritizing from Lamu County to the rest of the Country, before resorting to importation • Tender documents should include guidelines for the involvement of local entrepreneurs, businesses and SMEs from the local sector • APCL, through its CSR programme, should promote and support economic empowerment initiatives for the local community • APCL should endeavor to minimize, to the extent possible, production costs, subsequently lowering electricity cost nationwide			

	• APCL should remit all applicable taxes to the local and national Government, as per legal provisions			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	International	Medium term	High	Definite
	5	3	8	5
	Result: (+80) High positive			

8.11.4 Infrastructure development

Lamu County generally suffers from poor underdeveloped infrastructure. It is anticipated that the implementation of the proposed project will stimulate the enhancement of the following infrastructures:

- Transportation Infrastructure: improvement of existing roads, creation of new roads and associated structures such as bridges; Improvement of existing jetties and creation of new ones.
- Public Health Infrastructure: improvement of health facilities; desalination and provision of potable water supplies; wastewater treatment and management; solid and hazardous waste management and treatment
- Communications Infrastructure: enhanced telephone services (fixed lines and mobile) and associated transmission facilities
- Energy Infrastructure: improvement of electrical power supply

Table 8-72: Impact significance on infrastructure development - construction phase

Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without enhancement	Localized	Short term	Minor	Probable
	1	2	2	3
	Result: (+15) Low positive			
Enhancement measures	• APCL should collaborate with the relevant Government ministries to enhance infrastructural development, with emphasis on infrastructure that may experience immediate and adverse strain directly from project activities, and of which existing provisions are inadequate to handle project-related strain without compromising access by the local communities such as public health, education, transport and housing			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	Regional	Long term	Very high	High
	3	4	10	4
	Result: (+68) High positive			

Table 8-73: Impact significance on infrastructure development - operational phase

Enhancement Status	Extent	Duration	Magnitude	Probability
Without enhancement	Localized	Medium term	Minor	Probable
	1	3	2	3
	Result: (+18) Low positive			
Enhancement measures	• The County and national Government should leverage on the anticipated economic growth and support infrastructural development to meet the growing demands, both within Lamu County as well as Nationally • APCL should collaborate with the relevant Government ministries to enhance infrastructural development, with emphasis on infrastructure that may experience immediate and adverse strain directly from project activities, and of which existing provisions are inadequate to handle project-related strain without compromising access by the local communities such as public health, education, transport and housing • The County and national Government should endeavor to prioritize the development of crucial infrastructure for the County			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	National	Permanent	Very high	High
	4	5	10	4
	Result: (+76) High positive			

8.11.5 Capacity building

APCL aims at building capacity of the local communities to enable them to benefit from the immediate project opportunities such as employment during the construction phase, as well as for sustainability throughout the project lifecycle. APCL envisions imparting practical skills to 1000 local youth through the National Youth Service with an aim of absorbing them into the project during the construction phase. These skills will be retained in the local community even after the decommissioning of the power plant and will increase the residents' employability as they secure jobs in other developments that may arise in the area. Additionally, APCL will also increase the competency levels of its workers through continued capacity building and exposure.

Being the first project of its nature and magnitude, the proposed 1,050 megawatt power plant will employ various international experts who will work along local employees. Through this, there will be a transfer of technology and skills to the local community, creating a pool of highly skilled professionals with specialized knowledge that will be utilized in the continued implementation of the power plant as well as in implementing future projects of a similar nature. APCL will institute deliberate structures to promote and enhance this knowledge transfer. Throughout the construction and commissioning phases of the project, APCL and its contractors will maintain a workforce composition of at least 50% Kenyan personnel to work and learn alongside Chinese expatriates. Under the Energy (Local Content) Regulations (2014), APCL and its contractors are obligated to develop an

employment and training plan and succession plan with respect to all energy activities. The succession plan will make provisions for and require Kenyans to understudy the requirements of the position held by a non-Kenyan for a period determined by the Commission on a case-by-case basis after which the position occupied by the non-Kenyan will be assumed by the Kenyan to ensure that the minimum local content levels are met.

Education empowers a person to participate in the development process. It inculcates knowledge and skills needed to improve the income earning potential and in turn the quality of life. Lamu County suffers from inadequate education infrastructure and consistent poor performance in education as ranked nationally. Through its CSR program, APCL envisions to collaborate with the County Government and other development actors to support the improvement of education standards in the County.

Table 8-74: Impact significance on knowledge transfer and capacity building - construction phase

Enhancement Status	Extent	Duration	Magnitude	Probability
Without enhancement	Localized	Short term	Small	High
	1	2	0	4
	Result: (+12) Low positive			
Enhancement measures	• The EPC contractor should institute an elaborate structure to promote and enhance knowledge transfer between international experts employed by the project and the local employees. This should be a set requirement for all international firms contracted by APCL • The EPC contractor should ensure effective capacity building is afforded to the local communities to enable them to benefit from the available economic opportunities. This includes training for the skills required during the construction and operational phases of the project • The EPC contractor should effectively communicate the skill requirements to the local community well in advance of the construction and operational phases. This should be done through mediums that are easily accessible to the local community such as CLOs, community noticeboards, local radio, etc.			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	Regionally	Short term	High	Very high
	3	2	8	5
	Result: (+65) High positive			

Table 8-75: Impact significance on knowledge transfer and capacity building - operational phase

Enhancement Status	Extent	Duration	Magnitude	Probability
	Study area	Medium term	Small	High

Without enhancement	2	3	0	4
	Result: (+20) Low positive			
Mitigation measures	• The O&M Company should institute an elaborate structure to promote and enhance knowledge transfer between international experts employed by the project and the local employees. This should be a set requirement for all international firms contracted by the O&M Company • The O&M Company should ensure effective capacity building is afforded to the local communities to enable them to benefit from the available economic opportunities. This includes training for the skills required during the construction and operational phases of the project • As part of its CSR, APCL should consider support of tertiary education specifically to the Lamu community. The beneficiaries should then be absorbed by APCL and its contractors in gainful employment or provision of business opportunities • Additionally, in collaboration with the County Government and other non-state development agencies, APCL should consider supporting infrastructural development for local primary and secondary schools • The O&M Company should effectively communicate the skill requirements to the local community well in advance of the construction and operational phases. This should be done through mediums that are easily accessible to the local community such as CLOs, community noticeboards, local radio, etc.			
Enhancement Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With enhancement	Nationally	Medium term	High	High
	4	3	8	5
	Result: (+75) High positive			

8.11.6 Land acquisition and involuntary resettlement

The 1,050MW power plant will require approximately ~394.9 hectares (~975.4 acres) of land. This will necessitate the acquisition of the land and subsequent relocation of all legitimate project affected persons (PAPs) within the delineated project site including those who live on, have assets on, and or engage in commercial activities on the required land through a Resettlement Action Plan (RAP).

The Request for Proposal (RFP) for the proposed project stated that the Ministry of Energy and Petroleum (MoEP) would provide the developer with land free of encumbrances for constructing and operating the power plant. Subsequently, the RAP process is being led by the MoEP. The land tenure for the project site is defined as "Community Land" which according to the Constitution of Kenya 2010 is held in trust by the County Government of Lamu.

The RAP will be conducted in accordance with the requirements of the African Development Bank's Operational Safeguard 2 titled Involuntary Resettlement and the International Finance Corporation's Performance Standard 5 titled Land Acquisition and Involuntary Resettlement.

In order to satisfy the legal and lender requirements of the RAP, two committees were set up namely a Steering Committee and a Technical Committee. The steering committee is the higher level committee that provides leadership on the resettlement management framework while the technical committee provides technical advice on how resettlement and land acquisition issues for the proposed project should be handled. The membership of the two committees comprises the County Government of Lamu, The County Commissioner of Lamu (representing the national government), the National Lands Commission (NLC), the LAPPSET Corridor Development Authority (LCDA), Kenya Ports Authority (KPA), the community committees and the project developer.

The County Government Act, 2012 requires that any project of national significance must be presented to the County Assembly for consideration. The project developer satisfied this required in mid-2015 when the County Assembly of Lamu unanimously approved the development of the project. This paved the way for the County Government of Lamu to allocate the land to the project developer.

According to the Lands Act 2012, the implementing agency for acquiring community land is the National Lands Commission (NLC). The NLC will implement the recommendations of the RAP which is currently being undertaken by the MoEP.

Implementation of the RAP in accordance with the requirements of national legislation and lender requirements is a significant issue in the pre-construction phase of the project. The PAPs expressed this as an important milestone during the stakeholder engagement process. Some of the potential socio-economic concerns associated with land acquisition and involuntary resettlement include:

- Relocation of the PAPs to areas with fewer resources compared to the project site. This may include loss of farmland due to relocation to smaller parcels of land, absence of forests, fishing grounds, grazing grounds, etc.;
- Relocation of individuals to areas where their productivity skills are less applicable;
- Disruption of social networks and community organization;
- Loss of cultural identity and ancestral heritage through disruption of traditional authority, culturally significant sites and rituals, and dispersion of kin groups; and
- During consultations with the local women, they expressed concerns that since the men hold ownership rights to land and property, and given the high poverty and low financial literacy within the local communities, the women feared that the men would misappropriate resources provided as compensation for land and assets during the project-related land take, leaving the women and children poor and landless.

Table 8-76: Impact significance of land acquisition and involuntary resettlement – pre-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Long-term	High	Highly-probable
	3	4	8	4
	Result: (-60) High negative			

Mitigation measures	• The MoEP and NLC should implement a RAP that complies with Kenyan legislation and lender requirements of the African Development Bank's Operational Safeguard 2. The RAP should also comply with the requirements of Performance Standard 5 of the International Finance Corporation on Land Acquisition and Involuntary Resettlement • The National Land Commission (NLC) should ensure full disclosure, consultation and meaningful engagement of the PAPs throughout the resettlement process (including the host communities) • The NLC should develop and implement a compensation plan for displaced and relocated people commensurate to the lost socio-economic value. • The NLC should ensure that new locations are culturally and commercially compatible with the proposed project site • The NLC should provide counseling services for the PAPs to assist them in adaptation of the new surroundings • The NLC should provide financial literacy training for PAPs for sustainable management of the funds			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Regional	Long-term	Low	Improbable
	3	4	4	2
	Result: (-22) Low negative			

8.11.7 Disruption and loss of livelihoods

Disruption and loss of livelihoods is defined as the loss of assets or access to assets that result in a loss of income or means of livelihood. This type of economic resettlement can have greater effects than physical resettlement.

The land required for the proposed project (~360 hectares) is defined as community land (which is held in trust by the County Government of Lamu). Subsequently, none of the users of the affected land have formal land title.

The communities in the project area are primarily dependent on land cultivation for income and livelihood, supplemented by fishing and livestock husbandry. About 75% of the communities cultivating the land in the project area come from Pate Island.

The potential acquisition of land currently utilized for agriculture poses a risk in the loss of livelihoods from crop production. Those who conduct farming activities within the proposed project site include residents of Bargoni, Hindi and Pate Island. Nearly all of these do not reside within the proposed project site. Additionally, a section of the proposed project site covers land currently utilized for livestock grazing. These grazing lands are utilized by local farmers and nomadic pastoralists traveling from Garissa County in search of pasture.

There may also be limited tourism-related livelihoods at risk due to the negative visual/aesthetic impacts associated with the proposed power plant infrastructure. This is a perceptive risk based on one's visual sensitivity to the power plant.

According to the Statistical Abstract 2015 (produced by the KNBS), the quantity of fish landed in Lamu County in 2014 was 2,428 metric tons valued at KShs 277,945,000 which represents ~27% of the total fish landed in the coastal strip of Kenya. Of the 2,428 metric tons, marine fish accounted for 2,198 metric tons (valued at KShs 176,187,000), crustaceans accounted for 174 metric tons (valued at KShs 90,210,000) and other marine fish accounted for 56 metric tons (valued at KShs 11,548,000).

Given the above, disruption and loss of livelihoods related to the fishing industry was a concern expressed by the local community during stakeholder engagement meetings. The community's perception is that the proposed project may adversely impact fish landing sites and poisoning of fish through hazardous discharges into the sea by the power plant.

Even though ~75% of communities in Lamu depend directly or indirectly on fishing, the sector remains inadequately developed. Majority of the fishermen employ traditional techniques which have limited their capacity to fish in deep seas. An expressed concern was that project activities will destroy current fishing sights located adjacent to the islands, and result in migration of fish to the deep sea.

The extent of the impact associated with disruption of livelihoods will extend to the Bajuni community from Pate Island that cultivate in the Kwasasi area and is considered to be local. The loss of land in the project area and therefore impacts on livelihood and income generation will be permanent in duration for those cultivating in the project area.

Table 8-77: Impact significance on disruption and loss of livelihoods - construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long-term	Moderate	Highly probable
	2	4	6	4
	Result: (-48) Medium negative			
Mitigation measures	• The EPC contractor should avoid contamination of and destruction of fish landing sites while construction of the power plant and associated infrastructure; • The EPC contractor should have develop and implement a transparent recruitment plan for employment and business opportunities for the local community; • The EPC contractor should implement a capacity building program for the local communities to enable them to benefit from the available economic opportunities; • The MoEP should develop and implement an IFC compliant Resettlement Action Plan (RAP) for project affected persons. The NLC should implement the RAP developed by the MoEP • To mitigate loss of tourism-related livelihoods, the design of the power plant facilities should be done in a way that: o Minimizes loss of existing aesthetic and visual quality o Reduces the impact or disruption of activities at tourism and recreational areas / facilities			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**

With mitigation	Study area	Long term	Low	Improbable
	2	4	4	2
	Result: (-20) Low negative			

8.11.8 Impacts to demographic profile

Lamu town is an important religious center for Islam in East Africa. It is also a dominant cultural center reputed for its historic past and socio-cultural traditions that have been upheld to date.

It is envisaged that with the construction of the project, a substantial amount of money will be spent in the project area and its environs for sourcing construction materials. The local content could potentially amount to about 10% – 20% of the envisaged US$2 billion project cost which would amount to a significant amount of money that can be injected into the economy of Lamu County and the country as a whole. While there are positive aspects associated with such local content injection into the local economy, there may also be adverse impacts that could potentially result from access to disposable income which hitherto are not there.

Over the construction period of about 42 months, the peak workforce is expected to be approximately 2,978 persons; 50% of these are expected to be Chinese while the other 50% are expected to be Kenyan.

A temporary construction camp is will be constructed within the southern section of the project site. The EPC contractor will design and build the accommodation, cooking and sanitary facilities for the construction workers, laydown areas and parking areas. The entire project site (~394.9 hectares) will be fenced off; the construction camp which will be located within the project site will be fenced off too and access will be controlled and restricted to employees. The EPC contractor will develop and implement specific policies for the management of the camp and construction workforce.

The project is expected to impact the social fabric in the project area in the following ways:

- Broken family bonds from migration of workers to the project area;
- Rise in prevalence of sexually transmitted infections; and
- Increase in crime.

The extent of the impacts to demographics will largely be contained within the project-affected communities and subsequently, will be local in scale. The duration of impacts associated with the construction phase will largely be short-term, lasting about 42 months.

In some cases, impacts will be of shorter duration, particularly if opportunistic job seekers who are unable to secure work leave the area. The probability of impacts, however, is highly likely, based on past experience in the region and current conditions.

The communities living in the project area are ethnically homogenous as the vast majority of people in and around the project site belong to the Bajun tribe; subsequently any influx of "foreigners" whether Chinese or those from other parts of Kenya, will be keenly felt.

It is important to take cognizance of the existing tensions between the Bajun and other ethnic minorities from the rest of Kenya who may be perceived to take over jobs meant for the local communities living within Lamu County. Adding large numbers of people from other parts of Kenya seeking employment opportunities may further exacerbate such tensions.

The operational phase of the project is expected to begin in September 2019 and continue for approximately 25 years. The operational phase is estimated to require about 500 directly employed workers to operate the power station and its auxiliaries; about 50% will be Chinese and the other 50% will be Kenyan. The Operations and Maintenance (O&M) company will source these jobs locally within Lamu County if the skills base exists. Employment opportunities that will be made available and the stakeholder expectations in this regard must be managed appropriately.

The majority of the local and regional recruitment will be for semi-skilled and unskilled positions (such as kitchen staff, security guards and cleaners).

The skilled workers that will be sourced by the O&M Company will overshadow their Chinese counterparts with the view of taking over such positions over a period of time. The power plant will be operated on a 24-hour, seven day basis. The control room operators, general operators and watch keepers will work on rotating shifts and a number of them will be accommodated at the permanent worker colony.

The impacts of the project on demographic profile during the operational phase are expected to be similar to those of the construction phase and include:

- Population increase due to influx of opportunistic job seekers and operation workforce; and
- Change to the ethnic structure of the local area, created by non-local workforce.

The extent of impacts to demographics will remain largely contained within the project affected communities and will therefore be local in nature. The duration of impacts associated with the operations phase will be long term, continuing for the life of the Project and ceasing when the Project stops operating.

The small and ethnically homogenous nature of the affected communities increases their sensitivity to the arrival of newcomers, particularly foreigners (Chinese and those from other parts of Kenya). This sensitivity of the changing demographics during the operational phase could raise tensions in the project area.

Table 8-78: Impact significance on changes to demographic profile – construction and operational phases

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Long-term	Moderate	Probable
	3	4	6	3
	Result: (-39) Medium negative			
Mitigation measures	• The EPC contractor should develop and implement a transparent recruitment process and communicate the same through the area Chiefs' offices to manage expectations and opportunistic influxes • Priority for employment and other economic opportunities should be given to the local community to minimize in-migration • The EPC contractor should develop and implement camp and workforce management protocols which are clearly communicated to the workforce and enforcement measures implemented • The EPC contractor should customize the grievance mechanism developed in this ESIA Study and implement it for the construction phase of the project.			

	• The EPC Contractor and Developer should facilitate small land medium enterprise (SME) development in the local communities and surrounding region. • The EPC Contractor and Developer should invest in infrastructure development that can provide long-term benefit to the communities • The Developer should identify and facilitate training opportunities with vocational training institutions such as the Lamu Polytechnic for the local workforce to participate in other job sectors • The Developer should support sustainable development and implementation of new technologies in local agricultural production and fishing			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Regional	Long term	Low	Improbable
	3	4	4	2
	Result: (-22) Low negative			

8.11.9 Impacts on infrastructure and social amenities

With the commencement of the construction phase of the project, there will be an influx of workers in the project area. During the peak construction period, it is expected that there will be about 3,500 workers on site; the construction period is expected to be about 42 months.

The proposed project lies in the Lamu West constituency whose population according to the 2009 Housing and Population Statistics was 82,698 people and has a population density of 21 persons per square kilometer.

The existing infrastructure in the project area is poor. The communities in and around the project area do not have access to piped clean drinking water, toilet sanitation facilities and solid waste disposal. Residents rely on community shallow wells for water (the water is generally saline) and dump household waste in improvised landfills.

The communities in the Kwa Sasi area and generally in Hindi sub-county do not have access to electricity. During the public stakeholder consultations, the communities expressed a hope that the developer will supply the project affected communities with cheap electricity.

The enrollment for pre-primary, primary and secondary schools is adequate, however the challenge is performance of the students in national examinations. The County's youth economic empowerment lies in tertiary education; there are 4 youth polytechnics in the County, all in a deplorable state.

Lamu County has a total of 688.5km of roads of which only 6km is tarmacked. There are two main roads namely the Mokowe-Garsen road (C112) which connects the county to the rest of the coast counties and the county, and Mokowe –Kiunga Road (D568 and E865) which connects the county to Somalia border. These roads are unpaved and become difficult to use during the rainy season.

The existing roads will be used to transport about 30% of the construction materials, plant and equipment required for the project while 70% of the materials will be transported via sea to the project area. Parts of the C112 road from Garsen to Mokowe will need to be upgraded in order to allow some of the construction materials to be transported to the project site.

On improvements to the infrastructure, the project developer has already commenced a program of corporate social responsibility for assisting the project affected communities. For example, the developer has undertaken the following improvements to the infrastructure among several other initiatives that they have commenced:

- Development of early childhood development classes at Bobo Primary School;
- Construction of the computer laboratory at Bargoni Primary School;
- Provision of water tanks at several locations in Kwasasi and its environs including weekly supply of potable water free of charge;
- Provision of solar lights to members of the project affected communities;
- Supply and installation of a cold storage facility at Mokowe for sea food for the fishermen;
- Provision of solar street lights and interlocking concrete block paving in Lamu town.

The main negative impacts to infrastructure associated with the 42-month construction phase of the project include:

- Deterioration of the C112 road from Garsen to Mokowe especially during the rainy season resulting from transportation of goods by heavy commercial vehicles. At the time of the ESIA Study, it was unclear how many truck trips will be required for transporting goods on the C112;
- Disruption to road access from project vehicles;
- Influx of opportunistic job seekers into the communities, adding pressure to the overburdened infrastructure services (roads, schools, health facilities, etc.);
- Increased household wastes and the inability to dispose of the same in an environmentally safe manner; and
- Contamination of water resources used by local communities.

The positive impacts to infrastructure associated with the construction phase include:

- Upgrading sections of the C112 road between Garsen and Mokowe especially near the project site by keeping it in a motorable state;
- Developing an effluent treatment plant appropriately sized for the construction phase of the project;
- Supporting the Lamu County Government to develop an appropriately designed and sized land fill for solid waste management;
- CSR projects related to infrastructure which will be undertaken by the developer and EPC contractor over the 42-month construction period; and
- Developing and/or upgrading health and educational facilities within Hindi sub-county.

Some of the key operational phase impacts include:

- Inadequate electrical supply to the community;
- Limited piped water;
- Poor toilet sanitation and solid waste disposal;

- Poor health facilities; and
- Inadequate road systems.

The proposed project will provide a net 981.5MW of electrical power to the national grid at the National Control Center in Nairobi via a 520km long 400kV overhead transmission line. This will increase the total available electricity in the country by 981.5MW (a figure representing more than 45% of the country's total on-grid generating capacity as at December 2014).

The Project will make use of public roads for Project-related transport and the frequency of vehicle movements will be significantly lower than that experienced during the construction phase. During the operational phase, the developer may develop a tarmac section of the road from the project site to Mokowe.

There will be a permanent worker colony for about 350 persons built within the project area. This facility will be self-sufficient from a resource and waste management perspective. There will be a desalination plant constructed as part of the project; the water will be used as process water in the power plant, potable water in the worker colony and a flanged connection for potable water will be provided to the community at no cost at the project boundary. There will also be a permanent effluent treatment plant constructed for the workers at the power station.

The impacts to infrastructure during the operational phase are similar to those characterized for the construction phase namely:

- Influx of opportunistic job seekers into the communities, adding pressure to the overburdened infrastructure services (roads, schools, health facilities, etc.);
- Contamination of water resources used by local communities;
- Project use of the C112 road could reduce their capacity; and
- Increased power supply for the national grid.

Table 8-79: Impact significance for existing infrastructure and social amenities - construction and operational phases

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Long term	Moderate	Probable
	3	4	6	3
	Result: (-39) Medium negative			
Mitigation measures	• The EPC contractor and project developer should consult with relevant agencies (local and national Government and non-governmental organizations) on the current and future infrastructural development plans for the County and supplement their implementation; • The EPC contractor should consider providing housing facilities for all construction workers. If this is not possible, the EPC contractor should make plans to transport workers daily to and from Mokowe and Hindi to the project site using buses; • The EPC contractor should provide adequate infrastructure for water supply, waste management, health facilities, schools, etc. so as not to strain the existing County resources; • The EPC contractor should develop and implement a traffic management plan which should be strictly enforced. Among other			

	things, the construction vehicle traffic should be limited to roads indicated specifically for the project and avoid use of roads that would adversely disrupt effective functioning of local communities; • The EPC contractor should develop and implement adequate communication infrastructure for improving connectivity between the project site, regionally and nationally.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Regional	Long-term	Low	Improbable
	3	4	4	2
	Result: (-22) Low negative			

8.11.10 Impacts on public health

Public health is the combination of sciences, skills, and beliefs that are directed to the maintenance and improvement of the health of all people. Therefore, the potential impacts of a major infrastructure project to public health can be substantial in both an adverse and a beneficial manner. Historically, there has not been a set of generally accepted standard guidelines or checklists to direct the public health impacts evaluation of large infrastructure projects, particularly in developing countries. Typically, public health evaluations have primarily focused on morbidity, mortality, and disability. Both the impacts and potential mitigation measures have generally been viewed through a health sector or disease specific perspective (e.g., malaria control programs) and have not necessarily considered the overall potential available to the infrastructure sector to positively impact and improve the quality of life and affect disease rates. Since the project is a major infrastructure effort, it is equally appropriate to evaluate its potential impacts in a broader perspective than traditional evaluation of disease morbidity, mortality and disability.

The analysis of potential health impacts for an infrastructure project should be conducted in a manner that is philosophically consistent with the shift from pure disease specific morbidity, mortality, and disability towards a broader consideration of the linkages between the proposed project and environmental health. In this setting, environmental health is the prevention of disease through the control of biological, chemical, or physical agents in air, water, and food, and the control of environmental factors that may have an impact on the well-being of people.

In general, increased personal disposable income as a direct result of project employment, business opportunities and associated effects would result in an increase in spending on preventive and curative health services. It is expected that the following sub-sectors of environmental health will improve as a result of the proposed project:

- Respiratory diseases where (i) new project workers would receive sanitation/hygiene training which should positively impact home environments and (ii) diseases discovered during the project worker screening process would be identified for possible treatment;
- Vector-related diseases in which (i) local contractors/entrepreneurs would obtain design measures for vector control which should beneficially affect other local projects, (ii) existing roads needed for the project will be improved, particularly drainage and the minimization of standing pools of water that provide vector habitats, and (iii) vector-related diseases which are discovered during new project worker screening would be identified for possible treatment;

- Sexual behavior in the local communities may positively change as new project workers would receive sexually transmitted diseases (STD)/HIV information, education and communication during orientation;
- Water and food-borne diseases in which (i) the EPC contractor would provide a potable water supply source to the local community as part of their CSR initiative and (ii) camp solutions providers would obtain guidelines in the areas of water and food sanitation which should have a positive impact on future local projects;
- Accidents and injuries which include (i) driver safety training that would be provided to all project drivers thus positively impacting overall road safety and, (ii) site-specific safety training received during new project worker orientation should positively influence safe work practices at other local projects;
- Chemical exposure-environmental disease through programs which would target potential chemical exposures and the prevention of environmentally related diseases, thereby positively impacting local health education.

The potential adverse impacts to public health as a result of the proposed project include the following:

- Temporary housing impacts including increased incidence of vector-borne diseases, respiratory illnesses, food supply and quality issues, injuries, and solid/liquid waste disposal problems for sanitary and non-sanitary wastes. Vector-borne diseases are represented by malaria, filariasis, yellow and dengue fever which are spread by mosquitos. The above diseases associated with temporary housing could emanate from (a) construction activities (temporary and permanent housing), (b) inadequate drainage within the project's camp area and external to the project (worker housing areas constructed locally), (c) clogged storm drains, (d) improper trash collection and disposal both within the project facilities and external to the project and (e) increased activity at public facilities due to influx of workers/worker families;
- Transportation which includes air emissions from project related construction activities and STIs associated with truck drivers. The role of truckers in spreading STIs is widely acknowledged to be a major contributor to the spread of HIV and other STIs. Accidents and injuries associated with increases in vehicular traffic, workers, and pedestrians on existing and proposed project related roads and road hazards created by construction equipment can enhance the risk of injuries;
- Water and sanitation impacts include spread of vector-borne diseases, storm drainage-related problems and water utilization and availability problems.

The impacts of the project on public health are expected to be local in nature and limited to the study area and its environs.

Table 8-80 : Impact significance on public health - construction and operational phases

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Low	Highly probable
	2	4	4	4
	Result: (-40) Medium negative			
Mitigation measures	• The EPC contractor should provide sanitation guidelines in the contracts for companies who are responsible for the construction			

	and operation of temporary housing and mobile construction camps; • Sanitation guidelines should address toilet facilities, potable water, sewage disposal facilities, laundry, hand washing and bathing facilities; • Sanitation and hygiene training should be incorporated by the EPC contractor into new employee orientation programs. • The O&M company should implement the above programs for the operational phase of the project; • Initial medical screening programs provided through the occupational health program would preclude workers with active respiratory diseases such as tuberculosis from working at the site. • The EPC contractor should undertake health screenings and malaria surveillance programs throughout the project occupational health program; • The O&M company should develop and implement a medical surveillance program for their employees during the operational phase of the project; • The EPC contractor should implement measures that prevent water pooling along construction routes, near water sources, drains, sewers, housing areas, and waste management areas; • The EPC contractor should develop and implement an HIV/AIDS peer educator program throughout the construction phase. The O&M Company should implement the same program during the operational phase.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Long-term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

8.11.11 Occupational health and safety

It is anticipated that during the construction phase of the proposed project, there will be about 2978 workers; during the operational phase, there may be up to 500 workers. The occupational health and safety concerns likely to arise include: accidents related to 'working at heights' and operation of machinery, trenches collapse, scaffold collapse, electric shock and arc flash/arc blast, failure to use proper personal protective equipment and repetitive motion injuries, working in confined spaces, occupational illness due to exposure to dust and other hazardous substances such as solvents and petroleum products, fire outbreaks due to electrical faults and mishandling of flammable substances; and fall injuries related

to excavated pits electric shocks, being struck by falling or moving objects, vehicle related accidents, accidents associated with lifting equipment,.

Without adequate controls, there will be potential adverse impacts on workers arising from inconsistent management of occupational safety and health.

There may also be industrial hygiene hazards that workers could potentially be exposed to such as chemical handling without the use of proper personal protective equipment or studying the Safety Data Sheet (SDS) for the chemical on safe handling.

The above hazards and risks associated with the construction phase may arise from the lack of a comprehensive written S&H Plan drawn up by the EPC Contractor for the construction phase of the project.

Additionally, the S&H regulator – DOSHS, lacks sufficient resources to regulate workplaces in Lamu County and there is currently no DOSHS office in Lamu. This is a significant S&H related weakness for the proposed coal fired power plant and could potentially lead to the lack of compliance with S&H related laws and regulations by the EPC Contractor during the construction phase which in turn could lead to accidents and incidents that do not get reported.

Table 8-81: Impact assessment and significance: Occupational health and safety concerns - construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Localized	Long term	Very High	Definite
	1	4	10	5
	Result: (-75) High negative			
Mitigation measures	• The EPC Contractor should develop and implement an Occupational Safety and Health (OSH) Management System (that is in line with the occupational Health And Safety Act of 2007 and its subsidiary regulations), OHSAS 18001 and the IFC General EHS Guidelines and will outline OSH procedures including: ✓ Provision of occupational safety and health orientation training to all employees; ✓ Periodic safety inspections; ✓ Employment of health and safety personnel; ✓ Development of a worker safety programme; ✓ Development and implementation of safe systems of work. • The EPC contractor shall comply with all applicable legislative requirements of the OSHA and its subsidiary legislation throughout the construction phase of the project. • The EPC Contractor shall conduct an occupational safety and health risk assessment for construction phase activities in accordance with Section 6(3) of the Occupational Safety and Health Act, 2007 (OSHA) and ISO 31000 and submit the report to the DOSHS for consideration • The EPC Contractor should ensure there is an effective and efficient firefighting system together with an adequately trained Emergency Response Team			

	• The EPC Contractor shall develop and implement a S&H training program for all workers that they employ during the construction phase of the project. The S&H training program will be based on a training needs analysis carried out of the workforce. Internal and external S&H trainers will be engaged for provision of project and site specific S&H training courses in order to prevent accidents and injuries.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Very short	Minor	Probable
	1	1	2	3
	Result: (-12) Low negative			

Table 8-82: Impact assessment and significance: Occupational health and safety concerns - operational phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Localized	Long term	Very High	Definite
	1	4	10	5
	Result: (-75) High negative			
Mitigation measures	• The O&M Company shall always ensure full compliance with the OSHA and its subsidiary legislation throughout the lifetime of the project. • The O&M Company shall conduct annual occupational safety and health risk assessment for the operational phase of the project in accordance with Section 6(3) of the OSHA. • Based on the S&H risk assessment findings, the O&M Company shall develop and implement a formal Occupational Health and Safety Management System compliant with the applicable requirements of the Occupational Safety and Health Act, 2007 (OSHA) and its subsidiary legislation, IFC General EHS Guidelines and OHSAS 18001 • The O&M Company will develop and rollout a S&H training program for all employees during the operational phase of the project. The S&H training program will be based on a training needs analysis undertaken for the workers in the power plant. • The O&M Company will enter into mutual aid agreements with first responders in Lamu in the event that emergency assistance is required; • APCL and its contractors should ensure there is an effective and efficient firefighting system together with an adequately trained Emergency Response Team			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Localized	Very short	Low	Improbable

	1	1	4	2
	Result: (-12) Low negative			

8.11.12 Increase in traffic and related incidents

The influx of construction workers will entail an increase in the traffic to and from the project site. Construction activities will potentially increase traffic in the Lamu main land as construction vehicles will have to go to the construction site to deliver construction materials and equipment. The increase in the number of road users is not an impact, but merely a change process. However, the number of construction vehicles, increased public transport vehicles and project-related traffic may change the movement patterns of other road users in such a way that their movement patterns are disrupted, and their safety levels are impacted on.

During the operational phase of the project, increased traffic levels will be caused by public transport vehicles used by workers as well as service contractor vehicles leaving and entering the power plant. Also, better roads graded by APCL will result in an increase in number of motorcycles in the area which record high levels of accidents.

Table 8-83: Impact assessment and significance: Increase in traffic and related incidents - construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Regional	Short term	High	Definite
	3	2	8	5
	Result: (-65) High negative			
Mitigation measures	▪ APCL and its contractors should undertake a risk management appraisal of their road transport carriers. This appraisal should be used to select those road transport carriers that can demonstrate compliance with set standards ▪ The EPC Contractor should develop a Traffic management plan for both the construction and operational phase ▪ The EPC Contractor will regularly inspect the access roads conditions and, whenever necessary, repair damages related to construction traffic ▪ Abnormal loads should be timed to avoid times of the year when traffic volumes are likely to be higher e.g. start and end of school holidays, long weekends, etc. ▪ Dust suppression measures must be implemented for heavy vehicles such as wetting of murram roads on a regular basis ▪ Prepare detailed plan for signage around the Construction Areas to facilitate traffic movement, provide directions to various components of the Works, and provide safety advice and warnings. Details regarding maximum permissible vehicular speed on each section of road. All signs shall be in both English and Swahili language			

	▪ APCL and its contractors should advance public awareness programs to identify areas of particular risk and approaches to reduce risk. This is expected to include awareness programs along roads leading to the site to frequent users on traffic dangers. Traffic calming and speed control measures should be instigated in consultation with the relevant authorities			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short term	Low	Probable
	2	2	4	3
	Result: (-24) Low negative			

Table 8-84: Impact assessment and significance: Increase in traffic and related incidents - operational phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Regional	Long term	High	Definite
	3	4	8	5
	Result: (-75) High negative			
Mitigation measures	▪ APCL and its contractors should undertake a risk management appraisal of their road transport carriers. This appraisal should be used to select those road transport carriers that can demonstrate compliance with set standards ▪ Develop a Traffic management plan for both the construction and operational phase ▪ Abnormal loads should be timed to avoid times of the year when traffic volumes are likely to be higher e.g. start and end of school holidays, long weekends, etc. ▪ Dust suppression measures must be implemented for heavy vehicles such as wetting of murram roads on a regular basis ▪ Prepare detailed plan for signage around the power plant to facilitate traffic movement, provide directions and provide safety advice and warnings. Details regarding maximum permissible vehicular speed on each section of road. All signs should be in both English and Swahili language ▪ APCL and its contractors should advance public awareness programs to identify areas of particular risk and approaches to reduce risk. This is expected to include awareness programs along roads leading to the site to frequent users on traffic dangers. Traffic calming and speed control measures should be instigated in consultation with the relevant authorities			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Regional	Long term	Low	Probable

	3	4	4	3
	Result: (-33) Medium negative			

8.11.13 Security related impacts

The developer has engaged the services of a specialist consultancy for the security impact assessment of the proposed project. Due to its nature, it cannot be disclosed as part of the ESIA. Subsequently, the potential impacts discussed below are associated with the general security to be provided as part of the project.

Not only do health issues impact on communities, but the physical safety of communities can also be endangered as a result of the influx of job seekers and construction workers (e.g. potential increase in crime). There is perception that crime increases in an area the moment that construction workers arrive on site. Because of this perception, occurrences of crime during the time of the project are likely to be ascribed to the construction workers. This has a mental health impact, such as fear. However, it should be noted that in most instances it is not the actual construction workers who engage in criminal activities but more likely job seekers who loiter at the site in search of employment.

Table 8-85: Impact significance on security-construction and operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	National	Long-term	Moderate	Probable
	4	4	6	3
	Result: (-42) Medium-negative			
Mitigation measures	**Comments/Mitigation:** • Construction workers should be clearly identifiable. Overalls should have the logo of the EPC contractor on it and/or construction workers should wear identification cards; • The construction site and construction camp should be fenced and access should be controlled by means of a security access point • Loitering of outsiders at either the construction site or at the construction village should not be allowed. Loiterers at the site or the camp should be removed in cooperation with the local National Police Service; • Unsocial activities such as consumption or illegal selling of alcohol, drug utilization or selling and prostitution on site should be prohibited			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	National	Long-term	Low	Improbable
	4	4	4	2
	Result: (-24) Low negative			

8.12 Impacts on archaeological artefacts

The surface soil of Kwasasi and its environs is clay mixed with beach sands. The vegetation cover is thick bush land and woodland. The whole of this project area was searched for any archaeological remains which would include pottery, archaeological bones, graves, stone and iron objects.

Although the above factors hampered the possibility of finding any in situ or surface archaeological materials, the Kwasasi residents reported having found potsherds below the surface when they were constructing their houses. The residents of Kwasasi led the specialists to an archaeological site which they referred to as a shrine at Ngini area which is a walking distance from the project site. The shrine had been in use by the residents until recently. On the archaeological site stands a *mwongo* tree which makes the residents to believe that their ancestors were buried here. The site contained a large collection of both local and imported pottery ware which had been dated elsewhere to between 7th and 16th Centuries AD.

The pottery includes archaeological Tana ware pottery which is known to occur all along the East African Coast. On the Kenyan coast, Tana ware is found along the Tana River up to Garissa area. The major Kenyan coastal sites, which have contributed Tana ware, are Shanga and Manda on the Lamu archipelago and Ungwana on the lower Tana River basin.

On a well site west of the project location, parts of a collapsed well were found still intact protruding from the edge of a cliff. More than half of it had already collapsed. The residents claimed out that the well was inside a mosque whose remains were still visible on the sea shore after several years of erosion.

About 3 meters away from the collapsed well, pottery could be seen eroding from a nearby ashy level. The composition of the pottery scatter included both local and imported wares.

Given that there have been moveable archaeological finds during the filed surveys, there is a potential that there could be other sites either within the project site or its environs.

Table 8-86: Impact significance for destruction of archaeological movable materials-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Permanent	Very high	Probable
	2	5	10	3
	Result: (-51) Medium-negative			
Mitigation measures	**Comments/Mitigation:** • Amu Power should develop and implement a chance finds procedure which must be complied with by all contractors engaged at the coal power plant site; • Amu Power must incorporate a chance finds procedure into their contract documents with their EPC contractor; • In the event of archaeological materials appearing during any construction related activities, work should stop immediately and a qualified National Museums of Kenya (NMK) scientist engaged to advise on the way forward;			

	• Due to the sensitivity of this region, Amu Power should engage an archaeologist(s) and cultural heritage expert(s) to offer watching brief throughout the construction phase.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Permanent	Minor	Improbable
	2	5	2	2
	Result: (-18) Low negative			

Table 8-87: Impact significance for destruction of archaeological built in heritage-construction phase

Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
Without mitigation	Study area	Permanent	Very high	Definite
	2	5	10	3
	Result: (-51) Medium negative			
Mitigation measures	**Comments/Mitigation:** • A watching brief must be put in place to cover all excavation activities. An archaeologist should be present at all times since the probability of finding buried ruins is high. • Amu Power should develop and implement a chance finds procedure which must be complied with by all their contractors; • Amu Power's must incorporate the chance finds procedure into their contract documents with their nominated contractors who will undertake construction works in Kwasasi; • In the event of archaeological materials appearing during any construction related activities, work should stop immediately and a qualified NMK scientist engaged to advise on the way forward;			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Permanent	Low	Improbable
	2	5	4	2
	Result: (-22) Low negative			

8.13 Landscape and visual impacts

During the construction period, the activities on site have the potential to impact upon the general character of the local area, which is currently undeveloped land. During the construction stage, when foundation work and excavation works commence, the area will undergo changes as trucks, drilling rigs and other machinery are transported to the site.

Stockpiles and storage yards, if not adequately managed, can be considered to be a detriment to the visual impact during the proposed construction period. Given the relative isolation and nature of the site, however, this is considered to be of minor negative importance.

If domestic and construction waste is not adequately managed and stored properly on the site, this has the potential to be of minor to moderate negative significance to the visual impact of the site and adjacent areas.

During the construction of the marine works, machinery such as dredgers, cranes etc. will be required for the intake/outfall structures. This is likely to obstruct views towards Pate Island.

Considering the absence of major sensitive receptors in the proximity of the site, impacts of a minor significance are expected.

The movement of soil around the site and general vehicle movements together with ground preparation works may result in a localized increase in visible pollution, comprising vehicle/generator exhausts and/or dust. This can be considered to be a visual impact of minor to moderate negative significance.

The plant design calls for the construction and operation of a stack and buildings, which will reach up to a maximum height of 210m. These will be visible from several kilometers away from the site. As required by Kenya Civil Aviation Authority (KCAA) laws and regulations, the stack will be colored in accordance with their approved color scheme and have flashing lights operating at all times.

Table 8-88: Impact significance for poor aesthetics-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Moderate	Highly probable
	2	4	6	4
	Result: (-48) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The EPC contractor should consider proper and efficient sequencing of construction to minimize vehicle movements and time of deployment • All vehicles, generators and machinery on site, will be required to be regularly maintained by the EPC contractor and any other sub-contractors on site, with records of the work undertaken and scheduled. Any vehicles, which come to site, will be inspected prior to entry to the site to ensure that visible emissions are not excessive. • Daily inspections will be required to determine if any vehicles, generators or equipment are emitting excessive smoke, with any non-complying machinery being taken out of commission to be repaired. • During periods of high wind activity, excavation works and ground moving equipment will be required to be minimized by the EPC as far as possible. Stockpiles of materials may also need to be sprayed with water in order to minimize the airborne particles and which should also be included within the dust suppression strategy followed during the construction period.			

	• During the construction period, the EPC contractor will be required to ensure that the site has proper housekeeping practices, in order for stockpiles and storage yards to be as well maintained as possible. • Waste generated on site, as well as being disposed of within designated areas on site, will be required to be transported by NEMA licensed transporters offsite and to registered landfills or equivalent. Records and receipts of such waste will also be required to be kept by all subcontractors and the EPC contractor. • The temporary worker accommodation and site facilities will be required to be adequately designed in accordance with the **IFC/EBRD Worker Accommodation Standards** in order to blend in with the surrounding environment, with landscaping features where appropriate also incorporated within the design. In addition, sanitary facilities should be efficiently designed for appropriate storage capacity and collection in addition to preventing any onsite contamination.

Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Study area	Long term	Low	Improbable
	2	4	4	2
	Result: (-20) Low negative			

Table 8-89: Impact significance for landscape and visual-operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Long term	Moderate	Probable
	2	4	6	3
	Result: (-36) Medium negative			
Mitigation measures	**Comments/Mitigation:** • The permanent worker accommodation and site facilities will be required to be adequately designed in accordance with good architectural practices in order to blend in with the surrounding environment, with landscaping features where appropriate also incorporated within the design. • No mitigation measures are available to reduce the visual impact of the stack proposed for the plant, especially given the regulatory requirement of lights and coloration • In order to provide a pleasant working environment on the site, natural vegetation on the site will be allowed to grow. Areas along the fence-line are likely to be kept clear for security purposes. • The plant and grounds should be well maintained at all times. • All buildings should be painted in a color appropriate to the surrounding area.			

Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Study area	Long term	Minor	Improbable
	2	4	2	2
	Result: (-16) Low negative			

8.14 Cultural Heritage

8.14.1 Impacts on graves

The behavior of planting *mwongo* trees on graves is customary to the Boni people. The tree therefore serves as a clear indicator of a grave; there are a few *mwongo* trees sighted within the project area and beyond. The Boni people who are hunter gatherers used the land in Kwasasi long before the farming activities began. As such, they may have buried their dead here although they could not point to the graves since they currently live about 1 hour drive from the project area having been pushed there by the farmers who come from Pate island and elsewhere.

There are no shrines within the project area as confirmed by the local guides and field surveys. Given below is the significance for destruction of graves on the project site.

Table 8-90: Impact significance for destruction of graves-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Permanent	Very high	Improbable
	2	5	10	2
	Result: (-34) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Amu Power and its service contractors should undertake construction works carefully especially around the areas with *mwongo* trees for any visible signs of human bones. • Where bones appear in the course of any construction works on site, work should stop and a qualified scientist from the NMK should be engaged to identify and advise the contractor on the way forward • In the event of such an occurrence, the EPC contractor must engage the Kwasasi Elders to undertake the necessary rituals to relocate the human bones and accord a proper burial at a new location.			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Permanent	Low	Highly improbable
	2	5	4	1
	Result: (-11) Low negative			

8.14.2 Impacts on cultural landscape

Table 8-91: Impact significance for loss of cultural landscape and sense of place-construction and operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Permanent	High	Probable
	2	5	8	3
	Result: (-45) Medium negative			
Mitigation measures	Comments/Mitigation: • The design of the power plant should consider the height and density of the planed buildings to harmonize the visual impact on cultural landscape • Amu power and its service contractors should ensure that buildings are designed in such a way that the architecture resembles Swahili houses and painted a similar colour in order to blend in with the surroundings • Amu Power and its service contractors should build vegetation buffer zones, including planting of trees within and in-between various service contractors work areas • Amu Power and its service contractors should only cut down vegetation and trees where their respective footprints are planned			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Low	Improbable
	2	5	4	2
	Result: (-22) Low negative			

8.14.3 Loss of plants of cultural value

Table 8-92: Impact significance for loss of medicinal and wild foods plants-construction phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Permanent	Low	Probable
	2	5	4	3
	Result: (-33) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Wherever medicinal trees and wild fruit plants are to be cut down within the project area, the EPC contractor should offset such trees and plants outside the project area.			

	• Amu power should support the existing health facilities and strive to empower the residents to visit for medical solutions

Mitigation Status	Extent	Duration	Magnitude	Probability
With mitigation	Study area	Short	Minor	Improbable
	2	2	2	1
	Result: (-6) Low negative			

8.14.4 Impacts associated with WHS OUV

Table 8-93: Impact significance for increased population density and pressure on the infrastructure at the WHS-construction and operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Low	Highly probable
	2	2	4	4
	Result: (-32) Medium negative			
Mitigation measures	**Comments/Mitigation:** • Amu Power to implement their drug and alcohol policy at the coal power plant • Amu Power should support activities in Lamu County that promote cultural heritage such as the Maulidi festival, Lamu Cultural Festival, etc. • Amu Power should sponsor competitions in calligraphy and exhibitions organized by the NMK and civil society groups			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			

Table 8-94: Impact significance for changes in population character on the WHS-construction and operational phase

Mitigation Status	Extent	Duration	Magnitude	Probability
Without mitigation	Study area	Short	Low	Probable
	2	2	4	3
	Result: (-24) Low negative			
Mitigation measures	**Comments/Mitigation:**			

	• Amu Power should build a flexible program that allows time for its workers to participate in the cultural festivals • Amu Power should allow time for Muslim faithful to attend prayers and other religious activities as required by Islamic faith in order to maintain the religious component of the UOV • Amu Power should encourage preparation and serving of local traditional dishes within its restaurants • Amu Power should have an induction program that introduces its workers to the traditional cultures of Lamu and where necessary promote the Swahili learning institutions within the Island • Amu power should impose a dress code to its workers (outside the PPE) and people doing businesses around the coal plant to maintain the cultural values and, which is not offensive to Lamu residents			
Mitigation Status	**Extent**	**Duration**	**Magnitude**	**Probability**
With mitigation	Study area	Short	Minor	Improbable
	2	2	2	2
	Result: (-12) Low negative			