
Environmental Impact Assessment Report

Jaliar Dip Economic Zone

*Submitted to
Bangladesh Economic
Zones Authority
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Bangladesh Economic Zones
Authority (BEZA)

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Abbreviation & Glossary

EZ	Economic Zone
BEZA	Bangladesh Economic Zone Authority
EIA	Environment Impact Assessment
DoE	Department of Environment
ISA	Initial Site Assessment
ToR	Terms of Reference
WB	World Bank
HFL	Highest Flood Level
Ft.	Feet
KV	Kilo Volts
BOD	Biological Oxygen Demand
MVA	Mega Volts Ampere
BTCL	Bangladesh Telecom Company Limited
STP	Sewage Treatment Plant
ETP	Effluent Treatment Plant
MSW	Municipal Solid Waste
TPD	Tonnes Per Day
ECA	Environment Conservation Act
ECR	Environment Conservation Rules
O.P.	Operational Policy
DPHE	Department of Public Health and Engineering
TDS	Total Dissolved Solids
ECC	Environment Clearance Certificate
HT	High Tension
°C	Degree Celsius
BRRRI	Bangladesh Rice Research Institute
BMD	Bangladesh Meteorological Department
IFC	International Finance Corporation
MLD	Million Liters Per Day
COD	Chemical Oxygen Demand
PwC	PricewaterhouseCoppers Private Limited

dB(A)	Audible Decibel
EMP	Environmental Management Plan
KLD	Kilo Liter per Day
VOC	Volatile Organic Compounds
kmph	Kilometer per Hour
HDPE	high-density polyethylene
m/s	meter / second
H&S	Health and Safety
mg/kg	microgram per kilogram
mg/l	microgram per liter
NO _x	Oxides of Nitrogen
PM ₁₀	Particulate Matter less than 10 micron size
PM _{2.5}	Particulate matter less than 2.5 micron size
PUC	Pollution Under Control Certificate
SO ₂	Sulphur Dioxide
µg/m ³	microgram per cubic meter
MACE	Mahindra Consulting Engineers Ltd.
ToR	Terms of Reference
RMG	Readymade Garments
PSDSP	Private Sector Development and Support Project
FDI	Foreign Direct Investment
BIWTA	Bangladesh Inland Water Transport Authority
BWDB	Bangladesh Water Development Board
SPM	Suspended Particulate Matter
BWDB	Bangladesh Water Development Board
EC	Electrical conductivity
TS	Total Solids
TDS	Total Dissolved Solids
DO	Dissolved Oxygen
SPM	Suspended particulate matter
EC	Electrical conductivity

1. Executive Summary

Bangladesh Economic Zone Authority (BEZA) has been promulgated under the Bangladesh Economic Zones Act, 2010 to develop the Economic Zones (EZ) across the country. BEZA, after the initial site assessment, finalized to develop an Economic Zone for tourism in Jaliar Dip, Teknaf upazila under Cox's Bazar district.

The proposed EZ site is an island and falls in Teknaf upzila in Cox's Bazar district. It is abutted by Naf River on all sides. Cox's Bazar-Teknaf National Highway (N1) runs parallel to the site at a distance of 3 Kms.

The proposed EZ is located in two different Mouzas which are Teknaf Maouza and Dakshin Nhillia, both of which comes under the Teknaf Upazila at Cox's Bazar district of Bangladesh, approximately 80 kms from the Cox's Bazar. The total land area demarcated for the EZ is 271.93 acres which has been transferred by DC to BEZA on 31st May 2016.

The site area does not have any railway connectivity. However, Cox's Bazar is located on the Bangladesh Railway's "Dhaka-Chittagong Cox's Bazar-Deep Sea Port Corridor". Currently this corridor is operational upto Dohazari Railway Station (located approximately 160 Kms from the proposed EZ via N1 National Highway). Dhaka-Chittagong Cox's Bazar Deep Sea Port Corridor is the busiest rail track for passenger and freight transport. The proposed Jaliar dip EZ is located about 82 km from the Cox's Bazar domestic airport. It takes around 2.5 hrs travel time via road to reach the Cox's Bazar airport.

PwC was appointed by BEZA to carry out the environmental and social impact assessment study for the development of the proposed EZ. As per the procedure, proposed Terms of Reference (ToR) was submitted to DOE in May 2016. Approved ToR was granted by DoE vide Memo No. DoE/Clearance/5605/2016/227, dated 13 June, 2016. Copy of the approved ToR by DoEB is attached as Annexure II. The EIA study for the development of proposed Jaliar Dip EZ has been carried out as per the ToR issued by DoEB, World Bank's requirements and Environmental Management Framework of BEZA.

1.1. Baseline and Social Environment

1.1.1. Temperature

The monthly minimum (average) temperature at Cox's Bazar varies between 10.3°C and 24.5°C and maximum temperature varies between 29.4°C and 37.50°C. The minimum and maximum temperature data indicates that December to February months are relatively cooler and April, May and June are the relatively hotter months.

1.1.2. Relative Humidity

The average relative humidity at Cox's Bazar varies between 68 % in the month of February and 87 % in the month of July and August. The humidity data for the past 10 years shows that average humidity is higher throughout the year. June to October months have relatively higher humidity (82% - 85%) as compared to humidity in rest of the year.

1.1.3. Rainfall

The rainfall data for the last 10 years shows that rainy season in Cox's Bazar mainly prevails from May to October. The rainfall follows the general climate pattern with the highest rainfall in the summer from April to October and minimum rainfall in the winter from November to March.

1.1.4. Wind speed and direction

Northerly winds prevail in October to February and southerly wind flows from March to September. The area experiences wind speeds lower than 5 m/s for 89% of time. Of this half the time (29% of the time) is calm condition throughout the year, 23.8% of the time with wind speed of 1-2.5 m/s and 35.6 % of the time with wind speed of 2.5-5 m/s. This indicates that weather conditions favours dispersion of air pollutants.

1.1.5. Natural Hazards

Jaliar Dip lies in Zone-2 which shows intermediate level of seismic activity. However, one of the major active tectonic belt of Bangladesh is at the eastern side. The Arakan subduction-collision system involves oblique convergence of the Indian and Burma plates. It has produced the N-S trending Indoburman range and a broad belt of folds along the western edge of the Bay of Bengal (Curry, 2005; Wang and Sieh, 2013). These lie above a mega thrust that dips moderately eastward beneath the Indoburman range but is nearly flat-lying beneath the folds. Beneath the 500-km long fold belt the mega thrust is also referred to as a decollement, because it is parallel or nearly parallel to sediment bedding within the Canges Brahmaputra delta. Many of the folds within the western 100 to 200 km of the fold belt appear to be actively growing, which implies that the underlying decollement is relaying slip onto thrust faults beneath these folds as it dies out westward toward a poorly defined deformation front. The proposed site location is also on the eastern side of Bangladesh. Hence, there is risk of earthquake due to the Arakan fault.

The proposed Jaliardip EZ is severely affected by cyclones. Devastating cyclones hit the coastal areas of Bangladesh almost every year usually accompanied by high-speed winds, sometimes reaching 250 km/hr or more and 3-10 m high waves, causing extensive damage to life, property and livestock. Cyclones in the Bay of Bengal occur in two seasons, April-May and October-November – i.e. before and after the monsoon.

The flood map shows that Jaliar Dip lies in flood free area. However, as per the stakeholder discussions, the water level during monsoon season varies from 2 meters to 3 meters depth inside the proposed EZ area.

1.1.6. Biological Environment

The proposed EZ is abutted by Naf River on all sides and Naithang River Forest is located at approximately 2 km from the proposed EZ location in the western direction. The primary field survey, secondary information available and stakeholder discussions, indicated that there are mangroves at the along the periphery of the site location. Mangroves support the habitat of different varieties of fishes. Teknaf wildlife sanctuary is approximately 2-3 km from the proposed EZ.

1.1.7. Agricultural Resources

Presently, the proposed aite area is not used for agriculture purposes.

1.1.8. Livestock and poultry

Presently, there is no livestock and poultry at the proposed site location.

1.1.9. Fisheries

The area demarcated for the development of the EZ has had 100 acres of land leased for undertaking pisciculture to 9 lease holder and subsequent to the expiry of the lease period, the land was transferred to BEZA on 31st May 2016. The land is not under any use presently

1.1.10. Socio-economic

The island does not have any residential settlements. At present, there is no provisions for electricity, potable water in Jaliadip. People have to cross Naf River for potable water.

1.2. Environment and Social Impacts of the Proposed Project

The proposed project involves development of following facilities to make site suitable for development of tourism EZ:

- Site development
- Administrative building
- Construction of hanging bridge
- Land filling
- Embankment
- Power supply system and substation at project site

Table 1: Environmental Impacts and Mitigation Plan for site preparation, embankment and construction of Administration Building

Impact	Mitigation Measures
Removal of Vegetation	<ul style="list-style-type: none"> • When clearing the site, care shall be taken to keep vegetation clearing at a minimum • Removal of as little vegetation as possible during the development and re-vegetation of bare areas after the project.
Setting up of construction camps/labour camps	<ul style="list-style-type: none"> • The construction camps should be constructed on the land side, at least 500 m distance from habitations from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. • Location for stockyards for construction materials will be identified at least 1 km from water sources • The living accommodation and ancillary facilities for labour shall be erected and maintained to standards and scales approved by the resident engineer • All sites used for camps shall be adequately drained. There should not be any risk of periodic flooding, nor located within 300 feet of pools, sink holes or other surface collections of water • The camps will be located such that the drainage from and through the camps will not endanger any domestic or public water supply • All sites shall be graded, ditched and rendered free from depressions to avoid water stagnation • Construction camps shall be provided with sanitary latrines (1 per 25 pax), bathing facility and urinals. • Sanitary latrines shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings • Adequate and suitable facilities for washing clothes and utensils shall be provided and maintained for the use of contract labour employed therein. • Sewerage drains shall be provided for the flow of used water outside the camp. • Drains and ditches shall be treated with bleaching powder on a regular basis. • The sewage system for the camp shall be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. • The soak pits/ toilets should not penetrate the aquifer and thereby contaminate ground water • Clean potable drinking water facility should be provided at the site and the water quality should be monitored regularly • Crèche facility should be provided for children if female workers are employed • First aid facilities should be made available at construction camp. First aid box should contain small, medium and large sized sterilized dressings, sterilized burns dressings, 2 % alcoholic solution of iodine, bottle containing salvolatile, snakebite lancet, , bottle of potassium permanganate crystals, scissors, Ointment for burns & surgical antiseptic solution • 1 first aid box should be available for every 50 labour

	<ul style="list-style-type: none"> • A person trained in first-aid treatment should be made in charge who will always be readily available during emergency • A suitable motor transport shall be kept readily available to carry injured or ill person to the nearest hospital. • The access to the island at night time should be strictly prohibited.
Landfilling	<ul style="list-style-type: none"> • Residential facility or sensitive facilities like hospitals, schools etc shall not be located in downwind direction of the identified sites for getting landfilling material. • The soil used for landfilling should have similar characteristics to the native soil and free of any type of contamination. <p>In case of dredging activity for landfilling purposes:</p> <ul style="list-style-type: none"> • Dredging should not impact natural drainage courses • Dredging sites should be located away from sensitive locations • Permission from concerned local body should be taken before finalizing the location • Magnitude and frequency of dredging activity should be monitored to avoid impacts on the natural drainage • Prior to dredging activity, analyse the soil sample to prevent impacts on the receiving environment as a result of mismatch in soil characteristics; • During dredging activity, physical barriers such as silt screen/ curtains should be employed to prevent the spread of suspended sediments; • Maintain the extent of the turbidity plumes close to the dredging and disposal areas to minimise impacts on marine fauna habitat; • Visually inspect for any marine life and terrestrial organisms and stop dredging activity in case of any organism in the vicinity; • Monitoring should be done continuously during dredging to observe impacts on the marine life and in case of visible impacts, stop the dredging activity; • Dredging should be carried out during day time to minimize impacts on marine life.
Soil Erosion and Sedimentation control	<ul style="list-style-type: none"> • Contractor should plan the activities so that no loose earth surface is left out before the onset of monsoon. • Top soil along the road side should be stripped and kept under covered shed for plantation • After the construction activity is over, top soil will be utilized for landscaping activity. • Turfing of low embankments and plantation of grasses and shrubs should be done in slope stabilization. • Soil erosion checking measures as the formation of sediment basins, slope drains, etc, should be carried out. • Do not disturb mangroves at the site periphery • Minimize tree and vegetation destruction • Stockpiling should be done in the opposite of wind direction
Disposal of Debris and any waste generated	<ul style="list-style-type: none"> • Waste from construction camp should be segregated at site. The waste should be disposed to authorized vendors • Dustbins should be provided at the site and construction camps to prevent littering of waste • Storage area of minimum 2 days should be provided at construction camp for storage of the waste generated from labour camps • Construction debris should also be segregated at the site. This debris should be used for filling to the extent possible. • All arrangement for transportation during construction including provision, maintenance, dismantling and clearing debris, where necessary will be considered incidental. • Construction debris should be stored under covered sheds on paved surfaces to prevent leaching • Any hazardous waste generated during construction activity shall be stored at designated place and then disposed through the TSDF using high temperature incineration or any other chemical, thermal, biological, and physical methods. Chemical methods include ion exchange, precipitation, oxidation and reduction, and neutralization. • Utmost care shall be taken to ensure safe collection, transport and disposal of construction waste and debris.
Dust Generation	<ul style="list-style-type: none"> • Compaction of prepared site to re-strain the fugitive emissions. • Water should be sprayed in the cement and earth mixing sites as well as after compaction. • In high dust areas, workers should be provided and encouraged to use masks. • Regular maintenance, servicing of the vehicles and periodic emission check for equipment and machinery would be carried out in conformity with Schedule 6 – ‘Standards for Emission from Motor’ of The Environment Conservation Rules 1997 (Amended 2002);

	<ul style="list-style-type: none"> • Water will be sprayed on the haul road. • All the vehicles entering the project site will be checked for Pollution-Under-Control Certificates. • Air quality monitoring to be carried out during construction phase to check the pollutants level in the air
Procurement & Setting up of Crushers, Hot-mix plants, other Vehicles, Equipment and Machinery	<ul style="list-style-type: none"> • Specifications of crushers, hot mix plants and batching plants, other Construction Vehicles, Equipment and Machinery to be procured should comply to the DoE Standards/ norms • Adequate stack height and emission control devices such as bag house filters, cyclone separators, water scrubbers etc., should be attached • Impervious platform for storage of bituminous and other liquid hazardous chemical • Pollution control measures for Diesel Generator (DG) set i.e. stack height (calculated by $H = h + 0.2 * \sqrt{kVA}$ where h = height of building where generator set is installed and kVA is total generator capacity), acoustic enclosure etc. should be ensured • Provision of readily available first aid kit, fire fighting equipments at the plant site at appropriate location to respond in case of accident. • Periodical monitoring of air quality and noise levels as per conditions stipulated under the statutory clearance from DoE. Whenever the emission exceeds the permissible level the plants should be stopped and necessary repairing works of faults should be done to bring down the emission levels
Contamination of soil	<ul style="list-style-type: none"> • Impervious platform and oil and grease trap for collection of spillage from construction equipment vehicle maintenance platform shall be appropriately provided at construction camp, servicing area and liquid fuel and lubes at storage areas. • Proper management of waste from labour camps and construction site • Proper disposal of wastewater generated from labour camp and construction site
Contamination of surface & ground water	<ul style="list-style-type: none"> • Car washing / workshops near water bodies shall be avoided. • Avoid excavation during monsoon season • Loosened soil shall be stabilized by Contractor through landscaping and developing vegetation, wherever possible, once construction activity is completed at any site. • Sanitation facility with septic tank followed by soak pit will be developed. Common toilets will be constructed on site during construction phase and the waste water would be channelized to the septic tanks and soak pits in order to prevent waste water to enter into the water bodies. • Provision of oil & grease traps upstream of storm water drains • Surface run off due to construction activity will not be discharged in open without treatment.
Loss of water bodies/ surface / ground	<ul style="list-style-type: none"> • No excavation from the bund of the water bodies. • No earth will be excavated for development of any off-site facility • No debris disposal near any water body. • Prior written permission from authorities is required for use of water for construction activity. • Construction labours to be restricted from polluting the source or misusing the source. • Labour camps will be located away from water bodies.
Drainage and runoff	<ul style="list-style-type: none"> • The Contractor will always clear all the cross drainage structures and natural drainage before onset of monsoon in order to keep all drainage unblocked Earth, stones, wastes and spoils will be properly disposed off, to avoid blockage of any drainage channel. • All necessary precautions will be taken to construct temporary or permanent devices to prevent inundation
Noise from Vehicles, Plants and Equipment	<ul style="list-style-type: none"> • Construction activities would be carried out in the daytime only. • The construction equipment would be provided with adequate noise control measures and should comply with the noise standards as prescribed by DoE • Regular maintenance of vehicles and equipment would be carried out and corrective action taken in case of any deviation. • Ear muff/ear plug shall be given to the workers working around or operating plant and machinery emitting high noise levels. • DG sets if installed should be provided with acoustic enclosures • Labour working in noise prone area should be provided with ear plugs and job rotation should be practiced to prevent the prolonged exposure of any workers to high noise levels
Loss or damage to flora and fauna	<ul style="list-style-type: none"> • Vegetation will be removed from the construction zone before commencement of construction. All works will be carried out such that the damage or disruption to flora other than those identified for cutting is minimum. • Only ground cover/shrubs that impinge directly on the permanent works or necessary temporary works will be removed with prior approval from the Environmental Expert. • Trees identified under the project will be cut only after receiving clearance from the Forest Department

	<ul style="list-style-type: none"> • Vegetation only with girth of over 30 cm measured at a height of 1.0 m above the ground will be considered as trees and shall be compensated. • Compensatory plantation should be carried out in the ratio of 1:2 minimum • Construction workers will be directed not to disrupt or damage the fauna. • Construction vehicles will run along specified access to avoid accidents to flora and fauna. • EZ development should be planned in such a way to avoid or minimize tree cutting • Twice the nos. of trees to be fell should be planted as compensatory plantation in affected areas to minimize the impact on the eco-system • No littering of waste should be allowed and waste should not be discharged in water bodies • Avoid construction activities on the periphery of the island • Do not carry out any construction activity during night time • Green buffer of 10 m all around the project site will include most of the native plant species, which will significantly improve the ecology of the area. • Periodic monitoring should be carried out as per the monitoring plan for air, water, noise and soil and ensure that no impact due to project activities. • Tree survival rate should be monitored • Non-native species should not be introduced in the Naf river • Tourist activities should be stopped after sunset. • reduction or banning of over/destructive fishing, extending alternative fishing and rehabilitation and exploitation of mangroves • Cutting of mangrove should be prohibited. Heavy fines should be levied for cutting of mangroves • No use of push nets in mangrove core protection • Limited use of destructive fishing gear in estuarine and near-shore area of the site • The disposal of untreated waste water, oily water from boats or solid waste into the Naf river should be strictly prohibited. • The development of EZ should not impact the natural characteristic of Naf river both during construction and operation phase.
Accidents	<ul style="list-style-type: none"> • Safety officer should be appointed at site to ensure all the safety guidelines are being followed at site • Cautionary guidance should be provided at site to aware people about the associated risk with the area. Entry to the fuel storage room or machinery operation room should be restricted only to authorized trainer personnel • All Accidents shall be reported immediately and incident analysis, preventive measures shall be implemented. • Provisions for rescue from the river should be available with the contractor
Clearing of Construction Camps & Restoration	<ul style="list-style-type: none"> • Contractors shall prepare site restoration plans. The plans shall be implemented prior to demobilization. • On completion of works, all temporary structures shall be cleared, all rubbish burnt, excreta or other disposal pits or trenches filled in and sealed and the site left clean and tidy.
Occupational Health & Safety Plan	<ul style="list-style-type: none"> • All construction worker should wear PPEs including safety jacket, helmet, gloves, gum boots, ear plugs, mask while working at the site • Workers should be made aware about the health issues related with open defecation • Training to workers should be provided for handling the construction equipment and machinery • Training to the workers should be provided to handle the emergency situations like fire, floods etc. • First aid facility and sufficient nos. of trained personnel should be available at all the time at construction camp • Cautionary signage and notice should be displayed in local language and English at the required places like fuel storage area so that hazards can be avoided. A security guard should be deputed in these areas and entry should be restricted • A register of all toxic chemicals delivered to the site shall be kept and maintained up to date. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product. • A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board, will be maintained
Disaster Management	<p>Precaution will be taken to prevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work.</p>

Table 2: Mitigation Measures Suggested for Developer

Impact	Mitigation Measures
Identification of Site for Disposal of construction Debris, construction labour camp and plant site	<ul style="list-style-type: none"> • Site identified should be 1.0 km away from settlement, sensitive locations, like school, hospital, religious structures, reserve forest and any other eco-sensitive zone etc. • Site identified should be approved by BEZA • Site should be located in downwind direction from settlement area • Fertile agricultural land and community land should be avoided for setting of these facilities
Air Pollution	<ul style="list-style-type: none"> • Sprinkling of water during construction phase on all unpaved roads, site and haul roads • Avoiding excess piling of raw material and debris at site • Storage & transportation of raw material and debris in covered conditions • Cutting of only identified trees after obtaining permission of forest department • Regular cleaning of site • Provision of adequate parking space at site so as to prevent idling of vehicles during construction phase • Upkeeping and maintenance of all the construction vehicles, machinery and equipment used for construction purpose • All vehicles entering the EZ site should carry PUC • Guiding signage should be provided at the site for vehicles entering the site to minimize the movement of vehicle within the site • Timings of the construction material vehicles should be fixed and should be during non-peak hours to prevent traffic congestion and traffic jams • Speed limits should be restricted within the site for all the construction vehicles • Usage of low energy intensive building material like fly ash mic cement and bricks • Usage of low sulphur diesel for running DG sets, construction vehicles and equipments • Obtaining temporary electricity connection during construction phase and operating DG sets only during power failure • Provision of wheel washing facility at exit point of site • Adequate air pollution control measures like provision of bag filters, stacks of adequate height should be provided with WMM, hot mix plant, batching plant etc. • Open burning of wood or any other material should be prohibited at site and all the workers should be made aware about the same
Water Pollution & water Conservation	<ul style="list-style-type: none"> • Minimizing the run-off from the site by construction of sediment basins for collection of storm run-off and re-using that water for curing purpose and wheel washing • Maintaining the flow of water sprinklers so as to avoid wastage of water • No debris should be thrown or disposed off in any water body like river, pond, canal etc or ground water source like functional or abandoned well • Excavation should not be carried out during monsoon • Provision of temporary storm water drainage system during construction phase to drain the storm water and should be connected to nearest surface water body • Excavated pits should be provided with garland drains to prevent entrance of water inside the pit • Provision of oil & grease traps with the storm water drains draining the parking and fuel storage area • Provision of septic tanks and soak pits at the site & labour camps for disposal of sewage generated by construction labour • Waste generated by construction camps should be disposed off regularly at the identified site for debris disposal • Provision of cross drainage structures like balancing for maintaining the drainage pattern • Stone & bricks should be purchased only from licenced vendors • Keeping provision of land for development of STP/ETP for each unit

	<ul style="list-style-type: none"> • Provision of rain water harvesting should be made at the point of extraction of ground water. Recharge should be atleast equal the amount of water extracted • Rain water harvesting tank should be developed at the site so as that water can be used for meeting daily water demand • Tank alarms should be installed so as to prevent overflow of water • Leakage detection should be carried out quarterly so as to detect any leakages in the gas pipeline
Soil Quality	<ul style="list-style-type: none"> • Top soil, if excavated from the project site should be stored in covered condition and should be used later for landscaping purpose • Storage of raw materials, debris and fuel on paved surfaces • Training the workers to handle the material so as to minimize spillage of material on soil • Provision of cross drainage structures to prevent water logging and soil erosion • Stone pitching with grass turfing should be done for the high embankment close to water body • Disposal of construction debris, municipal waste from labour camps and hazardous waste from site should be disposed off at the identified site • Keeping provision of land for development of soil waste management facility within the EZ site • No open area should be left without the vegetation to protect the soil. • Mulching of soil should be done regularly to prevent direct exposure of soil to wind and water
Noise Pollution	<ul style="list-style-type: none"> • Construction vehicles, machinery and equipment used for construction purpose should meet the standards prescribed by DoE • Upkeeping and regular maintenance of all the construction vehicles, machinery and equipment used for construction purpose • Speed limits should be restricted for all construction vehicles and equipment • Honking should be prohibited at the site • Provision of acoustic enclosures, noise mufflers, silencers etc with the DG sets and any noise generating machinery • Provision of temporary noise shield/barrier in areas where more noise will be generated
Ecology	<ul style="list-style-type: none"> • Only identified trees should be fell down after obtaining permission from forest department • Comensatory plantation should be carried out in ratio of min 1:2 under guidance of forest department • Development of 10 m (minimum) thick green buffer all along the periphery of EZ • Boundary should be constructed around the EZ site to prevent trespassing of the animals • Native plant species should be considered for plantation • Timber should be purchased only from authorized vendors • No waterbody should be filled outside the EZ site
Emergency Preparedness	<ul style="list-style-type: none"> • Provision of first aid kit and first aid room and well trained first aid practioner at the site all the time • Ambulance facility should be provided at the site • Tie-ups with local hospital should be made to handy emergency case, if any • Availability of safety officers and supervisors at all the time on the site • Workers should be given training for handling construction vehicles, equipment and handling emergency situations like fire, floods, earthquake and cyclone • Cautionary signage should be provided in the areas associated with risks like storage of explosives, fuels, heavy construction material etc. Entry for only trained authorized personnel should be allowed in such areas with adequate safety measures • Emergency handling cell & room should be developed at the site and should be headed by project & safety manager • Contact no. of nearest fire-station and hospitals should be displayed within the emergency handling room

1.3. Conclusion and Recommendations

Overall the impacts from both construction and operation phase have limited adverse environmental impacts, and can be readily addressed through mitigation measures as provided in EMP. BEZA, formed under EZ Act, 2010 is overall agency for implementation of EZ projects for rapid economic development of Bangladesh. The EZ will be developed following PPP approach. BEZA will invest in land and related off-site infrastructure development so as to make zone accessible and resourceful. Thereafter economic zone development will be responsibility of private developers. The off-site facilities proposed to be developed by BEZA include development of administration building, boundary wall, electrical supply, and access road. The project falls under Red category as per ECA, 1995 and requires prior environment clearance from DoE, Bangladesh.

The recommendations made for the project development on the basis of EIA study are given below:

- Construction activities for the development of project should be started after obtaining environment clearance certificate from DoE, Bangladesh
- Proposed environment management plan should be implemented strictly both during construction and operation phase of the project.
- Trees cutting should be minimum and compensatory plantation should be carried out in ratio of 1:2
- Proper training of maintaining environment, health and safety should be given to Project management unit in both construction and operation phase
- Provision of garland drain, thick green belt, STP, segregated storm water shall be adhered to.
- Environmental monitoring should be conducted as proposed in environment management plan.
- Before development, separate environment impact assessment study should be carried out by individual units proposed to be developed in the EZ.
- Ecological assessment should be carried out for the proposed EZ before commencement of the project.
- While commencement of the project, care should be taken to minimize impacts on biodiversity

2. Introduction

The Government of Bangladesh has embarked on the program to develop new Economic Zones (EZ) in the country, with the objective of inclusive economic growth and job creation through developments of industries. The new EZ regime provides for a new approach both in management and investment.

Bangladesh Economic Zone Authority (BEZA) has been promulgated under the Bangladesh Economic Zones Act, 2010 to develop the Economic Zones across the country. BEZA, after the initial site assessment, finalized to develop an Economic Zone for tourism in Jaliar Dip, Teknaf upazila under Cox's Bazar district.

As part of the Private Sector Development and Support Project (PSDSP), supported by the World Bank, PricewaterhouseCoopers Private Limited (PwC) was appointed by BEZA to undertake the Environmental Impact Assessment for the Jaliar Dip economic zone.

2.1. Project Background

The project involves development of EZ and off-site facilities for *Jaliar Dip Economic Zone* by BEZA. The proposed Economic Zone site falls in Teknaf upzila in Cox's Bazar district. The site details are provided in table below. The proposed project site is an island and it is located approximately 10 kms from the center of Teknaf Upazila. It is abutted by Naf River on all sides. Cox's Bazar-Teknaf National Highway (N1) runs parallel to the site at a distance of 3 Kms.

The proposed EZ is located in two different Mouzas which are Teknaf Maouza and Dakshin Nhilla, both of which comes under the Teknaf Upazila at Cox's Bazar district of Bangladesh, approximately 80 kms from the Cox's Bazar. The total land area demarcated for the EZ is 271.93 acres which has been transferred by DC to BEZA on 31st May 2016.

The proposed site area does not have any railway connectivity. However, Cox's Bazar is located on the Bangladesh Railway's "*Dhaka-Chittagong Cox's Bazar-Deep Sea Port Corridor*". Currently this corridor is operational upto Dohazari Railway Station (located approximately 160 Kms from the proposed EZ via N1 National Highway). *Dhaka-Chittagong Cox's Bazar Deep Sea Port Corridor* is the busiest rail track for passenger and freight transport. The proposed EZ is located about 82 km from the Cox's Bazar domestic airport. It takes around 2.5 hrs travel time via road to reach the Cox's Bazar airport.

The site photographs collected during site survey are shown in figure 1. The proposed project involves development of following facilities to make site appropriate for development of tourism EZ:

- Site development
- Administrative building
- Construction of hanging bridge
- Embankment
- Land filling
- Power supply system and substation at project site

Table 3: Site Details of the proposed site

Parameters	Details
Site co-ordinates	20° 54' 21.59"N to 20° 55' 30.32"N latitude, 92° 16'35.52"E to 92° 16'53.73"E longitude
Site boundaries on East	Naf River, Myanmar
Site boundaries on West	Naf River
Site boundaries on North	Naf River

Site boundaries on South	Naf River
Total area of the site	271.93 acres
Site is located in Maouza	Teknaf and Dakshin Nhilla
Distance from the International Boundary (Myanmar water boundary)	The international boundary lies towards the east of Jaliardip island. The international boundary will be 3 – 4 Kms from the eastern most premises of Jaliardip island.
Land tenure details	Transferred to BEZA on 31 st May 2016
Existing land use	Acquaculture

Figure 1: Photographs of the project site

Pisciculture Ponds at the project site	Boundary of Project site
	
Boundary of Project site	Trees present at the project site
	
View of Jaliar Dip surrounded by Naf river	Ferry Ghat for Jaliar Dip
	
Ferry for Jaliar Dip	Temporary bridge to Jaliar Dip
	



View of mangroves surrounding the site location

Temporary structures present at the site location

Figure 2: Location Map of Jaliar Dip EZ



Source: Banglapedia

2.2. Rationale for the Proposed Project

Bangladesh is primarily an agricultural economy with close to 50% of the labor force employed in agriculture. Industry sector contribution to Gross Domestic Product (GDP) has hovered around 25-30% only for past few years. Manufacturing sector of Industry shows predominance of export led garments and textile industries and comprise of 52% share of total exports in Bangladesh making it the world's second largest garment manufacturer.

Bangladesh has a lot of potential for tourism and is emerging as alluring tourist spot in the world. It has a lot of tourist attractions including historical and monuments, resorts, beaches, picnic spots, forest and tribal people, wildlife of various species. It also offers ample opportunities for water related activities including water skiing, river cruising, hiking, yachting, sea bathing etc. Tourist activities have increased in Bangladesh in the last 10 years.

Cox's Bazar is one of the most popular tourist centres in the country. It is located at the head of the world's longest sea beach and is blessed with many tourist attractions. Some of these includes – Aggmeda Khyang – a Buddhist monastery, Himchari picnic spot, Innani beach, Sonadia Island, Saint Martin Island a beautiful coral island 13kms from the headquarters and the Teknaf peninsula 80 km from the headquarters. To facilitate the growth in tourism, it is imperative to have coordinated efforts in development of the relevant support infrastructure. Considering at the macro-economic condition, and the geographical location of the island, it is proposed to develop Jaliar dip as EZ.

The Government of Bangladesh has, in the past, successfully provided tailored infrastructure services and business environment conditions through EPZs. EPZs were used as a strategic instrument for attracting Foreign Direct Investment (FDI) and dealing with the shortcomings of the overall investment climate, business registration, licensing, etc. which were restricting investments in the Domestic Tariff Area (DTA).

To overcome the limitations of EPZ model, new EZ regime has been adopted by the Government of Bangladesh so as more spill-over can be harnessed by local firms from FDI , additional investments can be encouraged within value chains, more local produce can be procured and better linkages can be established between manufacturing firms and educational institutions.

The EZ development, a zoned industrialization, is required in Bangladesh to maximize the growth benefits of agglomeration and ease the increasing urban congestion. More importantly, the project will enable new sources of growth, where investor will show their interest.

2.3. Scope and Methodology of the Study

The scope and methodology for the EIA of the proposed site are:

- Identification and review of applicable local, state, national and international environmental and social regulatory and institutional frameworks;
- Establishment of environmental baseline conditions of the site and surrounding area through the following:
 - Detailed surveys to observe environmental and social characteristics of the project area;
 - Discussions with the stakeholders and identification key issues during planning, construction and operation phase of the project;
 - Baseline data collection of the site and project area with respect to water and soil quality, ambient air and noise quality, environmental hazards and
 - Ecological assessment on flora and fauna of the site and project area through secondary data collection.

- Assessment of the socio-economic environment through collation of secondary information of the site, supplemented by consultations with the local communities to understand community perception with regard to the project and its activities;
- Preparation of the EIA report which includes:
 - Project Description describing the proposed project and its geographic, ecological, social, health and temporal context, including any related facilities that may be required;
 - Applicable Environmental Regulatory Framework including host country regulations, obligations for implementing relevant international social and environmental treaties, agreements, and conventions and IFC Performance Standards;
 - Environmental Baseline Conditions on the basis of the above identified parameters to understand the profile of the area and describe relevant physical, biological, health and labour conditions in the project area of influence;
 - Impact Assessment and Mitigation Measures for environmental and social components for pre-construction/construction and operation phases. To minimize the adverse impacts mitigations measures will also be suggested; and
 - Preparation of Environmental Management Plan (EMP) and Management System which includes the following:
 - Mitigations for adverse environmental impacts and associated risks;
 - Institutional arrangement - management tools and techniques for the implementation of environmental impacts and risk mitigations;
 - Monitoring and reporting of requirements and mechanisms for the effective implementation of the suggested mitigations;
 - Monitoring arrangements for effective implementation of suggested mitigations for the proposed project; and
 - Preparation of EMP accordance with the Performance Standards of IFC.

2.4. Limitation of the Study

The present EIA Report has been prepared based on the field investigations / assessment, and secondary data from data collected from Department of Public Health and Engineering (DPHE), Department of Environment (DoE), Bangladesh Meteorological Department (BMD), Bangladesh Water Development Board (BWDB), Bangladesh Fisheries Research institute (BFRI), Nature Conservation Management (NACOM) and published journals, and books, public consultation and site observations. The environmental and social assessment is based on the information collected from the various Agencies, community consultations and observations. Professional judgement and subjective interpretation of facts and observations has been applied for the preparation of the EIA Report. Since offsite facilities are proposed to be developed by BEZA, required information essential for EA are available. The onsite (industrial area detailed planning will be carried out by prospective private developer) information will limited to feasibility assessment.

2.5. ToR Compliance Matrix

The EIA study has been conducted in accordance with the ToR issued submitted to DOE. Table below presents the point-wise compliance of the issued ToR.

Table 4: Compliance of TOR Points

S. No.	ToR Point	Compliance
I	The project authority shall conduct a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of the said project in accordance with this ToR and following additional suggestions	EIA study has been carried out in line with the ToR Approved by DoE and WB guidelines

S. No.	ToR Point	Compliance
II	The EIA Report should be prepared in accordance with following indicative outlines:	Agreed
1	Executive Summary	Refer Chapter 1
2	Introduction: (background, brief description, rationale of the project, scope of study, methodology, limitation, EIA team, references)	Refer Chapter 2
3	Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)	Refer Chapter 3
4	Project Description	Refer Chapter 4
i.	Introduction	Section 4.1
ii.	Project objective	Section 4.2
iii.	Project options	Section 4.2
iv.	Interventions under selected options	Section 4.3
v.	Project activities: A list of the main project activities to be undertaken during site clearing, construction as well as operation	Section 4.6
vi.	Project schedule: The phase and timing for development of the project	Section 4.7
vii.	Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project	Section 4.8
viii.	Map and survey information Location map, cadastral map showing land plots (project and adjacent area), geological map showing geological units, fault zone, and other natural features	Section 4.9
5	Environmental and Social Baseline	Refer Chapter 5
5.1	Meteorology	Section 5.2.1
5.1.1	Temperature	Section 5.2.1.1
5.1.2	Humidity	Section 5.2.1.2
5.1.3	Rainfall	Section 5.2.1.3
5.1.4	Wind Speed	Section 5.2.1.4
5.1.6	Sunshine hours	Section 5.2.1.5
5.2	Water Resources	Section 5.2.2
5.2.1	Surface Water System	Section 5.2.2.1
5.2.2	Tropical cyclones and Tidal Flooding	Section 5.2.2.8 & 5.2.2.9
5.2.3	Salinity	Section 5.2.2.2
5.2.4	Drainage Congestion and Water Logging	Section 5.6.8
5.2.5	Erosion and Sedimentation	Section 5.2.2.3
5.2.6	River Morphology	Section 5.2.2.4
5.2.7	Navigation	Section 5.2.2.5
5.2.8	Ground Water System	Section 5.2.2.6
5.3	Land Resources	Section 5.2.3
5.3.1	Agroecological Regions	Section 5.2.3.1
5.3.2	Land Types	Section 5.2.3.2
5.3.3	Soil Texture	Section 5.2.3.3
5.3.4	Land Use	Section 5.2.3.4
5.4	Agriculture Resources	Section 5.2.7
5.4.1	Farming Practice	Section 5.2.7
5.4.2	Cropping Pattern and Intensity	Section 5.2.7
5.4.3	Cropped Area	Section 5.2.7
5.4.4	Crop Production	Section 5.2.7
5.4.5	Crop Damage	Section 5.2.7

S. No.	ToR Point	Compliance
5.4.6	Main Constraints of Crop Production	Section 5.2.7
5.5	Livestock and Poultry	Section 5.2.8
5.5.1	Feed and Fodder Shortage	Section 5.2.8
5.5.2	Livestock/Poultry Diseases	Section 5.8.7
5.6	Fisheries	Section 5.2.9
5.6.1	Introduction	Section 5.2.9
5.6.2	Problem and Issues	Section 5.2.9
5.6.3	Habitat Description	Section 5.2.9
5.6.4	Fish Production and Effort	Section 5.2.9
5.6.5	Fish Migration	Section 5.2.9
5.6.6	Fish Biodiversity	Section 5.2.9
5.6.7	Fisheries Management	Section 5.2.9
5.7	Ecological Resources	Section 5.2.10
5.7.1	Bio-ecological Zone	Section 5.2.10.1
5.7.2	Common Flora and Fauna	Section 5.2.10.2 and 5.2.10.3
5.7.3	Ecosystem Services and Function	Section 5.2.10
5.8	Socio Economic Condition	Section 5.2.11
5.8.1	Socio Economic Condition	Section 5.2.11
5.8.2	Quality of Life Indicators	Section 5.2.11.1 and 5.2.11.2 and 5.2.11.4
5.8.3	Income and Poverty	Section 5.2.11.5
5.8.4	Gender and Women	Section 5.2.11
5.8.5	Common Property Resources	Section 5.2.11
5.8.6	Conflict of Interest and Law and Order Situation	Section 5.2.11
5.8.7	Historical, Cultural and Archaeological Sites	Section 5.2.11
6	Identification and Analysis of Key Environmental Issues (Analysis shall be presented with Scenarios, Maps, Graphics, etc. for the Case of Anticipated Impacts on Baseline)	Refer Chapter 6
6.1	Environmental Sensitivity Investigation	Section 6.1
6.2	Environmental Aspect/Valued Environmental Components	Section 6.2
6.1	Environmental Hot Spots	Section 6.3
6.1	Likely Beneficial Impacts	Section 6.4
6.1	Community Recommendations	Section 6.5
6.1	Alternate Analysis	Section 6.5
7	Environmental and Social Impacts	Refer Chapter 7
7.1	Introduction	Section 7.1
7.2	Impact on Water Resources	Section 7.4
7.2.1	Pre-construction Phase	Section 7.4.1
7.2.2	Construction Phase	Section 7.4.1
7.2.3	Post-construction Phase	Section 7.4.2
7.3	Impact on Land Resources	Section 7.5
7.3.1	Pre-construction Phase	Section 7.5.1
7.3.2	Construction Phase	Section 7.5.1
7.3.3	Post-construction Phase	Section 7.5.2
7.4	Impact on Agriculture Resources	Section 7.7
7.4.1	Pre-construction Phase	Section 7.7.1
7.4.2	Construction Phase	Section 7.7.1
7.4.3	Post-construction Phase	Section 7.7.1
7.5	Impact on Fisheries	Section 7.8
7.5.1	Pre-construction Phase	Section 7.8.1
7.5.2	Construction Phase	Section 7.8.1
7.5.3	Post-construction Phase	Section 7.8.2
7.6	Impact on Ecosystem	Section 7.6
7.6.1	Pre-construction Phase	Section 7.6

S. No.	ToR Point	Compliance
7.6.2	Construction Phase	Section 7.6
7.6.3	Post-construction Phase	Section 7.6
7.7	Socio Economic Impact	Section 7.15 and 7.9 and 7.10 and 7.12
7.7.1	Pre-construction Phase	Section 7.15 and 7.9 and 7.10 and 7.12
7.7.2	Construction Phase	Section 7.15 and 7.9 and 7.10 and 7.12
7.7.3	Post-construction Phase	Section 7.15 and 7.9 and 7.10 and 7.12
8.	Public Consultation and Disclosure	Refer Chapter 8
8.1	Introduction	Section 8.1
8.2	Objectives of Public Consultation and Disclosure Meeting	Section 8.1
8.3	Approach and Methodology of Public Consultation and Disclosure Meeting	Section 8.2
8.4	Public Consultation Meetings (PCMs)	Section 8.3
8.5	Public Disclosure Meetings (PDMs)	Section 8.4
9.	Environmental Management Plan and Monitoring Indicators	Refer Chapter 9
9.1	Introduction	Section 9.1
9.2	Mitigation Plan	Section 9.2
9.3	Enhancement Plan	Section 9.2.5
9.4	Contingency Plan	Section 9.4
9.5	Compensation Plan	Section 9.8
9.6	Monitoring Plan	Section 9.5
9.7	Monitoring Indicators	Section 9.6
10	Cost Estimation for Environmental Mitigation Measures and Monitoring	Refer Chapter 10
11.	Conclusions and Recommendations	Refer Chapter 11
III	Without obtaining approval of EIA report by the Department of Environment, the Project authority shall not be allowed to conduct earth filling or any kind of physical intervention in the proposed project site and also not be able to start the physical activity of the project.	Agreed
IV	This approval of the Terms of Reference (ToR) would not mean any acceptance or site clearance of the Project.	Agreed
V	The proposed EIA study would not establish any claim, right in favour of the proponent for getting site clearance or environmental clearance.	Agreed
VI.	Without obtaining Environmental Clearance, the project authority shall not be able to start the operation of the project.	Agreed
VII.	The project authority shall submit the EIA along with the No Objection Certificate (NOC) from the local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the Bagerhat District Office of DOE with a copy to the Head Office of DOE in Dhaka.	Agreed

2.6. EIA Team

BEZA has appointed M/s PricewaterhouseCoopers Pvt. Ltd. For carrying out environmental and social impact assessment studies for development of five upcoming EZs in Bangladesh.

As per the procedure, proposed Terms of Reference (ToR) was submitted to DOE in May 2016. Approved ToR was granted by DoE vide Memo No. DoE/Clearance/5605/2016/227, dated 13 June, 2016. Copy of the approved ToR by DoEB is attached as Annexure II. The EIA study for the development of proposed Jaliar Dip EZ has been carried out as per the ToR issued by DoE, World Bank's requirements and Environmental Management Framework of BEZA.

The PwC team appointed for carrying out the ESIA studies is mentioned below:

Table 5: EIA Team

Team Member	Position	
Yasir Ahmad	Team Leader	More than 12 years of experience in Environmental and Social policy development, Social/Environmental audits, Environmental and Social impact assessment (ESIA) reviews, Environmental Due-diligence, Responsible investment related engagements for various industrial sectors including infrastructure, retail etc.
Dr. D.J Rao	Environmental Specialist	Doctrate with more than 28 years of experience in Environmental and Social Impact Assessment (ESIA) for diverse sectors, Community /Stakeholders' Consultation, Risk Management, Environment and Social Mitigation Plan, carbon and sustainability strategy, etc.
Mr. Sandeep Kota	Project Manager	More than 9 years of experience in Environment and Social impact assessment, Environmental management plan, Health and Safety compliance audits, Environmental Due-diligence, Responsible investment related engagements for various industrial sectors.
Ms. Anjali Yadav	Environmental Expert	Five years of experience in Environment and social impact assessment, Environmental and social reviews, Environment and social policy development, Environment health and safety audits, Site investigation & characterization, Environmental site assessments (phase I & phase II ESA) and Remediation of soil and groundwater.
Mr. Dhiman Chakraborty	Environmental Expert	Five years of experience in Environment and social impact assessment, Environmental and social reviews, Environment and social policy development, Environment health and safety audits, Site investigation & characterization, Environmental site assessments (phase I & phase II ESA) and Remediation of soil and groundwater

2.7. Structure of the Report

This EIA report has been prepared strictly following the report structure as per TOR. The EIA report contains project features, baseline environmental conditions, assessment of environmental impacts, and formulation of mitigation measures along with environmental management and monitoring plan.

The report includes the following chapters:

Chapter 1: Executive Summary

The chapter provides the brief summary of the EIA report.

Chapter 2: Introduction

This chapter provides background information of the project background, rationale for the proposed project, scope and methodology adopted for EIA study, limitations of the study, TOR compliance matrix, details of the EIA team, structure of the report and references.

Chapter 3: Legislative, regulation and policy consideration

This chapter deals with the details of the potential legal, administrative, planning and policy framework which have been used in the preparation of the EIA Report.

Chapter 4: Project Description

This chapter presents the details of the project, project objectives and options, interventions under selected options and activities, project area of influence, project activities, existing infrastructure in and around the site, project schedule and resources and utilities demand.

Chapter 5: Environmental and Social Baseline

This Chapter describes the baseline environmental conditions around the project site for various environmental attributes, in the project area of influence which is termed as the study area. Topography, soil, water, meteorology, air, noise, land constitute the physical environment, whereas flora and fauna constitute the biological environment.

Chapter 6: Identification and Analysis of Key Environmental Issues

This chapter identifies and details the key environmental issues related to the project.

Chapter 7: Impact assessment

This chapter details the impacts due to the project activities and suggestive mitigation measures

Chapter 8: Public consultations and disclosure

This Chapter provides details for the public consultation meetings in study area and the outcomes of public consultations

Chapter 9: Environmental Management Plan and Monitoring indicators

This Chapter provides mitigation and control measures to attenuate and/or eliminate environmental impacts, which are likely to be caused by the proposed project. An Environmental Management Plan (EMP) has been developed to mitigate the potential adverse impacts and to strengthen the beneficial impacts. This chapter also provides the environmental monitoring plan proposed for the project.

Chapter 10: Cost of EMP

This chapter provides the tentative cost for the implementation of EMP

Chapter 11: Conclusions and Recommendations

This chapter concludes on the findings that emerged from the environmental assessment study and summarizes the key points to be addressed to ensure the environmental sustainability of the project during the construction and operation phases.

2.8. References

List of secondary data used for carrying out EIA study and preparation of EIA report is given at the following table.

Table 6: Reference Used for EIA Study

S. No.	Reference
Government Departments	
1.	Bangladesh Economic Zone Authority
2.	Department of Public Health and Engineering
3.	Department of Environment
4.	Bangladesh Meteorological Department
5.	Bangladesh Forest Research Institute
6.	Bangladesh Bureau of Statistics
7.	Geological survey of Bangladesh
8.	Bangladesh Water Development Board
9.	Department of Disaster Management
10.	Marine Fisheries Research Institute, Cox's Bazar
11.	Bangladesh Inland Water Terminal Authority (BIWTA)
12.	Teknaf Upazila office
13.	District Forest Department, Cox Bazar
Journals & Books	
1.	Community Report, Bagerhat Zilla, June, 2012, Population and Housing Census 2011, Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning
2.	Sirajur Rahman Khan, Revised by Michiel Damen, ITC, Cyclone Hazard in Bangladesh, 2013
3.	Banani Mandal, Arunava Mukherjee, Subrata Sarkar & Samir Banerjee, Study on the Ornamental Fin Fish of Indian Sundarbans with Special Reference to Few Floral Sources for Carotenoid Pigmentation, 2012
4.	M. Monirul H. Khan, Species diversity, relative abundance and habitat use of the birds in the Sundarbans East Wildlife Sanctuary, Bangladesh, 2005
5.	Sayam U. Chowdhury, M. Abdullah Abu Diyan, Christoph Zöckler, Mohammad Foysal, Hilger W. Lemke, A Survey Of Shorebirds in the Sundarbans of Bangladesh, 2014
6.	Md. Manirul Mamun, Md. Golam Sarower, Md. Aslam Ali, S.M. Bazlur Rahman, Khandaker Anisul Huq, Abundance And Distribution Of Plankton In The Sunderbans Mangrove Forest, 2009
7.	Professor Dr. Md. Saifuddin Shah, Professor Dr. Khandaker Anisul Huq, Professor Dr. S.M. Bazlur Rahaman, M. G. Mustafa, Study on the Conservation and Management of Fisheries Resources of the Sundarbans
8.	Tonmoy Sarker, Sedimentation process at navigation channel of Mongla port on the Pasur Sibsa river system in Bangladesh, UNESCO IHE Institute of Water Education The Netherlands
9.	Chandra K.J., Chowdhury A. R. & Das D.R., Shrimp Culture Practices at Farmers' Level in Bagerhat District, Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University, 2010,
10.	Adhikary, S.K., Gupta A. D. & Babel M.S., Modelling Groundwater Fow and Salinity Intrusion by Advective Transport in the Regional Unconfined Aquifer of SouthWest Bangladesh
Existing Studies	
1.	Md. Golam Mahabub Sarwar, Impacts of Sea Level Rise on the Coastal Zone of Bangladesh, Land University International Masters, Programmes in Environmental Sciences, 2005
2.	Lubna Seal, Mohammed Abdul Baten, Salinity Intrusion in Interior Coast: A New Challenge to Agriculture in South Central part of Bangladesh, Unnayan Onneshan-The Innivators
3.	Mohammed Mizanur Rahman, 2006, A study on Coastal Water Pollution of Bangladesh in the Bay of Bengal, BRAC University
4.	Md. Abdul Matin Mondal, Sea Level Rise along the Coast of Bangladesh, Bangladesh Inland Water Transport Authority, Ministry of Shipping
5.	Md. Mohosin Ali Impacts Of Climate Change On Cropping Pattern In Coastal Region Of Bangladesh: A Case Study Of Sharankhola Upazila, Bagerhat, 2012, BRAC University
6.	Initial Environmental Examination, BAN: Coastal Climate-Resilient Infrastructure Improvement Project Market Subprojects in Khulna Region, Asian Development Bank
7.	District Statistics, 2011, Bagerhat, December, 2013, BBS, Statistics and Information Division, Ministry of Planning, Govt. of the people's republic of Bangladesh
8.	Fisheries Statistical Yearbook of Bangladesh, 2012-2013, department of Fisheries, Bangladesh, Ministry of Fisheries and Livestock
Website	
1.	Wikipedia
2.	Google maps
3.	http://www.bangladeshtourismdirectory.com/bangladesh-archaeological-sites-list.html
4.	Google earth imageries
5.	http://www.saarc-sadkn.org/countries/bangladesh/disaster_mgt.aspx (Bangladesh Disaster Knowledge Network)
Others	
1.	Site visits
2.	Initial Site Assessment Reports
3.	Nature Conservation Management (NACOM), Dhaka
4.	WB General EHS Guidelines
5.	WB Performance Standards 2012

6.	BEZA EMF

3. Legislative, Regulation and Policy Consideration

3.1. Regulatory Requirements for the Proposed Project

This section highlights the regulatory requirements set out by Government of Bangladesh (GoB) and World Bank (WB) in relation to protection of environment and its resources as well as protection of the social environment from adverse impacts associated with the project development. These requirements are summarized below.

Table 7: Applicability of Key Environmental Legislation at a Glance

Name	Key Requirement	Applicability	Remarks
The Environment Conservation Act, 1995 and subsequent amendments in 2000 and 2002 and 2010 Environment Conservation Rules, 1997 (Subsequent Amendments in 2002 and 2003)	Mandatory requirement of prior environment clearance for certain category of project for conservation and improvement of environment and control and mitigation of pollution of the environment. To ascertain responsibility for compensation in case of damage to ecosystem Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes. Declaration of ecologically critical areas Promulgation of standard limit for discharging and emitting waste. Formulation and declaration of environmental guidelines. Restriction on polluting automobiles, sale and production of environmental harmful items. Categorization of industries, development projects and other activities on the basis of pollution activities of the existing or proposed industries/ development projects/ activities.	Applicable. The project is classified under red category EIA study required to be undertaken	Site approval certificate is to be obtained from DoE
Environment Court Act, 2000 and subsequent amendments in 2002	To give high priority to environment pollution prevention	Applicable as the project shall have environmental impacts	All the developments to be carried out as per ECA, 1995 & ECR, 1997 and amendments.
The Private Forests Ordinance Act, 1959	Conservation of private forests and for the afforestation on wastelands.	Applicable as the tree cutting is involved in development of EZ.	Tree cutting to be carried out after taking permission from Regional Forest Officer, Forest Department

The Protection and Conservation of Fish Act, 1950 and subsequent amendments in 1982	Prohibit or regulate the construction, temporary or permanent of weirs, dams, bunds, embankment and other structures	Applicable. The project involves construction of embankment	Necessary permission would need to be taken for construction of embankment.
Water Pollution Control Ordinance 1970	Prevention of water pollution	Applicable from the prospective of prevention of pollution	Applicable during both construction stage (e.g. sewage and equipment washing and maintenance liquid waste discharges at construction camps) and operation phase (tourism activities)
The ground Water Management Ordinance 1985	Management of Ground Water Resources. Tube well shall not be dug in any place without permission from Upzilla parishad.	Applicable. It is envisaged to install two bore wells on site to meet the water demand.	Permission should be taken before digging bore wells
The Embankment and Drainage Act 1952	An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion and other damage by water.	Applicable. The project involves construction of embankment.	Regulatory authority Ministry of Water Resources and FCD
Wetland Protection Act 2000	Adhere to a formal environmental impact assessment (EIA) process, as set out in EIA guidelines and manuals for water sector projects or related to alteration of natural drainage. No construction of roads if likely to effect the flow of navigable water ways without clearance from concerned authorities Upland flow in water channels to preserve eco-system Protection against degradation and resuscitation of natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by man-made interventions or other causes. Completely stop the filling of publicly-owned water bodies and depressions in urban areas for preservation of the natural aquifers and environment. Stop unplanned construction on riverbanks and indiscriminate clearance of vegetation on newly accreted land.	Applicable. The proposed site location has low lying area.	Permission to be taken from the Ministry of Water Resources and DOE
The Building Construction Act 1952 (with latest	An Act to provide for the prevention of haphazard construction of building and excavation of tanks which are likely	Applicable as the project involves development of infrastructure	Regulatory authority is Ministry of Works

amendment 2006)	to interfere with the planning of certain areas in Bangladesh		
The Vehicle Act, 1927 The Motor Vehicles Ordinance, 1983 The Bengal Motor Vehicle Rules, 1940	To regulate vehicular exhaust emissions	Applicable as heavy vehicle movement is involved during construction phase	Regular maintenance and upkeeping of the vehicles should be carried out. Regulatory authority is Bangladesh Road Transport Authority
The Factories Act, 1965 Bangladesh Labour Law 2006, amendment 2013 Bangladesh Labour Rules 2015	This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions.	Applicable as the workers will be employed during construction and operation phase of EZ	Regulatory authority is Ministry of labour
Policies			
National Environment Policy, 1992	For sustainable development	Applicable for all development projects	Usage of energy efficient building material, fuel etc. should be encouraged
National Environment Management Action Plan 1995	Conservation of natural habitats, bio-diversity, energy, sustainable development and improvement of life of people	Applicable for all development projects	Usage of energy efficient material, green building techniques, reduction of carbon foot prints etc.
National Conservation Strategy	Sustainable development of Industrial Sector	Applicable for all development projects	Usage of energy efficient material, green building techniques, reduction of carbon foot prints etc.
The National Energy Policy, 1995	Protecting the environment by requiring an EIA for any new energy development project, introduction of economically viable and environment friendly technology.	Applicable. EIA study is to be carried out	Energy efficient materials and techniques should be explored
The National Water Policy, 2000	To ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management	Applicable. Ground water is required to be withdrawn for fulfilling water requirement during operation phase	Conjunctive use of water should be explored
The National Water Management Plan, 2001	Addresses options for water quality, considerations behind measures to clean up industrial pollution, where effluent discharge monitoring and zoning regulations for new industries are emphasized	Applicable as it is tourism sector project and will involve generation of sewage	Installation of sewage treatment facility within the premises
World Bank's Safeguards			
OP 4.01 Environmental Assessment	Ensures sustainability and environmental feasibility of the project. Projects are classified into A, B & C category depending on the nature and extent of the impact.	Triggered	Project classified as Category A considering impacts of project
OP 4.04 Natural habitats	Ensures conservation of natural habitats and discourages disturbance of any natural habitat due to project development by recommending adoption of alternative method/route/approach or adopting management measures	Triggered	Presence of mangroves surrounding the proposed EZ site.
Private Sector Development Support Project			

Environment Management Framework (EMF)	Describes all the mandatory environmental and social clearances and purpose of the same required to be taken before development of the project	Triggered	EIA report is prepared referring to the guidelines mentioned in BEZA's EMF. The framework sets out mitigation, monitoring and institutional measures to be taken during design, implementation and operation of the project activities to eliminate adverse environmental impacts, offset them, or reduce them to acceptable levels.
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3.2. Environment Management Framework for the PSDSP and AF

The Environmental Management Framework (EMF) for the PSDSP and the AF, provides the systems, procedures and institutional arrangements of PSDSP, that ensure compliance to the environmental regulations of GoB and the safeguard policies of The World Bank. The Environmental Management Procedures developed for PSDSP are aimed at minimizing the environmental impacts of the project and ensures adequate integration of environmental aspects in the project planning, design, construction and operation phases. In addition to complying with the regulatory requirements of GoB and the safeguard policies of The World Bank, the procedures provide a framework to (i) identify, predict, and evaluate beneficial and adverse environmental impacts of project activities, (ii) designing enhancement measures for beneficial impacts, and (iii) suitable institutional arrangements to implement the environment management measures.

3.3. Project Categorization

As per the Environment Management Framework prepared for the PSDSP and AF; in order to address various environmental issues associated with the project and to formulate suitable strategies, the sub-projects of PSDSP are categorized as below.

- 'Category A' sub-projects that have potential to cause significant, adverse environmental impacts in the project influence area;
- 'Category B' sub-projects that have potential to cause moderate and reversible environmental impacts in the project area;
- 'Category C' sub-projects that have potential to cause minor and temporary environmental impacts, primarily during construction phase of the project.

In accordance with the table 4.1 of the EMF for PSDSP and ADF, the development of the proposed EZ and the off-site infrastructures is categorized as "**Category A**"

Further, the development of the EZ and the off-site infrastructures is categorized in "**Red category**" based on the categorization of the projects by the DOE based on the impacts on the environment.

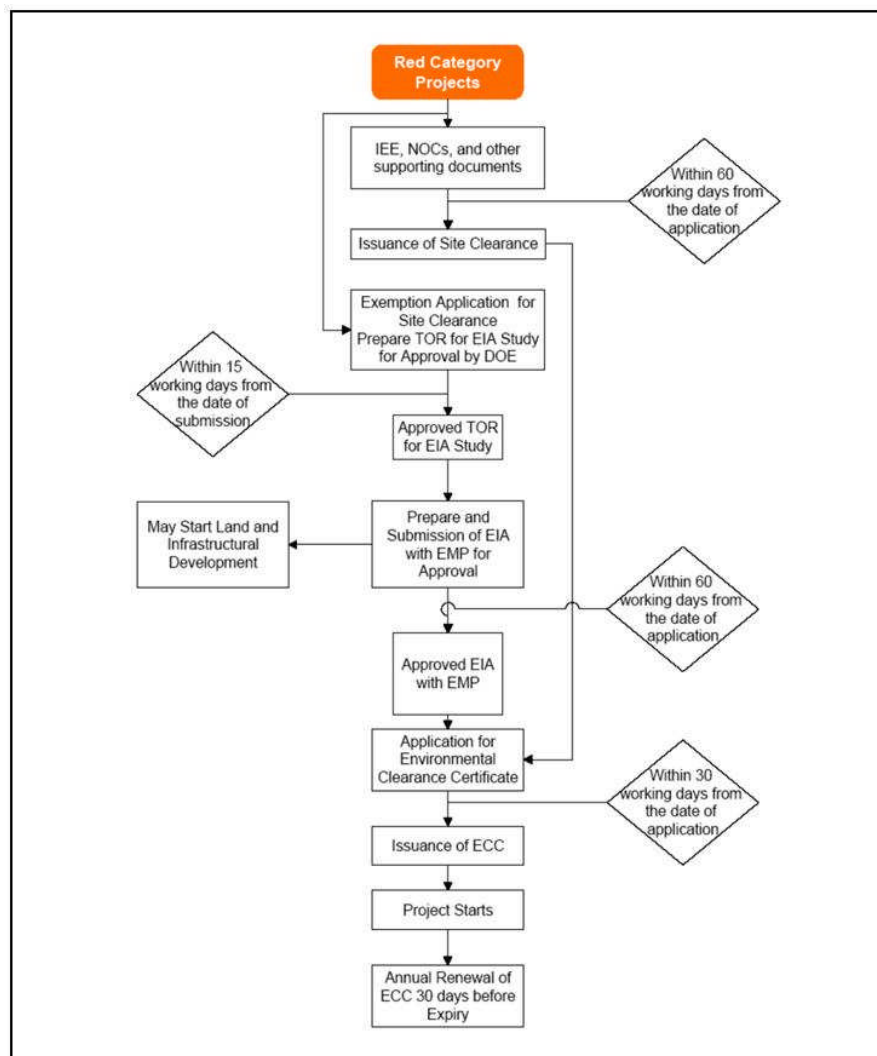
3.4. Procedure for Obtaining Environmental Clearance from DoE, Bangladesh

Bangladesh has very lucid administrative framework regarding environmental aspect. It has strong interface between local government and federal Government. Department of Environment is responsible for grant of

environmental clearance to a project. In addition to three are other ministries to deal with specific area of importance to the country like Forests, Water.

According to the Section 12 of the Environment Conservation Act 1995, (subsequent amendments in 2000 and 2002 and 2010) no project will be established or undertaken without obtaining permission, in the manner prescribed by the Environment Conservation Rules 1997 (amended in 2003), an Environmental Clearance Certificate from the Director General. Therefore, every development projects/industries which are specified under the Schedule – 1 of the Environment Conservation Rules 1997 (amended in 2003) require obtaining site and environmental clearance from the Department of Environment. According to the Rule 7 (1) of the Environment Conservation Rules 1997 (amended in 2003); for the purpose of issuance of Environmental Clearance Certificate (ECC), every projects, in consideration of their site and impact on the environment and will be classified into the four categories, i.e. green, orange A, orange B and red. Development of off-site facilities for economic zone will fall under red category. Thus EIA study is required to be carried out for the project. The present EIA study has been conducted for the proposed project complying with the ToR and applicable World Bank guidelines. A schematic representation of the various steps involved in below.

Figure 3: Steps for Obtaining Environment Clearance from DoE



4. Project Description

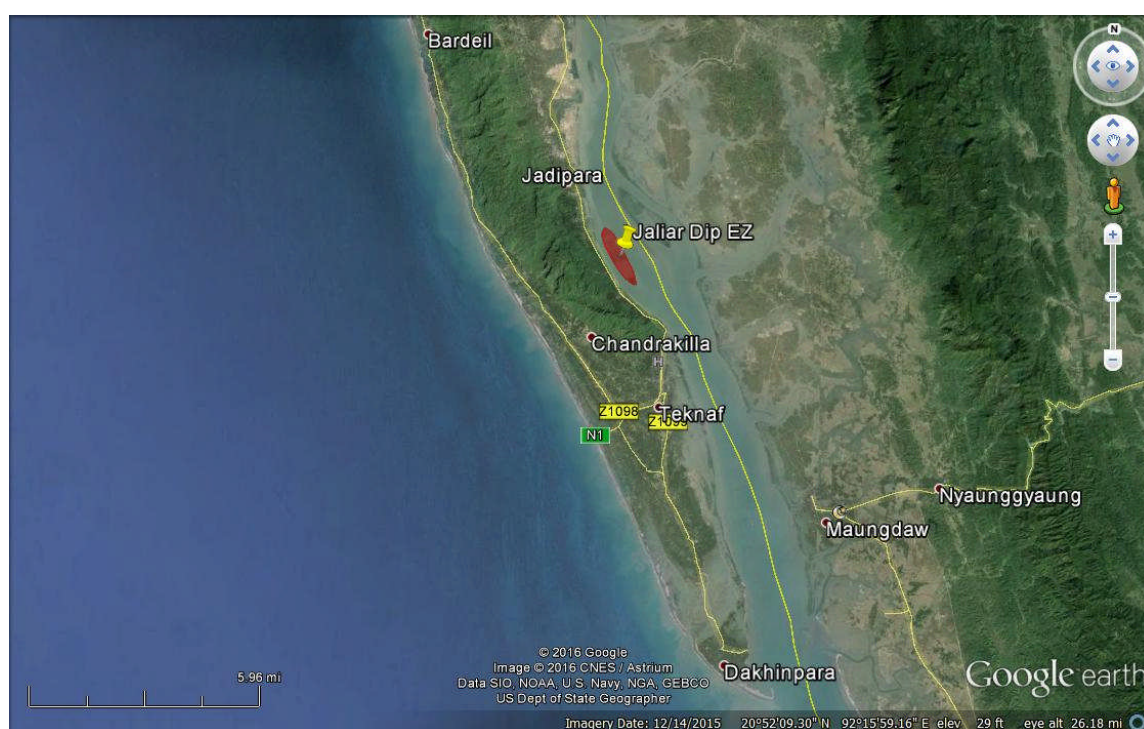
4.1. Project Introduction

The project involves development of EZ and off-site facilities for *Jaliar Dip EZ* by BEZA. The proposed EZ site falls in Teknaf upzila in Cox's Bazar district. It is an island and is located approximately 10 kms from the center of Teknaf Upazila. The proposed EZ is abutted by Naf River on all sides. Cox's Bazar-Teknaf National Highway (N1) runs parallel to the site at a distance of 3 Kms.

The proposed EZ is located in two different Mouzas which are Teknaf Maouza and Dakshin Nhilla, both of which comes under the Teknaf Upazila at Cox's Bazar district of Bangladesh, approximately 80 kms from the Cox's Bazar. The total land area demarcated for the proposed economic zone is 271.93 acres which has been transferred to BEZA by DC on 31st May 2016. The site details are shown in figures below.

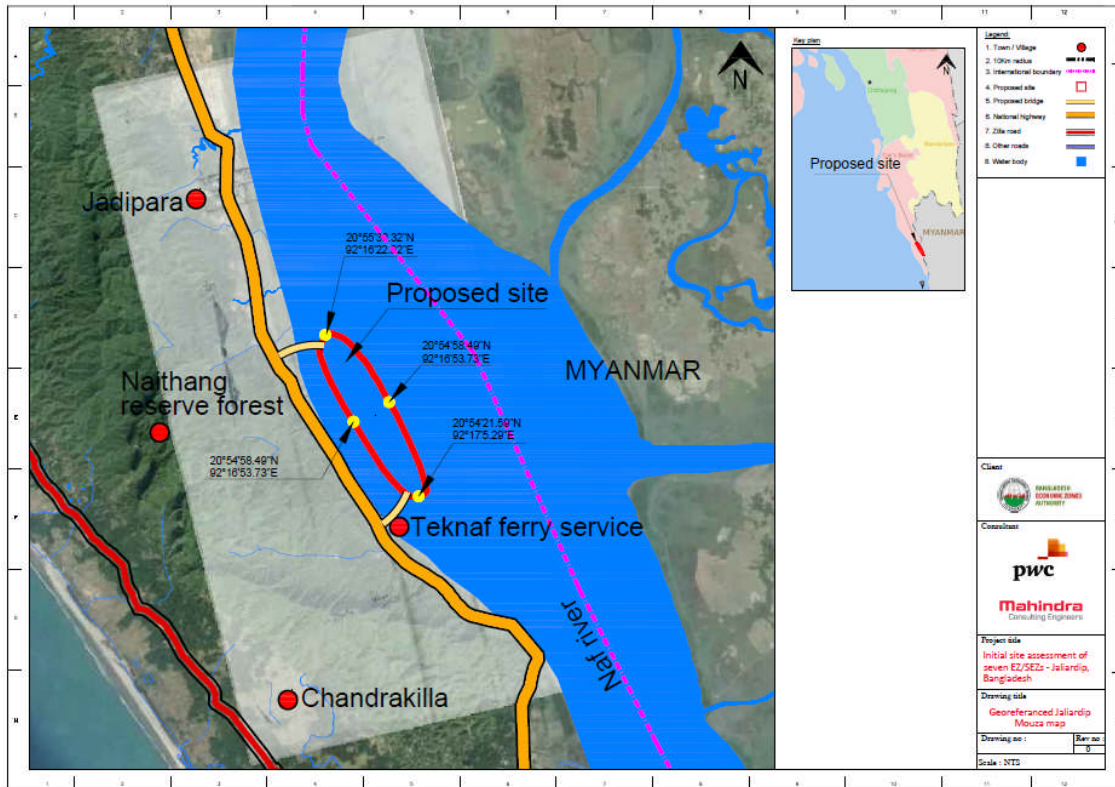
The site area does not have any railway connectivity. However, Cox's Bazar is located on the Bangladesh Railway's "*Dhaka-Chittagong Cox's Bazar-Deep Sea Port Corridor*". Currently this corridor is operational upto Dohazari Railway Station (located approximately 160 Kms from the proposed EZ via N1 National Highway). *Dhaka-Chittagong Cox's Bazar Deep Sea Port Corridor* is the busiest rail track for passenger and freight transport. The proposed Jaliar dip EZ is located about 82 km from the Cox's Bazar domestic airport. It takes around 2.5 hrs travel time via road to reach the Cox's Bazar airport.

Figure 4: Location of Jaliar dip EZ



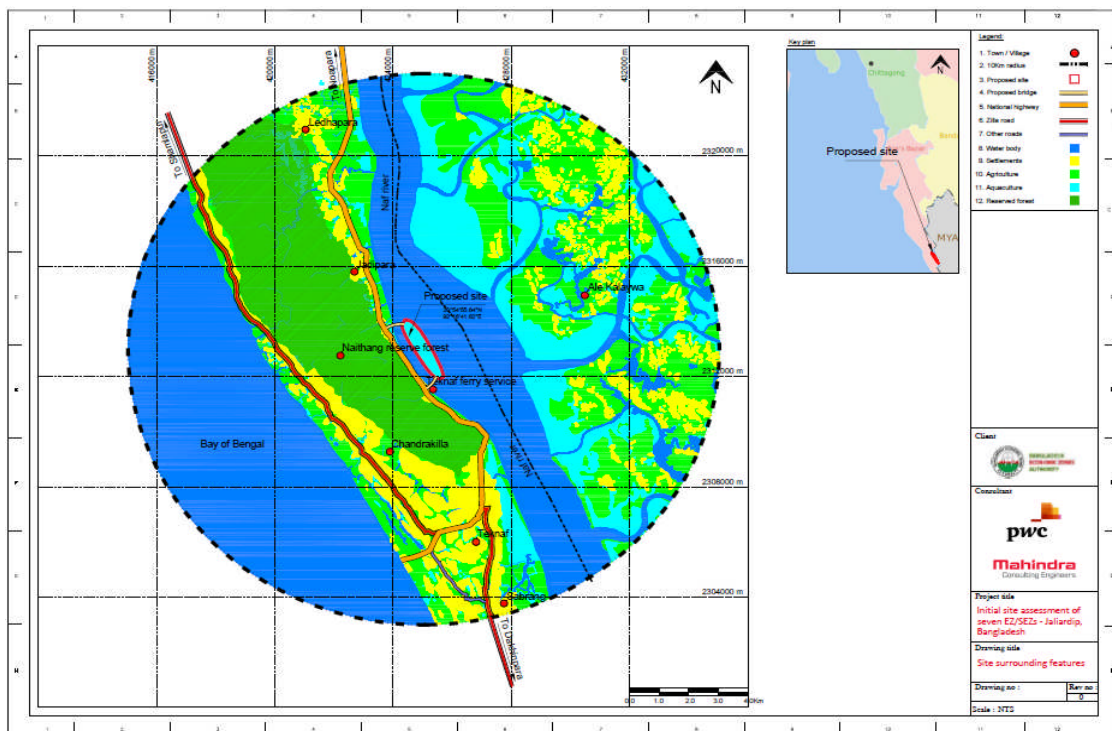
Source: Google earth

Figure 5: Mauza map superimposed on google map



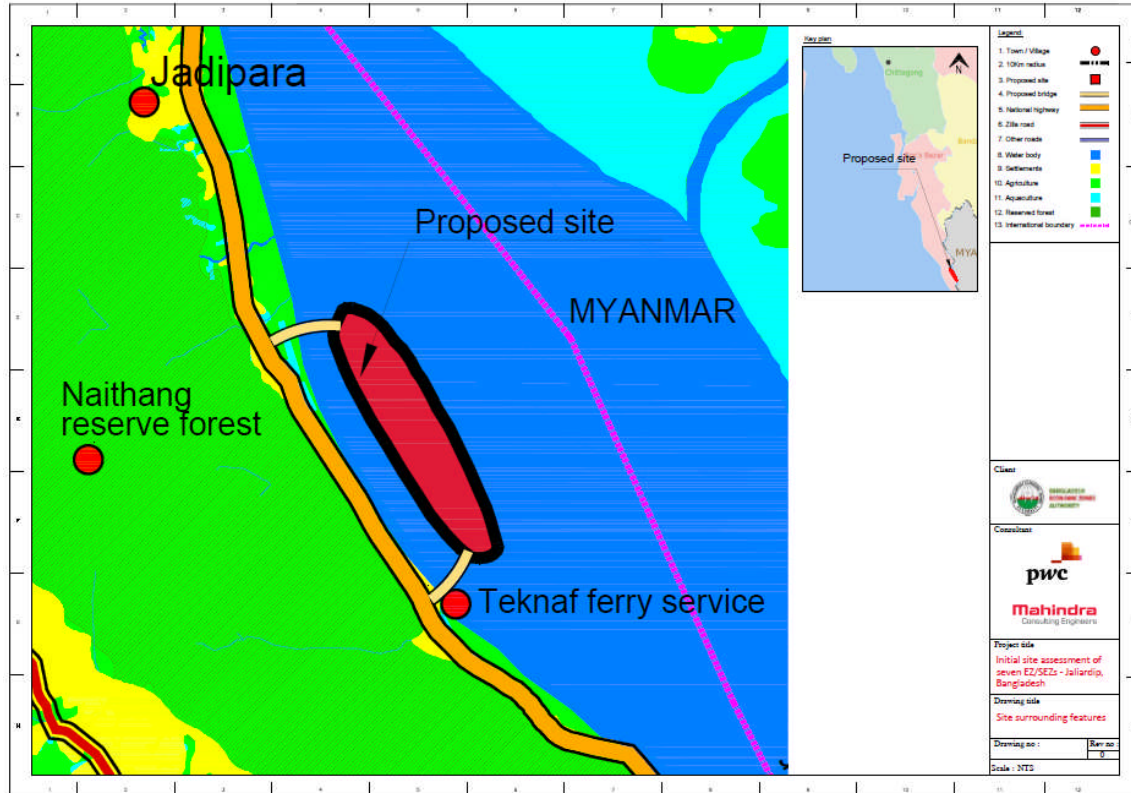
Source: ISA report

Figure 6: Site Surroundings Features



Source: ISA report

Figure 7: Site Surroundings Features



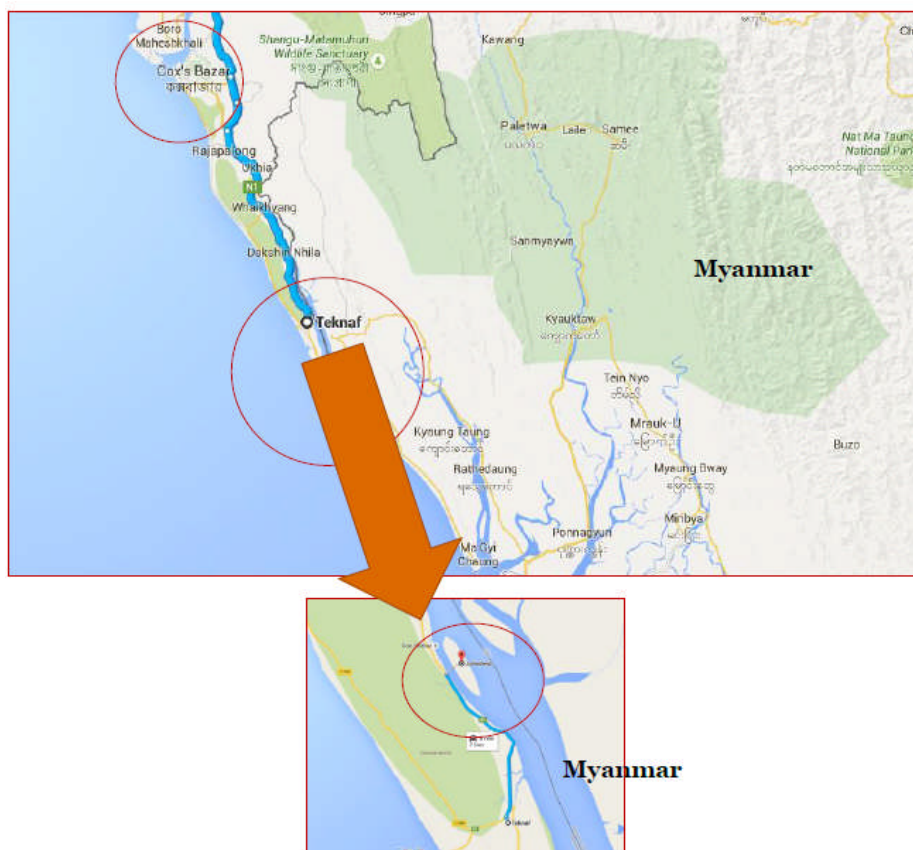
Source: ISA report

4.2. Project Objectives and Options (Alternative Analysis)

The proposed EZ location is an island in Teknaf Upazila and is located very near to the Myanmar border. This upzilla forms the southmost point in mainland Bangladesh and Naaf River forms the boundary of the same. The proposed EZ is approx. 100 km from Cox’s Bazar, which is known for wide and long sandy beach and is claimed to be world’s longest natural sandy sea beach (120 km). The warm and shark free waters are good for bathing and swimming while the sandy beaches provide opportunities for sunbathing. There are other attractions as well including mangorves, mudflats, sand dunes, towering cliffs, surfing waves, rare conch shells, colourful pagodas, Buddhist temples etc. Due to its geographical location, this sub-district has become an attraction for foreign and local tourists. October to March is the most favoured time for tourism due to the tropical weather of Bangladesh.

Cox Bazar is the tourist capital of Bangladesh and the presence of various tourist attractions within few km of the proposed EZ location favours its development for tourism sector.

Figure 8: Geographical location of proposed EZ and its surrounding



Source: ISA report

The identified strengths and weakness of the site are provided in the table below.

Table 8: Strength and Weakness of Site

Parameters	Strengths	Weaknesses
Road connectivity	<ul style="list-style-type: none"> One of the major on-going projects in Bangladesh of upgrading Dhaka-Chittagong highway to 4 lanes could ensure fast and smooth conveyance of goods and passengers between Dhaka and Chittagong. These roads can form part of the regional road network, as well as the Trans-Asian Road network facilitating trade between Bangladesh and neighbouring countries The Teknaf-Cox's Bazar National Highway (N1) is just 3 Kms away from the island. 	<ul style="list-style-type: none"> The road traffic on Dhaka Chittagong highway is severely hampered because of the lack of capacity of the existing highway and the load restrictions of the bridge; with journeys taking around 10 hours due to the congestion of road. The road also suffers for poor road safety records.
Water availability		<ul style="list-style-type: none"> There is no existing source of water at the proposed EZ location.

Landfilling Requirements		<ul style="list-style-type: none"> • The proposed site is an island abutted by Naf river in all the directions • Land-filling is envisaged which can be cost intensive
Resettlement issues	<ul style="list-style-type: none"> • The area demarcated for the proposed EZ is Khas land and has been transferred to BEZA as on 31st May 2016 by the DC. There are no permanent structures nor human settlements in the project area. 	
Loss of income/livelihood	<p>The area demarcated for the proposed EZ is Khas land and has been transferred to BEZA as on 31st May 2016 by the DC. There are no permanent structures nor human settlements in the project area.</p>	
Rail connectivity		<ul style="list-style-type: none"> • Proposed EZ in Jaliardip has no railway station in the vicinity. At present there are no railway station at Cox's Bazar also. • Cox's Bazar is located on the Bangladesh Railways "Dhaka-Chittagong Cox's Bazar – Deep Sea Corridor ". Currently this corridor is operational upto Dohazari Railway Station which is located approx. 160 Kms from the proposed EZ via N1 highway) • Dhaka-Chittagong Cox's Bazar –Deep Sea Port Corridor is the busiest rail track for the passenger and the freight transport.
Air connectivity	<ul style="list-style-type: none"> • The airport is being considered for an upgrade by the Bangladesh Civil Aviation and Tourism Ministry. Prime Minister of Bangladesh has already inaugurated (July 2015) the commencement of the construction works for International Airport in Cox's Bazar 	<ul style="list-style-type: none"> • The nearest airport is Cox's Bazar domestic airport, which is at a distance of 80 Kms from the proposed EZ. The connectivity from the airport to the site area takes around 2.5 hrs of travel time via Cox's Bazar-Teknaf National Highway.
Water ways Connectivity	<ul style="list-style-type: none"> • Proposed EZ seems to be strategically located with respect to water connectivity to Chittagong Port, proposed Sonadia deep sea port and Mongla port. • Teknaf port (Bandar) is currently used only for goods and passengers between Bangladesh and Myanmar to cross the river for about 1 Km width. Approximately 3-5 trips are being made to and fro from Bangladesh. • Proposed EZ could leverage on its proximity to its water connectivity for seamless movement of cargo to other parts of Bangladesh and also for cross-border trade to Myanmar, Singapore etc. 	

<p>Power connection</p>	<p>Following power connections are available in the proximity of the proposed EZ:</p> <ul style="list-style-type: none"> • The nearest sub-station to the proposed EZ is Teknaf substation with capacity of 10 MVA. • Grid substation of 132/33 KV is available at Cox's Bazar which is located at a distance of 80 Kms from the site. • 33 KV line is passing along the road which is located within 500 meters from the proposed EZ. 	
<p>Existing industrial ecosystem and possible backward linkages for industries</p>	<ul style="list-style-type: none"> • Cox's Bazar district has presence of manufacturing sector (at SME level). Rice Mills, Salt Mills, Ice Factories, Flour Mills, Fish Processing Industries, Saw Mills etc. are located in the vicinity. In addition, there are about 27 large scale industries in Cox' Bazar region. • Cox's Bazar is one of the most populated tourist centers in the country. Located at the head of the World's longest sea beach, the area is blessed with many tourist. These includes-Aggmeda Khyang-a Busddhist monastery, Himachiri picnic spot, Innani beach, Sonadia Island, Saint Martin Island 	<p>Geographic location and profile of Jaliardip island is a major challenge in the development of the proposed EZ. Instead of natural and geographic challenges, this area is rich in mineral sources of minor forest produce sources which could provide the EZ easy access to raw material.</p>
<p>Proximity to major cities</p>	<ul style="list-style-type: none"> • The proposed site is located in close proximity to Cox's Bazar city and is connected to Chittagong. 	
<p>Availability of quality manpower</p>	<ul style="list-style-type: none"> • Cox's Bazar district has 21 colleges (government and non-government) and 157 secondary schools (government and non-governmental). • Apart from this, the district also has 1 medical college and 7 technical and vocational institutions • Most of these institutions are located at Chakoria and Cox's Bazar Sadar Upazila. Around 3 technical training centers are located at Cox's Bazar district 	<ul style="list-style-type: none"> • There are no technical and vocational institutions located at Teknaf Upazila.
<p>Availability of medical facilities</p>	<ul style="list-style-type: none"> • There is 1 government hospital in Teknaf union and 1 government dispensary at Nhillia union • The government hospital has provision for 50 beds. • Teknaf union also has 2 private dispensaries where the doctors' visits twice a week 	<ul style="list-style-type: none"> • The better medical facilities are available at Cox's Bazar which is at 80 Kms from the proposed EZ site. • There are no international standard medical facility in the vicinity. For complex medical treatment, local inhabitant tend to travel to Cox's Bazar, Dhaka or Chittagong
<p>Availability of good residential facility and quality lifestyle in the nearby areas</p>		<ul style="list-style-type: none"> • Good quality residential settlements are available at Cox's Bazar which is at is 80 Kms from the proposed EZ. • There are no dwelling units and residential facilities available in the vicinity of the proposed EZ

4.3. Interventions under selected options and Project Activities

Jaliar Dip EZ has been selected for development of economic zone. Scope of the proposed project is to develop EZ and off-site facilities for upcoming EZ zone. These off-site EZ facilities will be developed by BEZA. The EZ area will be developed by prospective developer who will also undertake detailed planning for the same. Proposed off-site facilities will help in improving the infrastructure of the area. Proposed interventions at the project site are given below:

- Site development
- Administrative building
- Construction of hanging bridge
- Land filling
- Construction of embankment
- Power supply system and substation at project site

It is proposed to develop the proposed EZ for tourism activities. Following development of offsite facilities, economic zone shall be developed under Public Private Partnership Model and a separate Environmental Clearance shall be obtained on a later date.

4.4. Project Area of Influence

The project area of influence encompasses, as appropriate:

The area likely to be affected by: (i) the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.

- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

Hence the area of influence for the project is the project site and the immediate air-shed including the hanging bridge proposed to be constructed.

4.5. Existing Infrastructure in and around the site

The proposed EZ is located in Jaliar dip (an island in Teknaf upzila). It is bound by Naf river on all of its sides. Teknaf Peninsula is one of the longest sandy beach ecosystems (approx. 80 km) in the world.

The proposed EZ area falls under aquaculture zone of Cox's bazaar district. Due to the proximity to Bay of Bengal, Naaf River and other rivers, the area in the proximity of the EZ is used as a habitat for varieties of species of fish, crab and prawn. After catering to domestic requirements, fishes are also exported to abroad.

As observed during site visit, the proposed EZ has a level difference of 5 to 7 m (approx.) with a gentle slope towards South East direction with minor undulations. The entire site is located below the Maximum flood level. The depth of land filling across the project area would vary according to the contour variation.

Based on the interaction with the UNO officials and local inhabitants, flood level during monsoon season varies from 2 meters to 3 meters depth inside the proposed EZ area. To avoid inundation during monsoon season, land filling above the flood level could be considered. The top level shall be aligned along with existing marine drive. i.e. +4 m from NGL. The existing infrastructure linkages to the proposed EZ location are described in subsequent sections. The utility map of the proposed site location is shown in figure below.

4.5.1. Power Supply for the proposed Site

The nearest substation to the proposed EZ is Teknaf substation having capacity of 10 MVA. As per the ISA report, this substation has excess capacity of 3.5 MVA. 33 KV line is passing along the road which is located within 500 meters from the proposed EZ and tapping may be taken from this line and 33/11 KV substation may be proposed at site. Grid substation 132/33 KV is available at Cox's Bazar which is located at a distance of 80km from the site.

Bangladesh government has proposed to develop multi-plant power complex with 6000 MW Ultra Super Critical Coal Based Thermal Power Plant and 3000 MW LNG Based Combined Cycle Power Plant in different phases at Moheshkhali Upazila in Cox's Bazar District, and is expected to be commissioned by 2021.

4.5.2. Water Availability for the proposed Site

Groundwater is the major source of drinking water in the region. There is no existing water supply system at the proposed site. Depth of water table is 120 meters – 150 meters from the ground level. The water requirement for the site is envisaged to be met through the construction of borewells inside the project site.

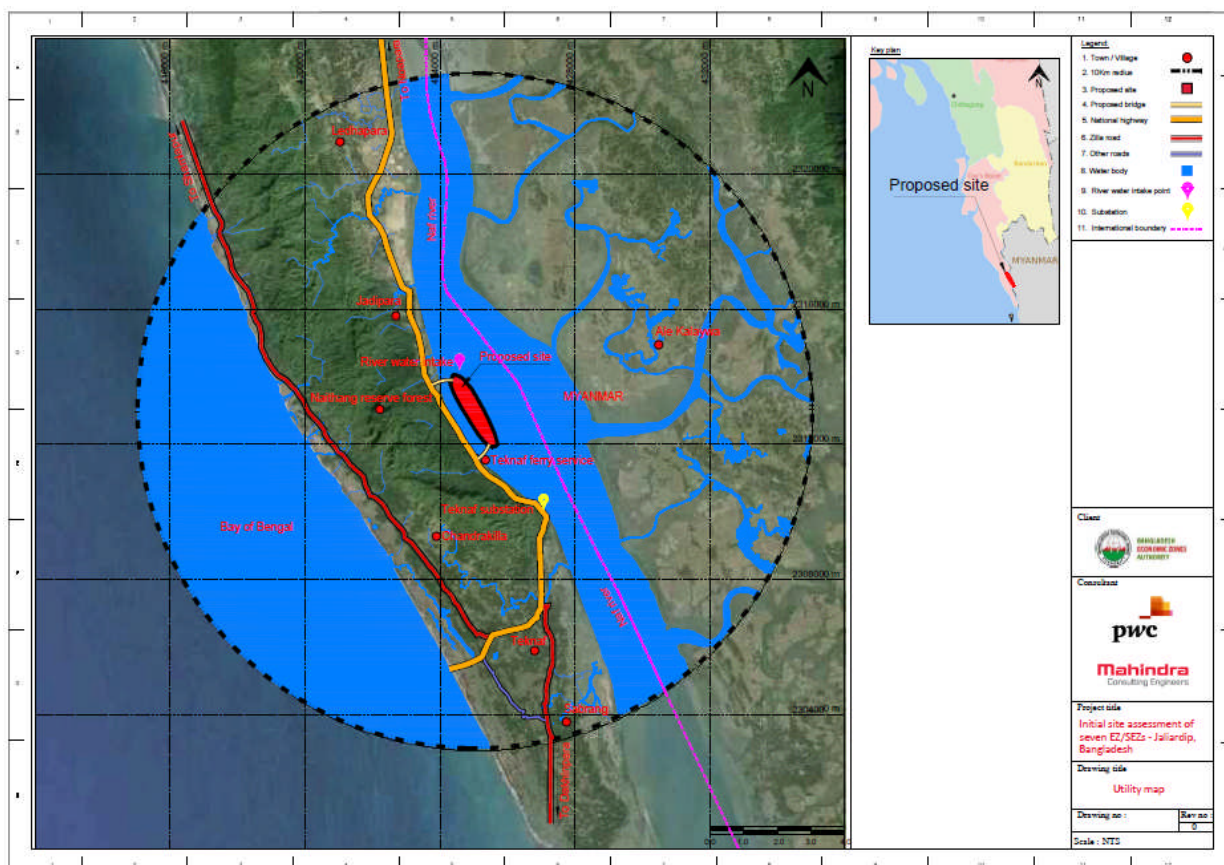
4.5.3. Gas Supply to the proposed Site

At present there is no gas transmission / distribution network is available in this region. 24" gas transmission line is available upto Shikalbaha power plant, Chittagong (located at a distance of approx. 190 km from proposed EZ).

4.5.4. Telecom/ Internet connectivity to the proposed Site

Basis interaction with UNO officials, optic fiber cables are not available in vicinity of proposed EZ. The internet and telecom services are currently provided by mobile companies such as Grameen Phone, Bharti Airtel, Banglalink, Teletalk in this region. Service by private operators has improved the telecom connectivity in the district.

Figure 9: Utility map for the proposed site location



Source: ISA report

4.5.5. Connectivity

The proposed site location is accessible by roadway and waterway. The road distance between Cox’s Bazar city and proposed EZ via N1 highway (Cox’s Bazar-Teknaf Highway) is approx. 80 km. Last mile connectivity to proposed EZ (located in Jaliardip Island, being bounded by Naf River on all sides) could only be possible by waterways.

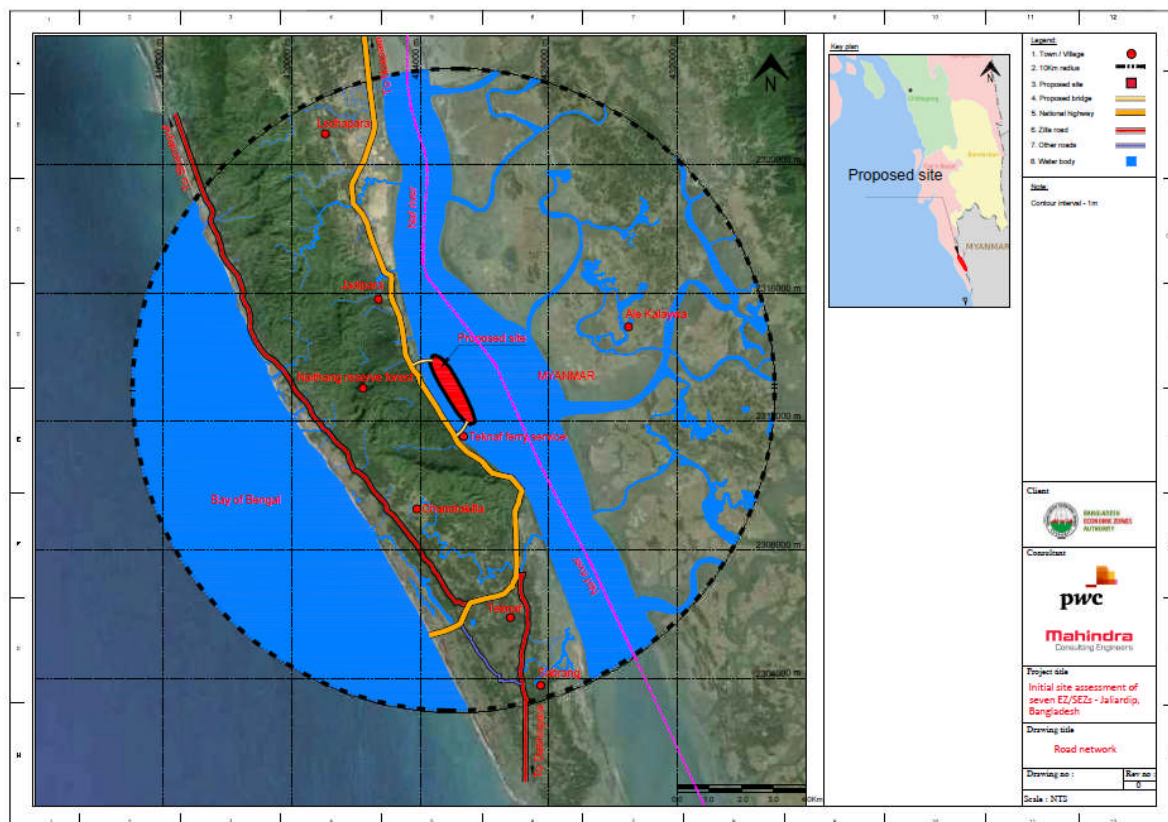
4.5.5.1. Road

The proposed EZ is accessible from Cox’s bazaar through two roads:

- Dhaka – Chittagong highway (N1) approximately 80 km distance to the site
- Cox's Bazar-Teknaf Sea beach Road (Z1098) which runs up to Teknaf and then from Teknaf it connects the proposed site through Dhaka – Chittagong highway (N1).

The total distance to the site via route 2 is approximately 100 km. These roads are single lane and it takes around 3 hours to reach the Cox’s bazaar from the proposed EZ by road. The proposed EZ, Cox’s Bazar-Teknaf Sea beach Road and Dhaka-Chittagong Highway are shown in figure below.

Figure 10: Road network map for proposed site



Source: ISA report

4.5.5.2. Rail

- The whole district of Cox's Bazar doesn't possess any railway connectivity. Nearest existing railway station is Chittagong railway, which is 210 km (approx.).
- A new railway station has been proposed at Gundun, which is 50 km (approx.) from the site. The proposal has already received approval from the Railway Ministry.

4.5.5.3. Airport

- The nearest airport to the proposed site is Cox's Bazaar domestic airport is at a distance of 80 km (approx.) from the proposed EZ. The connectivity from airport to the proposed EZ takes around 2-2.5 hours (approx.) of travel time via road via Cox's Bazar-Teknaf National Highway (N1) road.
- There is proposal to develop an international airport in Cox's Bazaar to attract foreign tourists to the area. Prime Minister of Bangladesh has inaugurated (Jul' 2015) the commencement of construction works for International Airport in Cox's Bazar.

4.5.5.4. Port

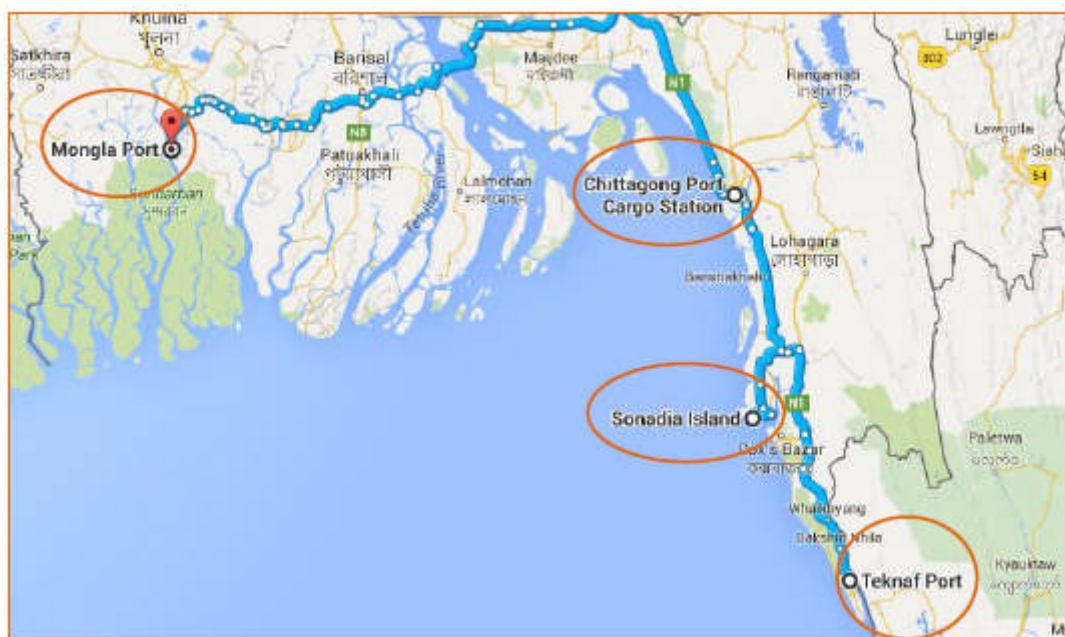
The site at present is an island and last mile connectivity is via Naf river. The site may be linked to other waterway terminals as below:

Chittagong port is the principal Port of Bangladesh. Proposed EZ is located at a about distance of 190 km from this port.

Teknaf port is only used to transport goods and passengers between Bangladesh and Myanmar to cross the river for about 1 km width. Approximately 3-5 trips are being made to & fro from Bangladesh. Preliminary assessment suggests that expansion of cargo and passenger handling capacity of Teknaf port to other major ports of Bangladesh as well as to ports in Myanmar may be explored. Once the proposed EZ is developed, this could aid in trade related transport to other parts of Bangladesh as well as exports to Myanmar.

The figure below depicts the geographical importance of proposed EZ with respect to water connectivity to Chittagong port, proposed Sonadia deep sea port and Mongla port.

Figure 11: Location of Teknaf Port, Sonadia Island, and Chittagong and Mongla port



Source: ISA report

4.6. Project Activities

The proposed EZ is planned on an area of 271.93 acres which has been transferred by DC to BEZA on 31st May 2016. At present only off-site developments will be carried out by BEZA. Details of the offsite facilities are as described below:

- Site Development – It is proposed to provide embankment for a length of 5.60 km around the site. The top level shall be +4 m from NGL. A finger jetty of 15-20 m length is envisaged to facilitate the landing of cruise. The proposed site plan and site development works are shown in figures below.
- Construction of Access Road – The site is an Island there is no separate access road required only bridge is required to connect this island with the approach road. Hence no separate access road is envisaged.
- Bridge - Pedestrian access bridge to connect the existing approach road and the site for a length of 450 m length x 3m width is envisaged
- Construction of Boundary Wall - There is no need of separate boundary wall and embankment will act as boundary wall.
- Construction of Admin Building - G+2 building considered as typical design.
- External water supply system – It is proposed to construct 2 bore wells within the site to meet the initial demand of 1-2 MLD. Additional borewell can be added at later stage depending upon the requirement.

External power supply system – It is proposed to construct 33 kV substation within the site to meet the initial demand of 10 MVA with the provision for meeting the future demand.

Figure 12: Proposed Regional plan

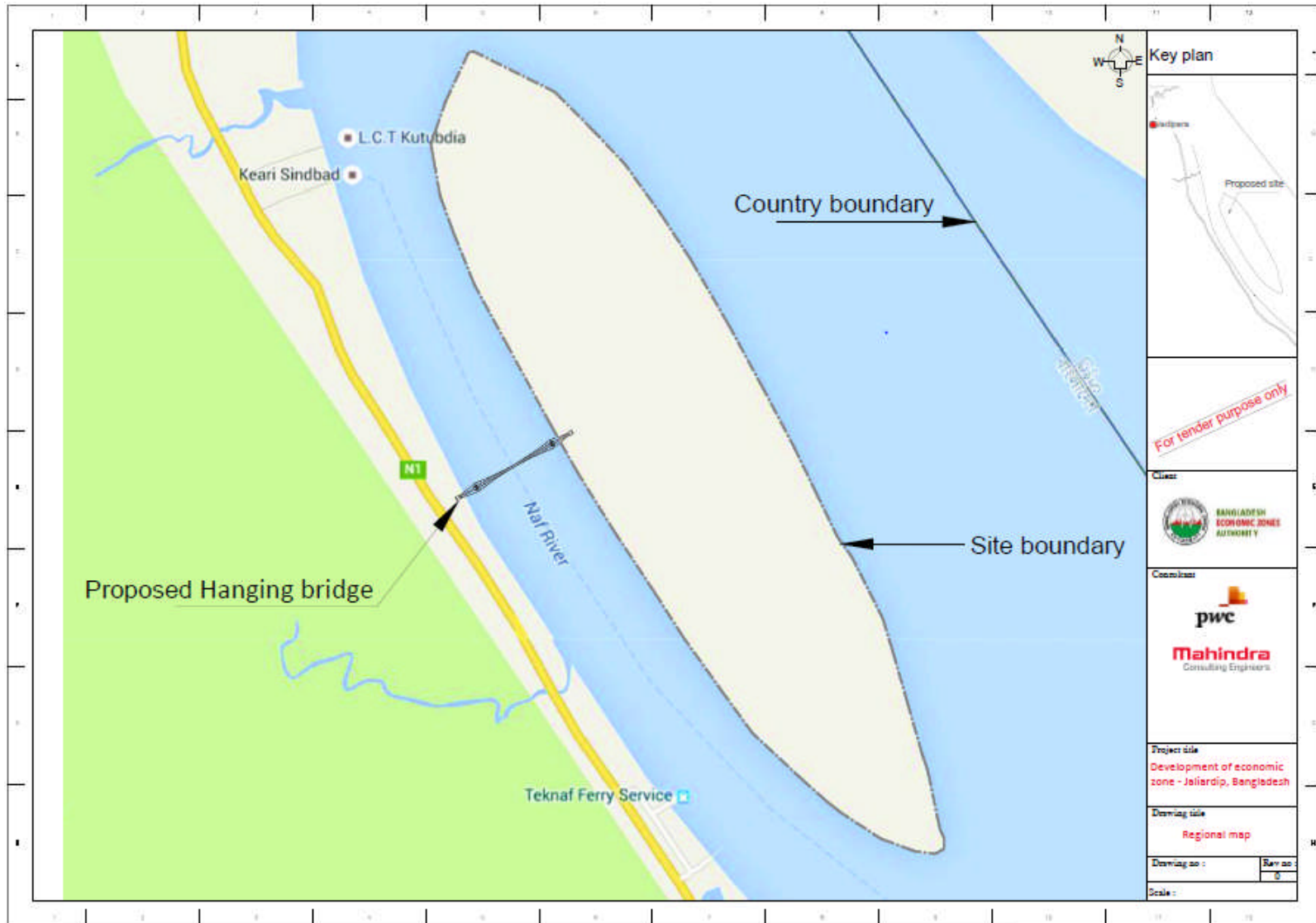


Figure 13: Proposed Site plan

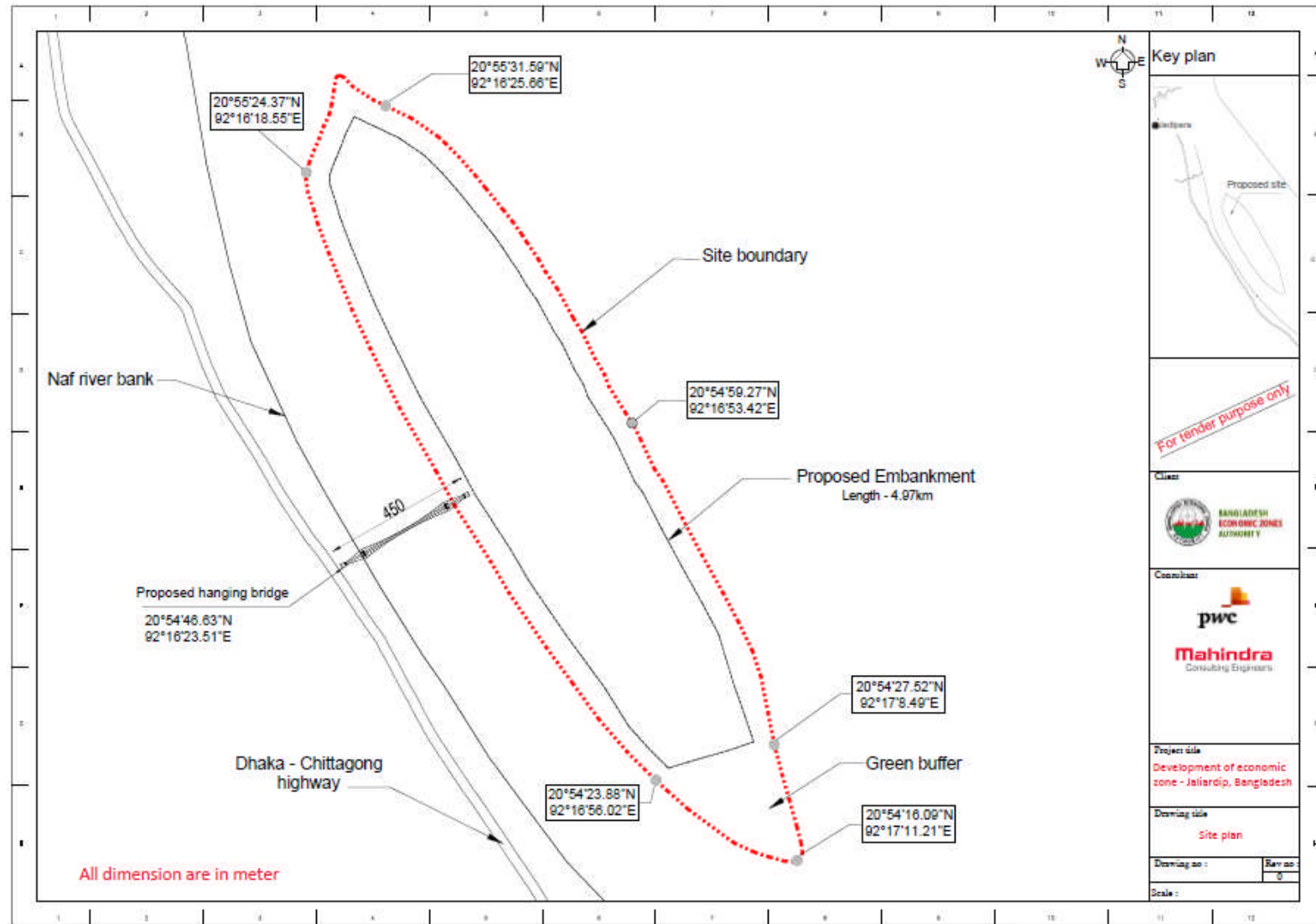


Figure 14: Site Development Plan

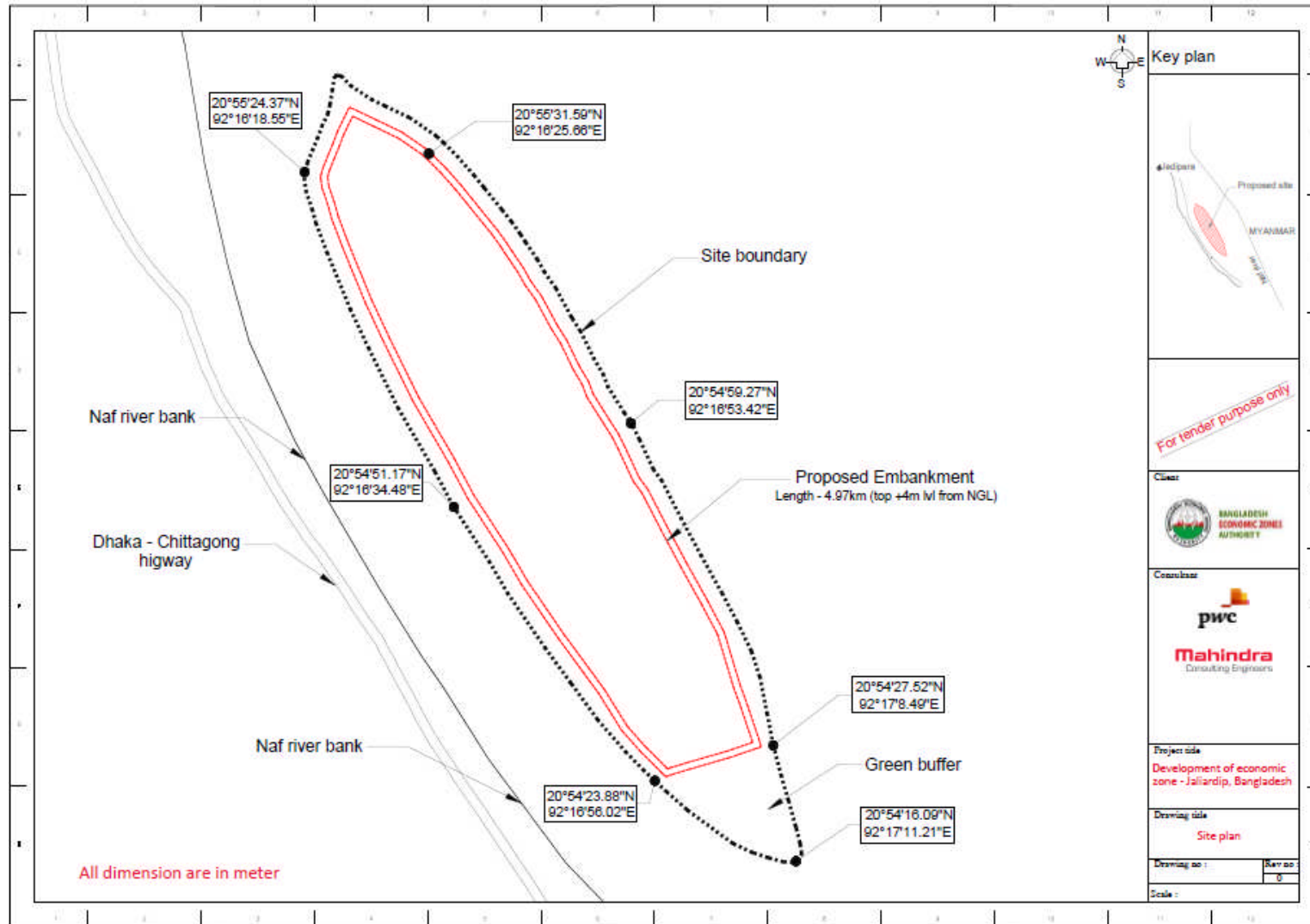


Figure 15: Hanging Bridge Location Plan

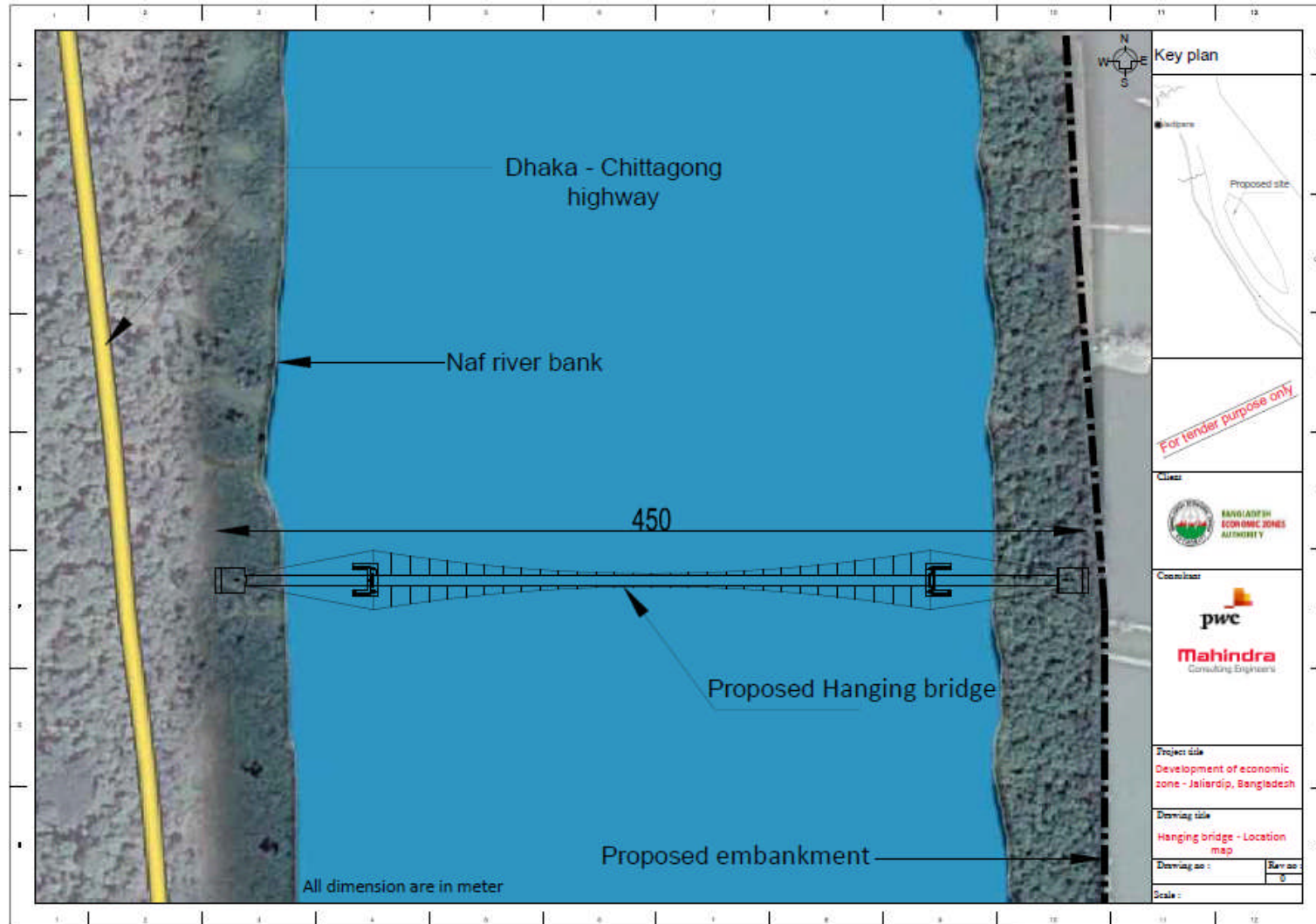


Figure 16: Hanging Bridge Details

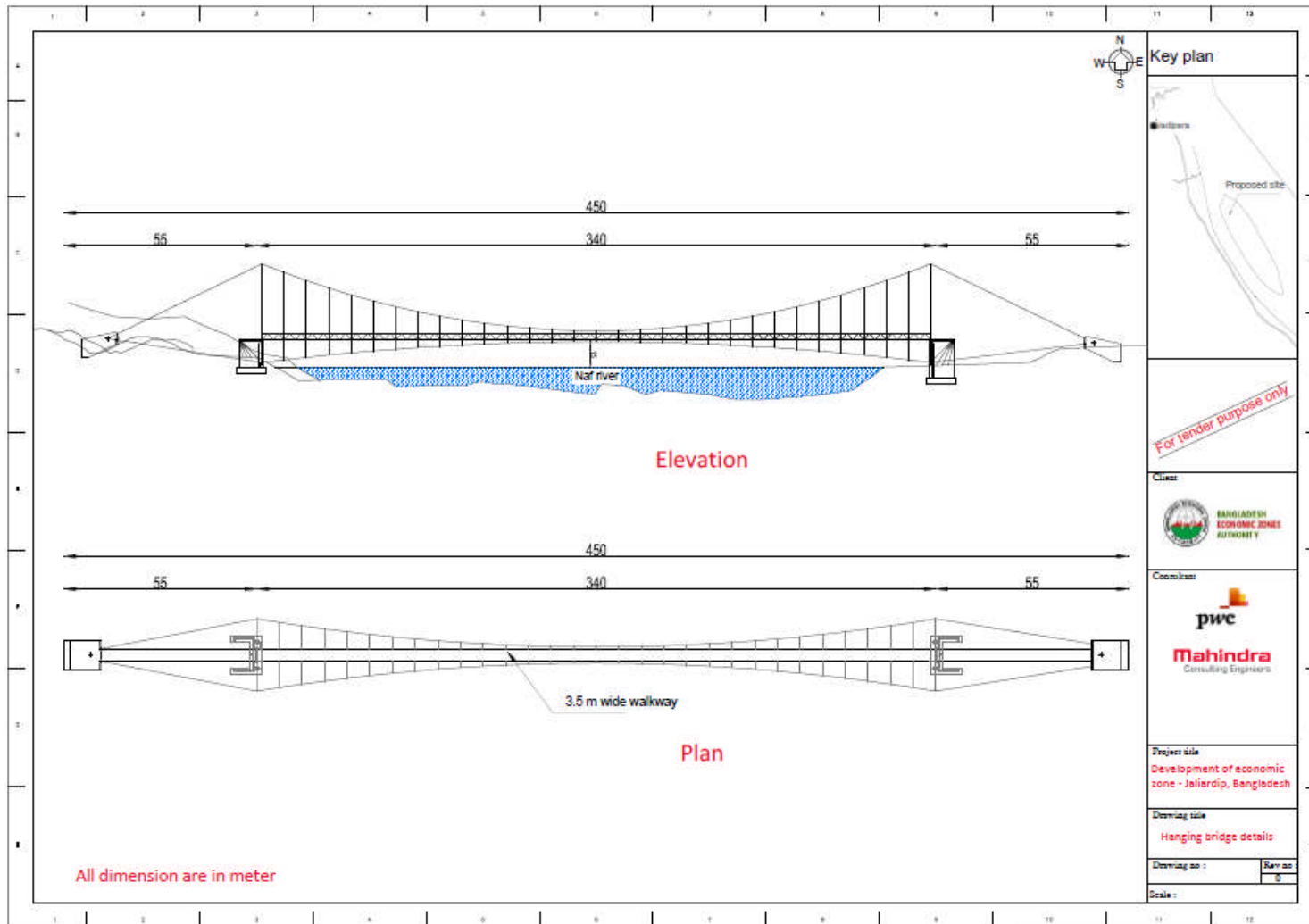


Figure 17: Embankment Layout

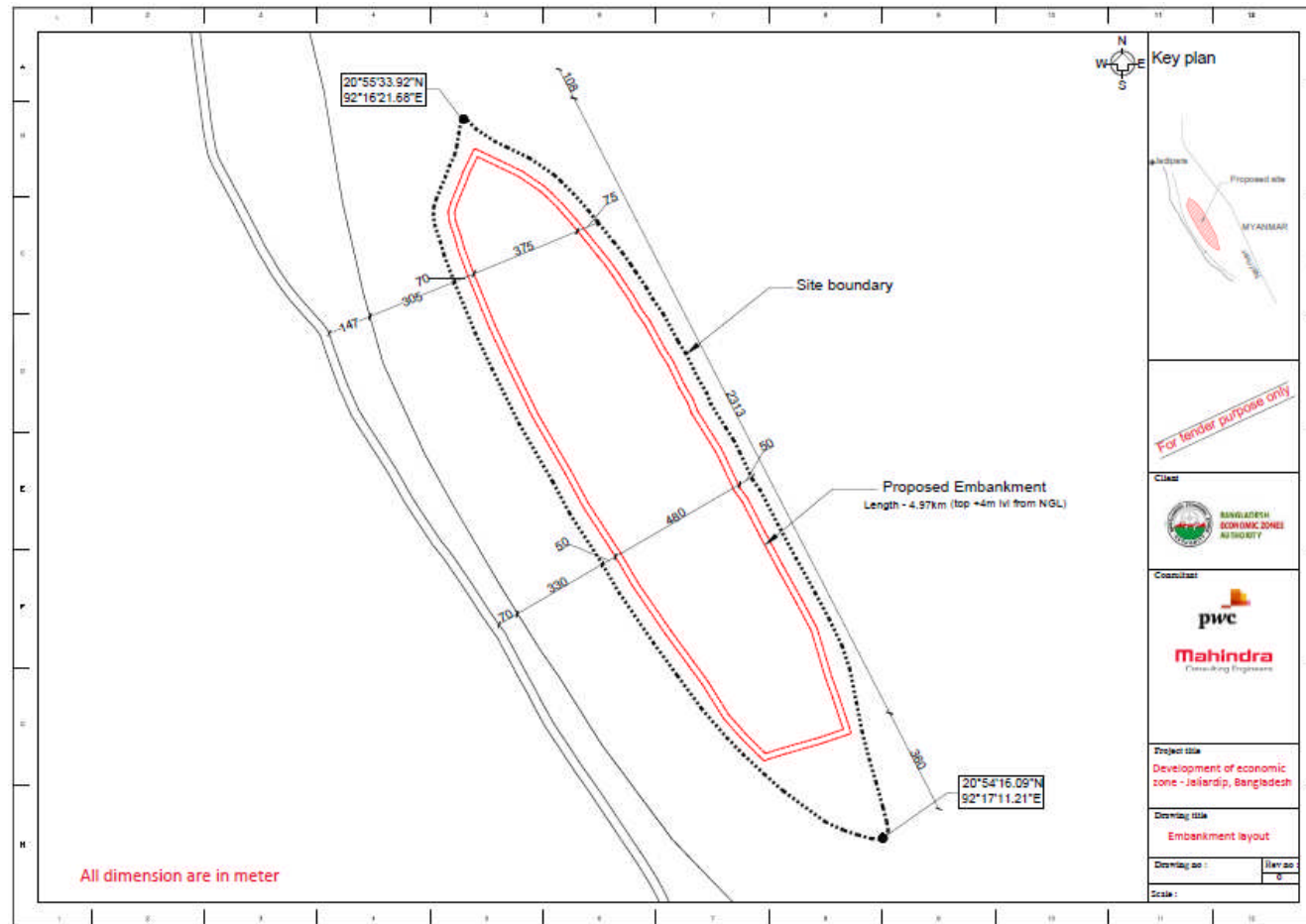


Figure 18: Embankment Cross-section Details

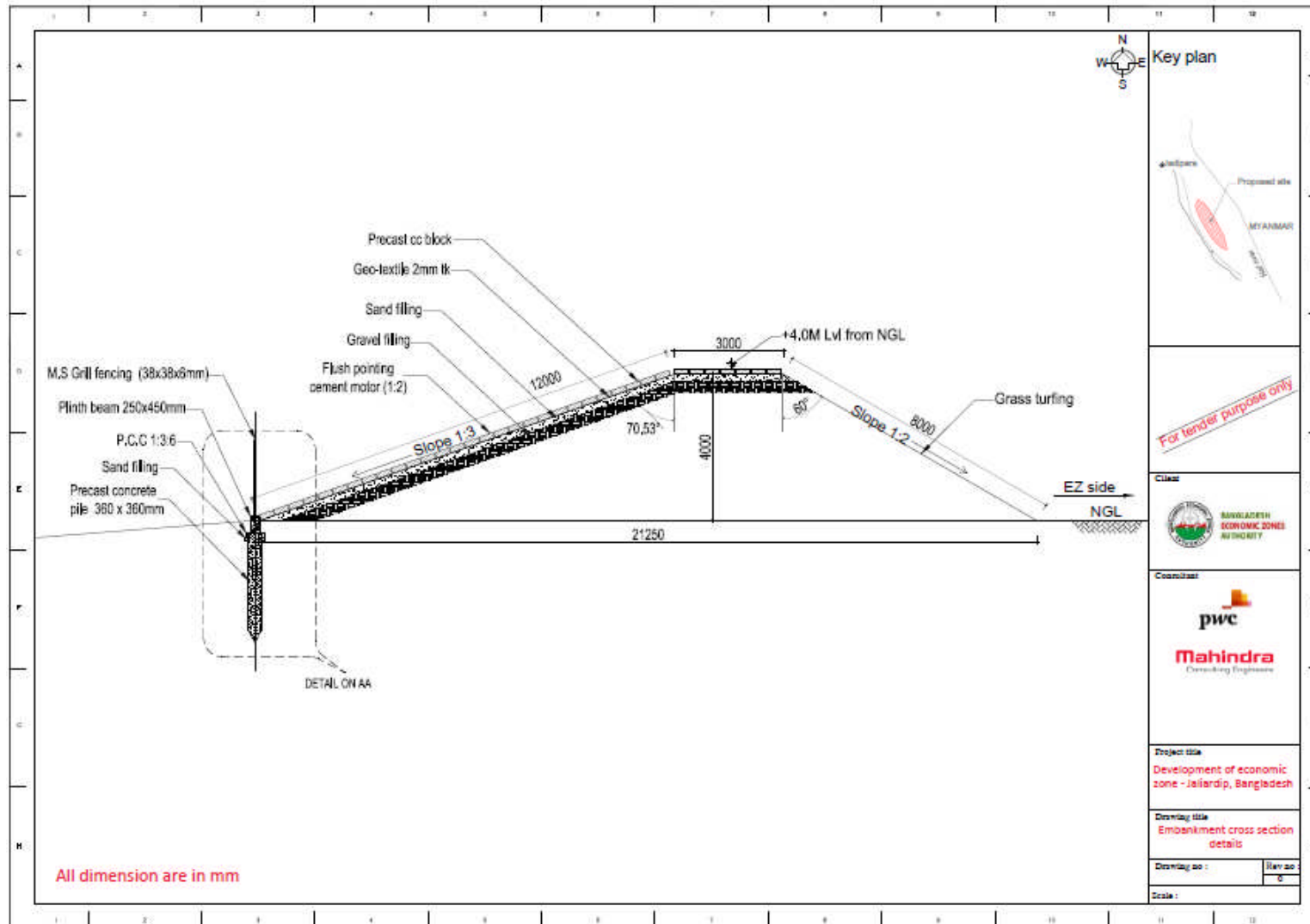
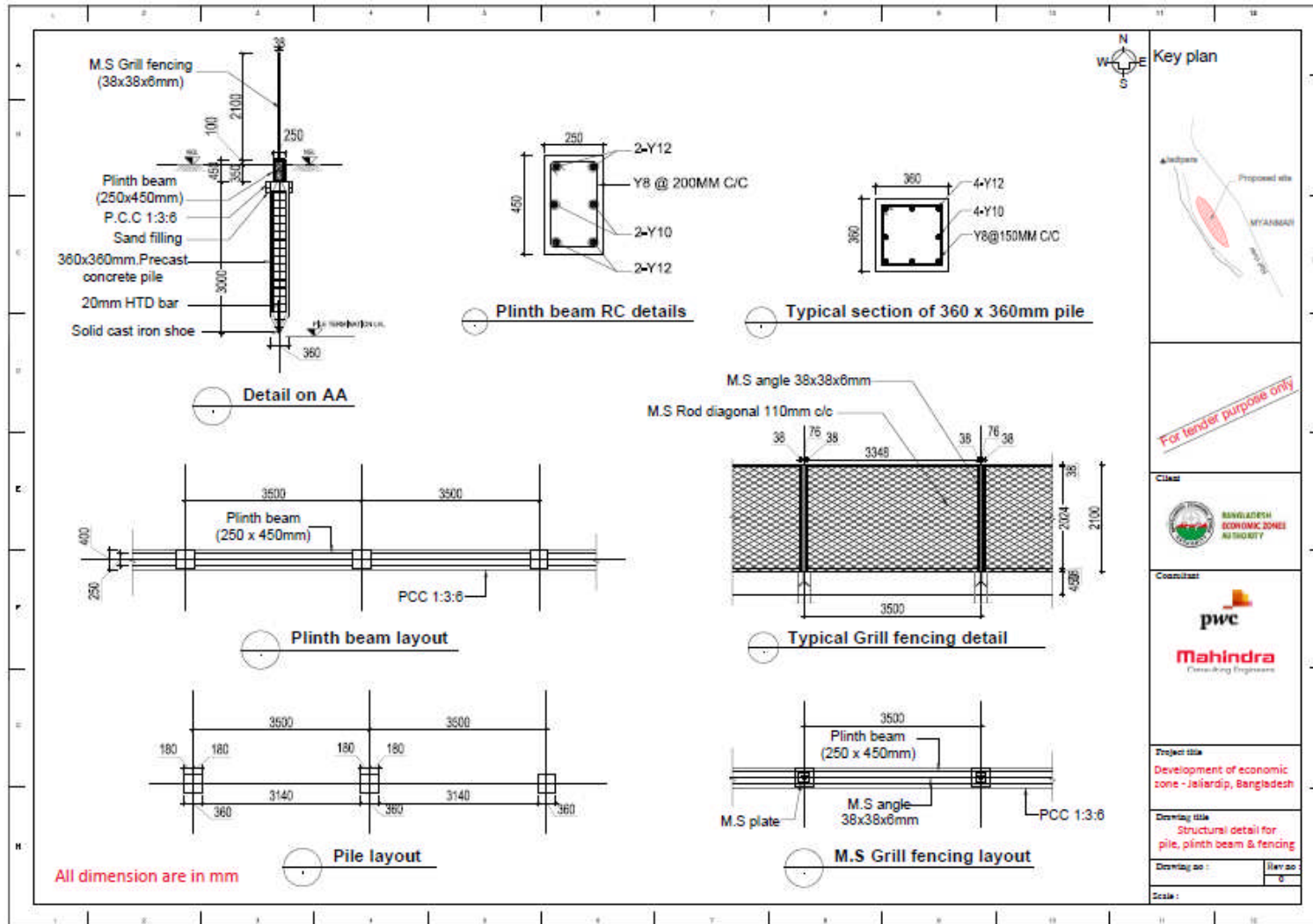


Figure 19: Structural Details for Pile, Plinth Beam and Fencing



4.7. Project Schedule

The tentative schedule for the off-site infrastructure development is provided in table below:

Table 9: Implementation Schedule of Off-site Infrastructural Details

S.No	Offsite infrastructure	Duration in months from start
1	Site Development	12
2	Hanging Bridge	9
3	Embankment	6
4	Admin building	12
5	Power distribution	9

4.8. Resources and Utilities Demand

Construction material like steel, cement, concrete, bricks, aggregates etc. will be required for each of the proposed off-site facilities and EZ development. Since the planning has been carried out for offsite development, the detail provided below pertains to off-site facilities. The EZ development requirement though will remain similar in nature but these details for EZ shall be available after the master developer is appointed and his plan is finalized. The Bill of Quantities requirement for the off-site facilities is given in the table:

Details for BOQ of Bund and Fencing Works (1/5)




Consultancy services for preparation of engineering design, drawings, BOQ and bid documents for off-site infrastructure for 5 EZs

Abstract for formation of bund and fencing works - Jaliardip EZ

Abstract for formation of bund and fencing works - Jaliardip EZ

Item. No	BPWD Item. Code	Description	Unit	Total Qty	Rate in Tk	Amount in Tk
1	2.1	Earth work in excavation in all kinds of soil for foundation trenches including, layout, providing center lines, local bench-mark pillars, leveling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer; subject to submit method statement of carrying out excavation work to the Engineer for approval. However, Engineer's approval shall not relieve the contractor of his responsibilities and obligations under the contract.				
	2.1.1	Layout and marking for earthwork in excavation in foundation accepted by the Engineer. [Plinth area of the structure shall be considered for measurement]	Sqm	114540.00	11.00	1,259,940.00
2	2.16	Site development/formation of bund/improvement by carted earth or dredged sand, sandy silt (free from any organic, foreign, environmental hazardous substances) carried by head or truck or any other means in/c cost of cutting or by dredging of sand, sandy silt, all; in/c local carrying, placing the earth/sand, sandy silt in the designated area, maintaining slopes, breaking lumps, levelling and dressing in layers up to finished level etc. all complete as per direction and accepted by the engineer in charge.	Cum			
	02.16.2	For bund				
	02.16.2.1	By other than dredging Bund formation	Cum	258960.00	284.25	73,609,380.00
3	02.17	Mechanical compaction of earth or sand in 150mm layers including leveling, watering and consolidation each layer with chain dozer, grader, roller etc. to achieve minimum dry density of 90% with optimum moisture content (modified proctor test) up to finished level all complete and accepted by the engineer subject to submission of the method statement same as filling Qty				
				258960.00	364.00	94,261,440.00
4	31.31	Compaction test				
	31.31.1	Modified proctor	Per test	25.00	1950.00	48,750.00
5	9.9	Pre-cast pile made in reinforced cement concrete with minimum cement content relates to mix ratio 1:1.5:3 having minimum $f_{cr} = 30$ Mpa, and satisfying specified compressive strength $f_c = 25$ Mpa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM & cement conforming to BDS EN-197-1: CEM1, 52.5N (52.5MPa) ASTM-C 150 Type -I, best quality coarse sand (F.M.2.2), 20 mm down well graded stone chips conforming to ASTM C-33, mixing in standard mixture machine and fed by standard measuring boxes, including all related works like cost of breaking chips, screening through proper sieves, cleaning and washing, centering and shuttering with M.S sheet, M.S angle, F.I bar, nuts and bolts,				

Details for BOQ of Bund and Fencing Works (2/5)




Client: BANGLADESH ECONOMIC ZONES AUTHORITY

Consultancy services for preparation of engineering design, drawings, BOQ and bid documents for off-site infrastructure for 5 EZs

Abstract for formation of bund and fencing works - Jaliardip EZ


Item No	BPWD Item Code	Description	Unit	Total Qty	Rate in Tk.	Amount in Tk.
	09.9.3	chamfering edges if so, preparation of casting beds, laying polythene there in, placing reinforcement cages in position, casting, compacting by vibrators and tapered rods as where necessary, curing for 28 days etc. cost of water, electricity and other charges, providing fitting fixing pile shoe in position as per design and drawing, tools, plants & equipments, mobilization, demobilization, hire charge of driving set, labour, test of materials and concrete etc. all complete as per design, drawing and accepted by the Engineer. [Rate is excluding the cost of reinforcement and its fabrication, binding, welding and placing] 360 mm x 360 mm size pre-cast pile [1 : 1.5:3] with stone chips	metre	4269.00	1520.00	6,488,880.00
6	09.9.4	Providing the pile shoe as per design and drawing	Each	1423.00	2559.00	3,641,457.00
7	9.17	Driving 360 mm x 360 mm size pre-cast pile by rig fitted with automatic diesel operated hammer and maintaining Driving Log in prescribed format. Before commencing driving operation by rig fitted with automatic diesel operated hammer. Contractor shall submit method statement for carrying the operation including Mobilization and demobilization of automatic diesel hammer mounted, sequence of driving to the Engineer for approval. However, Engineer's approval shall not relieve the Contractor of his responsibilities and obligations under contract.	Rm	4269.00	895.00	3,820,755.00
8	9.6	Labour for breaking head of hardened cast in situ bored pile/pre-cast pile up to a required length by any means but without damaging the rest and removing the dismantled materials such as concrete to a safe distance including scraps and cleaning concrete from steel/M.S. rods, straightening and bending of pile bars, preparation and making platform where necessary, carrying, all sorts of handling, stacking the same properly after clearing, leveling and dressing the situ and clearing the bed etc. complete in all respects and accepted by the Engineer. [Measurement will be given for the actual pile head volume to be broken]	Cum	83.00	3603.00	299,049.00
9	2.1	Earth work in excavation in all kinds of soil for foundation trenches including, layout, providing center lines, local bench-mark pillars, leveling, ramming and preparing the base, fixing bamboo spikes and marking layout with chalk powder, providing necessary tools and plants, protecting and maintaining the trench dry etc., stacking, cleaning the excavated earth at a safe distance out of the area enclosed by the layout etc. all complete and accepted by the Engineer, subject to submit method statement of carrying out excavation work to the Engineer for approval. However, Engineer's approval shall not relieve the contractor of his responsibilities and obligations under the contract.				
	2.1.2	Earthwork in excavation in foundation trenches up to 1.5 m depth and maximum 10 m lead: in soft clayey soil / loose sand / silt. For Plinth beam	Cum	1096.00	67.00	73,432.00
10	2.10.1	Sand filling in foundation trenches and plinth with sand having F.M. 0.5 to 0.8 in 150mm layers including leveling, watering and compaction to achieve minimum dry density of 90% with optimum moisture content [Modified proctor test] by ramming each layer up to finished level as per design supplied by the design office				



Consultants: pwc Mahindra Consulting Engineers

2

Details for BOQ of Bund and Fencing Works (3/5)




Client: BANGLADESH ECONOMIC ZONES AUTHORITY

Consultancy services for preparation of engineering design, drawings, BOQ and bid documents for off-site infrastructure for 5 EZs

Abstract for formation of bund and fencing works - Jaliardip EZ

Item No	BPWD Item Code	Description	Unit	Total Qty	Rate in Tk	Amount in Tk
		only etc. all complete and accepted by the Engineer. For plinth beam & cement concrete block	Cum	15836.00	602.00	9,533,272.00
11	3.4.	Mass concrete [1:3:6] in foundation with cement, sand [F.M. 1.2] and picked jhama chips including breaking chips, screening, mixing, laying, compacting to levels and curing for at least 7 days including the supply of water, electricity and other charges and costs of tools and plants etc. all complete and accepted by the Engineer. (Cement: CEM-II/A-M)				
	3.4.1	Mass concrete in foundation [1:3:6] with cement, brick chips and sand of F.M.1.2 For Plinth beam	Cum	199.00	6319.00	1,257,481.00
12	7.6	Reinforced cement concrete works using steel shutter with minimum cement content relates to mix ratio 1:1.5:3 having minimum $f_{cr} = 30$ Mpa, and satisfying a specified compressive strength $f_c = 25$ Mpa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM & Cement conforming to BDS EN-197-1-CEM 1 (32.5 to 52.5 N) / ASTM-C 150 Type -1, best quality Sylhet sand or coarse sand of equivalent F.M. 2.2 and 20 mm down well graded stone chips conforming to ASTM C-33, making, placing shutter in position and maintaining true to plumb, making shutter water-tight properly, placing reinforcement in position; mixing with standard mixer machine with hopper, fed by standard measuring boxes, casting in forms, compacting by vibrator machine and curing at least for 28 days, removing centering-shuttering including cost of water, electricity, testing and other charges etc. all complete approved and accepted by the Engineer. (Rate is excluding the cost of reinforcement and its fabrication, binding, welding and placing)				
	7.6.5	Plinth beam				
	7.6.5.1	Concrete For plinth beam	Cum	560.00	10929.00	6,120,240.00
13	7.6.5.2	Formwork/ shuttering, prop and necessary supports etc. (steel) For plinth beam	Sqm	4482.00	380.00	1,703,160.00
14	8.1	Supplying, fabrication and fixing to details as per design deformed bar reinforcement in concrete in accordance with BDS 1313 : 1991 standard including straightening cleaning rust and cost of welding, if any, bending and binding in position including supply of G.I. wires etc. complete in all respects and accepted by the Engineer.				
	8.1.2	Grade 500 (RB 500 / 500W: complying BDS ISO 6935-2:2006) ribbed or deformed bar produced and marked according to Bangladesh Standard, with minimum yield strength f_y (ReH) = 500 Mpa but f_y not exceeding 418MPa and whatever is the Yield strength within allowable limit as per BNBC sec 8.3.3.5 / ACI 318-11 sec 2.1.1.5.2, the ratio ultimate tensile strength f_u to yield strength f_y , shall be at least 1.25 and minimum elongation after fracture and minimum total elongation at maximum force is 16% and 8% respectively : up to ground floor.	Kg	97427.00	85.00	8,281,295.00

Consultants:



3

Details for BOQ of Bund and Fencing Works (4/5)



Consultancy services for preparation of engineering design, drawings, BOQ and bid documents for off-site infrastructure for 5 EZs

Abstract for formation of bund and fencing works - Jaliardip EZ

Item No	BPWD Item Code	Description	Unit	Total Qty	Rate in Tk	Amount in Tk
15	2.11	50 mm downgraded picked jhama Khoo consolidation in foundation trenches by mixing the same with best quality local sand [F.M. 1:2] in [2:1] [khok sand] proportion to achieve minimum dry density of 90% with optimum moisture content. [Modified proctor test] including breaking and screening chips, laying and spreading in 75mm layers uniformly etc. all complete and accepted by the Engineer.	Cum	5864.00	3652.00	21,415,328.00
16	2.8	Supply and laying 3 mm thick Geo-textile of approved quality and origin /manufacturer as per manufacturer's instructions approved and accepted by the Engineer. Before commencing laying of Geo-textile, the Contractor must submit the method statement for carrying out this work including sample with evidence of origin and compliance certificate from independent testing laboratory for approval. For precast block	Sqm	78186.00	130.00	10,164,180.00
17	7.4	Providing and Placing of Precast 300x300x150mm/400x400x150 cement concrete solid block for revetment using steel shutter with minimum cement content relates to mix ratio 1:2:4 having minimum $f_{cr} = 30$ Mpa, and satisfying a specified compressive strength $f_c = 25$ Mpa at 28 days on standard cylinders as per standard practice of Code ACI/BNBC/ASTM & Cement, conforming to BDS EN-197-1-CEM 1 [32.5 to 52.5 N] / ASTM-C 150 Type -1, best quality Sylhet sand or coarse sand of equivalent F.M. 2.2 and 20 mm down well graded stone chips conforming to ASTM C-33, making, placing shutter in position and maintaining true to plumb, making shutter water-tight properly, placing reinforcement in position, mixing with standard mixer machine with hopper, fed by standard measuring boxes, casting in forms, compacting by vibrator machine and curing at least for 28 days, removing centering-shuttering including cost of water, electricity, testing and other charges etc. all complete approved and accepted by the Engineer. [Rate is excluding the cost of reinforcement and its fabrication, binding, welding and placing]				
	7.4.B.1	For Concrete block Concrete block pitching for bund production		11728.00	10472.00	122,815,616.00
18	15.7	Flush pointing to CC blocks with cement sand [F.M. 1:2] mortar [1:2] with cement including raking out the joints, and necessary scaffolding curing at least for 7 days, cost of water, electricity and other charges etc. all complete in all respect as per drawing and accepted by the Engineer. [Cement: CEM:11/A.M]. Ground floor. For concrete block pitching	Sqm	78186.00	117.00	9,147,762.00
19	21.4	Manufacturing, supplying, fitting and fixing M.S. tube [angle box] post [bottom and bifurcated] made by thorough welding of two Nos. 38 x 38 x 6-mm M.S. angle and vertically placing the post into C.C. or R.C.C. foundation including cutting angle to required shape and size including covering the top / bottom of the post with 6 mm thick M.S. plate, painting 2 coats of synthetic enamel paint over a coat of anti-corrosive priming, cost of welding etc. all complete as per drawing. [Rate is excluding the cost of C.C./R.C.C. foundation and paint]	Pmt	2988.00	932.00	2,784,816.00

Details for BOQ of Bund and Fencing Works (5/5)



Consultancy services for preparation of engineering design, drawings, BOQ and bid documents for off-site infrastructure for 5 EZs

Abstract for formation of bund and fencing works - Jaliardip EZ

Item No	BPWD Item Code	Description	Unit	Total Qty	Rate in Tk	Amount in Tk
20	21.3 + 16.6	Manufacturing, supplying, fitting and fixing M.S. grill fencing as per design with outer frames having 38 x 38 x 6 mm M.S. angle and inner members having 6 mm dia M.S. rbd placed @ 110 mm c/c diagonally on both direction, welding each Cruz-cross end of rbd with corners of outer frame including cutting rods and size angles to required shapes and size, and setting the entire fence with the previously installed tube (angle box) post including thorough and full welding the frame with the angle box posts, painting 2 coats of synthetic enamel paint over a coat of anti-corrosive priming, coat of welding etc. all complete as per drawing and accepted by the Engineer.	Sqm	10458.00	2421.00	25,318,818.00
21	24.3	Creating turf on the side slopes and top of embankment with good quality turf not less than 225 mm square chunk, watering till the grass grown including all leads and lifts etc. complete and accepted by the Engineer.	Sqm	44820.00	13.00	582,660.00
					Total	402,627,711.00
					in Lakh (Tk)	4,026.28

4.8.1. Water

Water requirement during construction phase is estimated to be app. 50 KLD, which includes Domestic water requirement of construction workers. For storing rain water during construction phase, temporary rain water harvesting ponds can be constructed at the site. Water for construction shall be sourced from rain water harvesting ponds & Ground water. The total water requirement for operational phase is estimated at about 1 MLD which is proposed to be met through the bore wells (2 bore wells within the site to meet the initial demand of 1 MLD) to be constructed at the project site.

4.8.2. Power Requirement

Power demand during construction phase is insignificant. Power required during operation phase is estimated to be 10 MVA. Power supply system will be developed at later stage by developer. The nearest substation to the proposed EZ is Teknaf substation having capacity of 10 MVA. Initial interaction with the UNO and Rural Electrification Board officials revealed that this substation has access capacity of 3.5 MVA. Basis of the discussions with UNO officials, tapping may be taken from this line and the 33/11 KV substation may be proposed at site. Grid substation 132/33 KV is available at Cox's Bazar which is located at a distance of 80 Kms from the site 33 KV line is passing along the road which is located within 500 meters from the proposed EZ.

4.9. Estimated Project Cost

The project cost as envisaged for this project includes three major infrastructure which are a) Construction of the Embankments; b) Site Filling; and c) Construction of the Hanging Bridge. The estimated project cost is summarised in the table below.

Table 10: Estimated Project Cost

Infrastructure	BDT (Millions)	USD (Millions)
Embankments	240	3.0
Site Filling	400	5.0
Hanging Bridge	120	1.50
Total	760	9.5

4.10. Maps and Survey information

4.10.1. Project Location

The proposed economic zone is located in two different Mouzas which are Teknaf Maouza and Dakshin Nhillia, both of which comes under the Teknaf Upazila at Cox's Bazar district of Bangladesh, approximately 80 kms from the Cox's Bazar. The total land area demarcated for the proposed economic zone is 271.93 acres which is Khas land transferred to BEZA on 31st May 2016. The project site is an island and it is located approximately 10 kms from the center of Teknaf Upazila. The proposed EZ is abutted by Naf River on all sides and Naithang River Forest is located at approximately 2 km from the proposed EZ location in the western direction. Cox's Bazar-Teknaf National Highway (N1) runs parallel to the site at a distance of 3 Kms.

The below figure indicates the site locations, features in the vicinity and the road connectivity with the site.

Figure 20: EZ location on Upzila Map



Figure 21: Project site and surroundings



Figure 22: Mouza Map with the project site

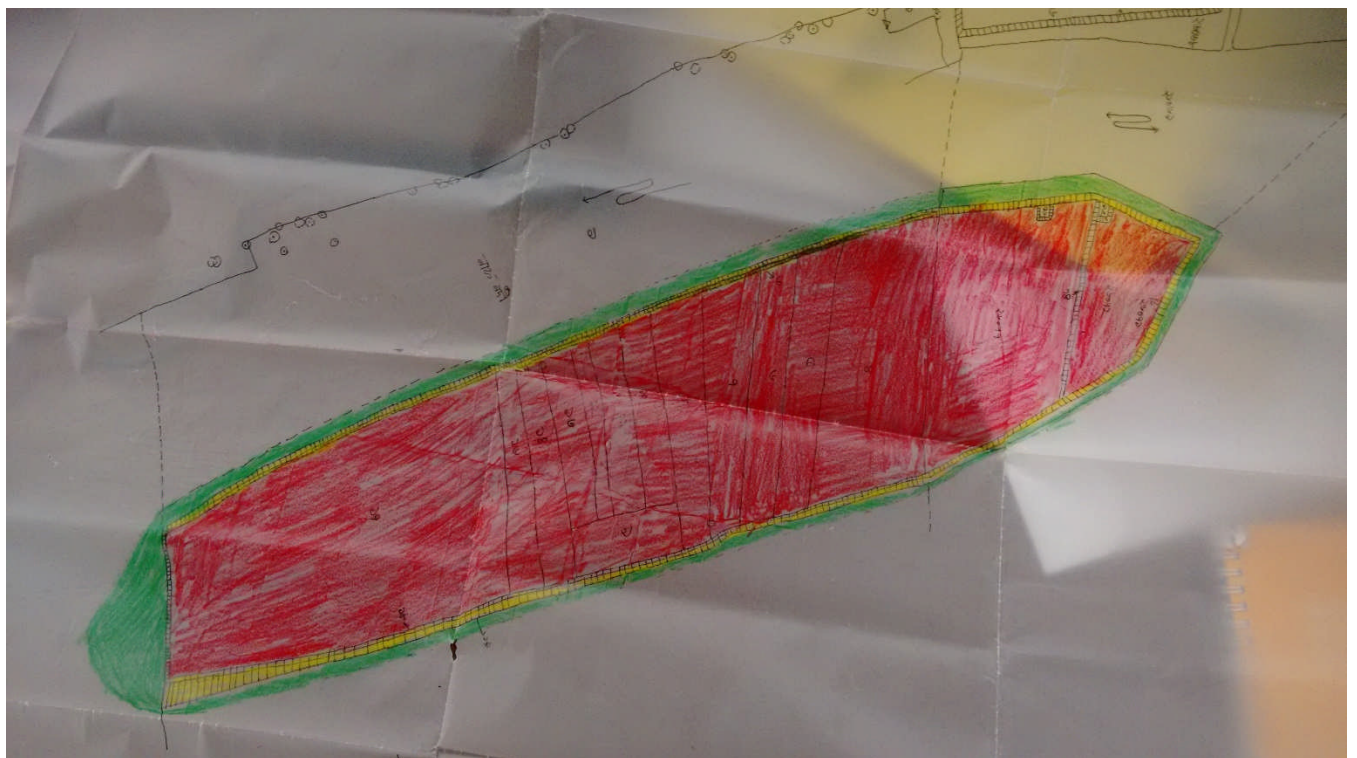


Figure 23: Contour Map of the Proposed EZ

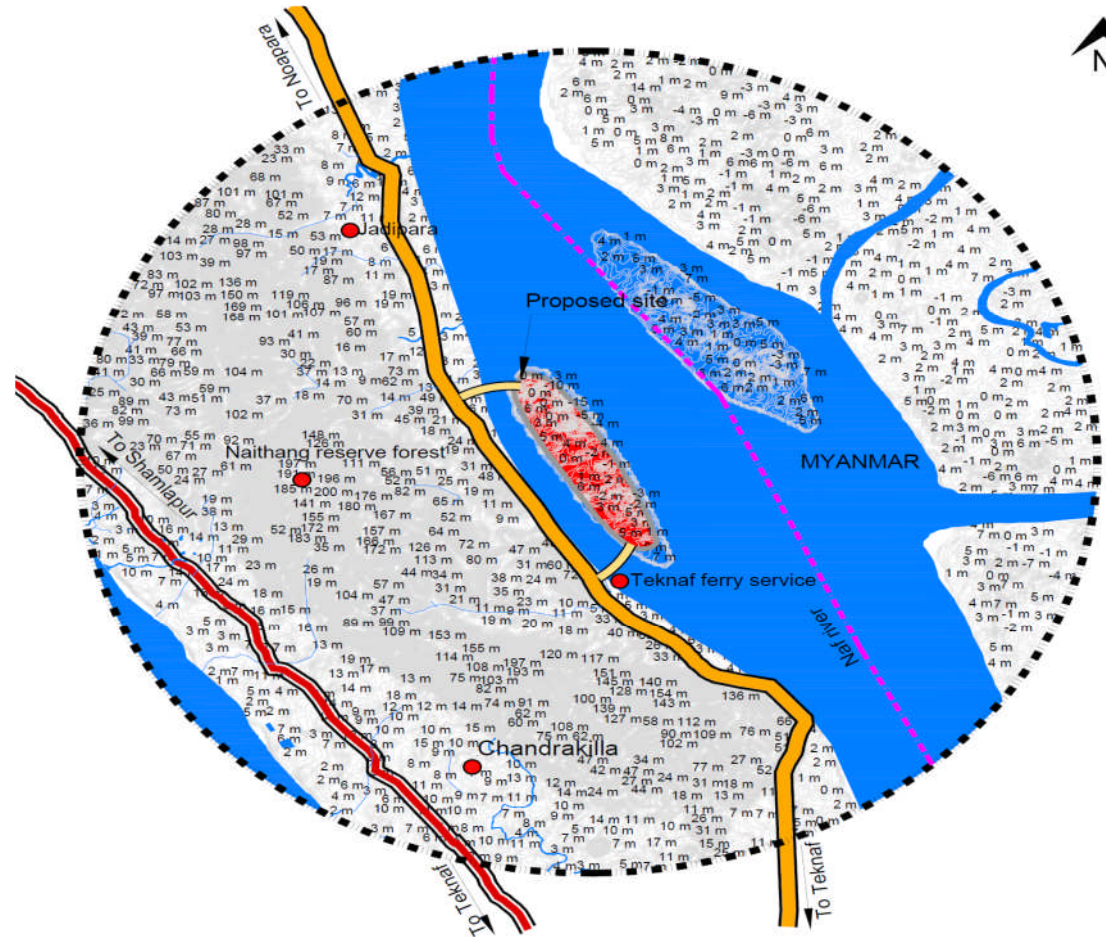


Figure 24: Topography of the Site

4.11. Eco Sensitivity

Teknaf wildlife sanctuary is approximately 2-3 km from the proposed EZ. It comprises an area of 11,615 hectare. This is one of the few places in Bangladesh where Elephants can be seen in the wild. It was established in 1983 as a sanctuary to protect wild Asian Elephants. This vast sub-tropical forest has several other attractions like Nitong Hill, Kudum Cave, Kuthi Hill etc.

Naithang Reserve forest is approximately 2 km from the proposed EZ location. Himchari National Park is approximately 55 km from the proposed EZ. It is 5 kilometers south of Cox's Bazar and is a 1729-hectare reserve bordering the Bay of Bengal. It is well-known waterfalls. The several sites in Himchari National Park have been concessioned for management by the private sector, including the waterfall with a footfall of close to a lakh tourists every year. It is managed by the Forest Department.

4.12. Geology

The Teknaf town and its adjoining area can be divided into three distinctive physiographic units. The units are 1) Eastern Naf River and its adjacent flood plain; 2) Middle Dakhin Nhila Anticline and 3) Western Bay of Bengal. The topographic features such as hills cliffs, streams, escarpments etc. characterize the major portion of the central hill range. The distribution of various topographic features is mainly the result of subareal weathering and erosion process of streams. The whole hill range is characterized by isolated peaks and ridges. The sloping nature of the sides of the hill range is not same.

The eastern flank of the Anticline is wide and gentle than the western flank. The highest ridge of the hill inside the Teknaf pourashova area is about 76m above the sealevel. Valleys are irregularly situated in this hill range. The height of the cliffs of the hills varies within a narrow range from about 30m to 76m and these cliffs terminate abruptly against the beach presenting vertical sections.

The geology of Teknaf area has been described into two parts, such as 1) geological structure on which Cox's Bazar town is located and 2) stratigraphy by which the subsurface ground and the hilly area of Cox's Bazar town is formed of.

4.12.1. Geological Structure

Teknaf Town and surroundings are located on the Dakhin Nhila Anticline which is the southernmost structure of Chittagong-Tripura folded belt, mainly comprises of Neogene Sedimentary rocks. It is the western most extension of Arakan-Yoma Anticlinorium's and separated from the main body of the Arakan-Yoma by several km wide flood plain of Naf River.

The Dakhin Nhila Anticline lies under Teknaf Upazila and Cox's Bazar District and bounded by latitudes from 20°52' to 21°07'N and longitudes from 92°08' to 92°18'E. The hills and valleys striking N 17°W and S 17°E represent the axial direction of the anticline. The maximum elevation is about 266m above mean sea level. The northern pitch is represented by low relief due to saddle separating from Inani Anticline, whereas southern pitch abruptly merges with the plain land. Dakhin Nhila Anticline is an elongated, asymmetric, and box like structure. It is a complicated structure due to the presence of longitudinal and transverse faults.

4.12.2. Stratigraphy

The oldest exposed rock in the Dakhin Nhila Anticline is the Upper Bhuban Formation that is about 545m thick. The exposed rock formations from older to younger are Upper Bhuban formation, Boka Bil Formation, Tipam Formation and Dupi Tila Formation. Mostly argillaceous sediments with little coverage of arenaceous sediments characterize the structure. The axis of the structure runs along NNW-SSE direction. Some portion of western flank and younger formation of southern pitch has been eroded away due to erosion by the Bay of Bengal.

The axes of folds run along NNW-SSE direction which is disrupted and complicated by the presence of numerous faults. It is generally observed that the intensity of folding increases towards the east. The development of Bengal Foredeep is directly related to the development of Himalayan in the north and the ArakanYoma Mountains in the east due to the northeastern collision of Indian plate with Eurasian plate. The movements of the Arakan Sub-plate bounded by the Ninety East Ridge and covering the eastern and southeastern part of Bangladesh, have been suggested to have result the formation of folds of the eastern flank of the Bengal Basin (Faruquee, 1975).

Folds of Chittagong and Chittagong Hill Tracts are the western extension of the Arakan Yoma Anticlinorium, which are known in Bangladesh as folded flank of Bengal Foredeep of Bengal Basin. The surface relief of the area is represented by north-south stretched hills of sedimentary cover.

From the above discussion, it is observed that the relative movement of the Indian and Burmese plate has developed the main east west compression in the region. The Burmese plate being overridden the plate has been serving as the main pushing agent and as a result the magnitude of force is higher in the east than the west. Another major plate movement took place in the Pliocene that resulted in a large-scale movement along the Dauki Fault and the Dhubri Shear Zone. During the Eocene, basin wide emergence and maximum regression occurred in the Bengal Basin, followed by deposition of the Barail Group in the Oligocene. But during most of the Miocene the deep basin featured conspicuous subsidence and Marine transgression and during the late Miocene a new phase of structural and depositional development took place because of global eustatic regression. The onset of the final uplift and of structural deformation the Himalayan and Indo-Burmese orogenies as well as the renewed rise

of the Shillong Plateau resulted in largescale erosion and thus in the supply of huge quantities of coarse-grained detritus in the Pliocene (Reimann,1993). This structure falls in the tropical climate zone and receives heavy shower during monsoon.

Figure 25: Geological Map of Bangladesh

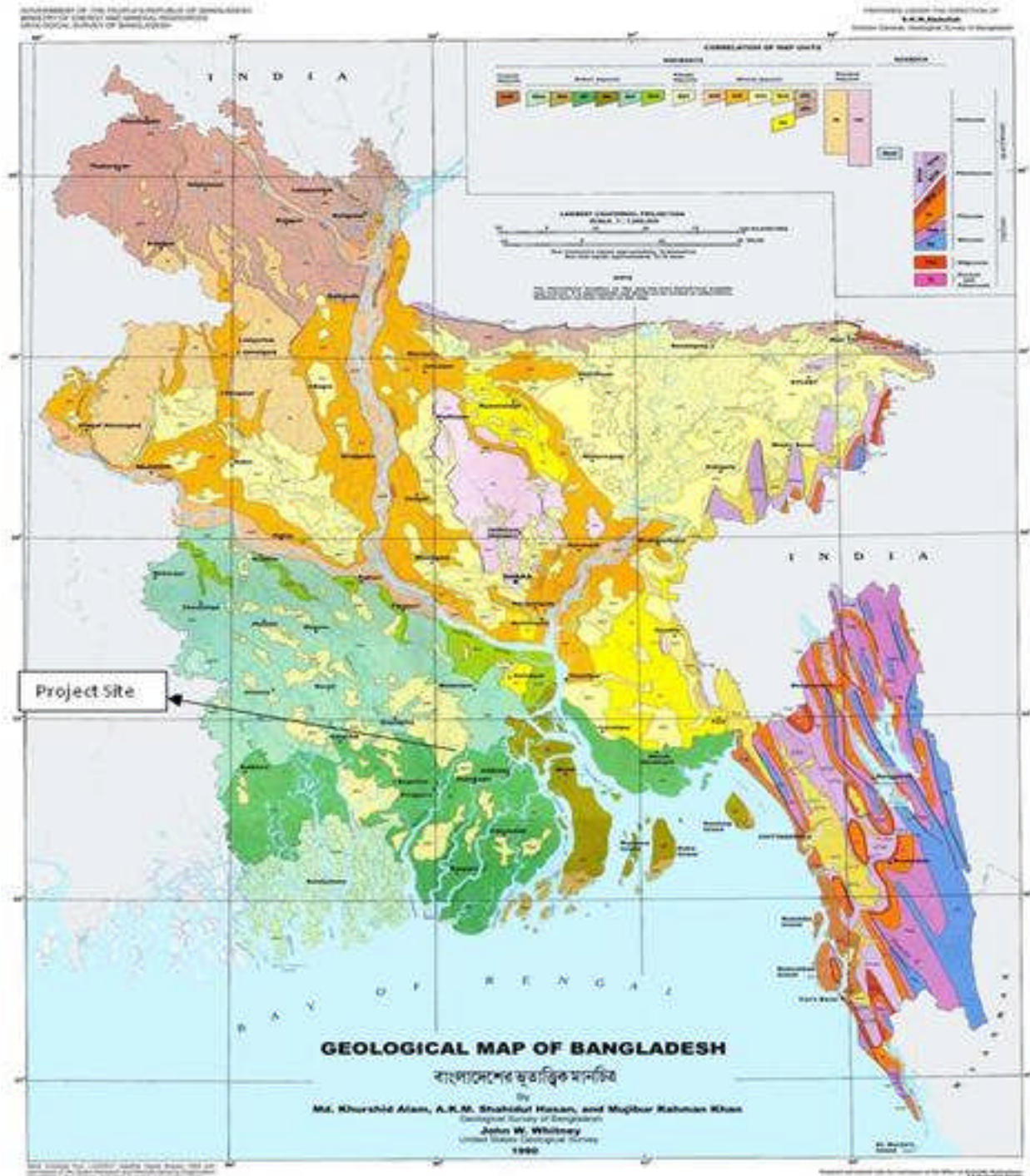
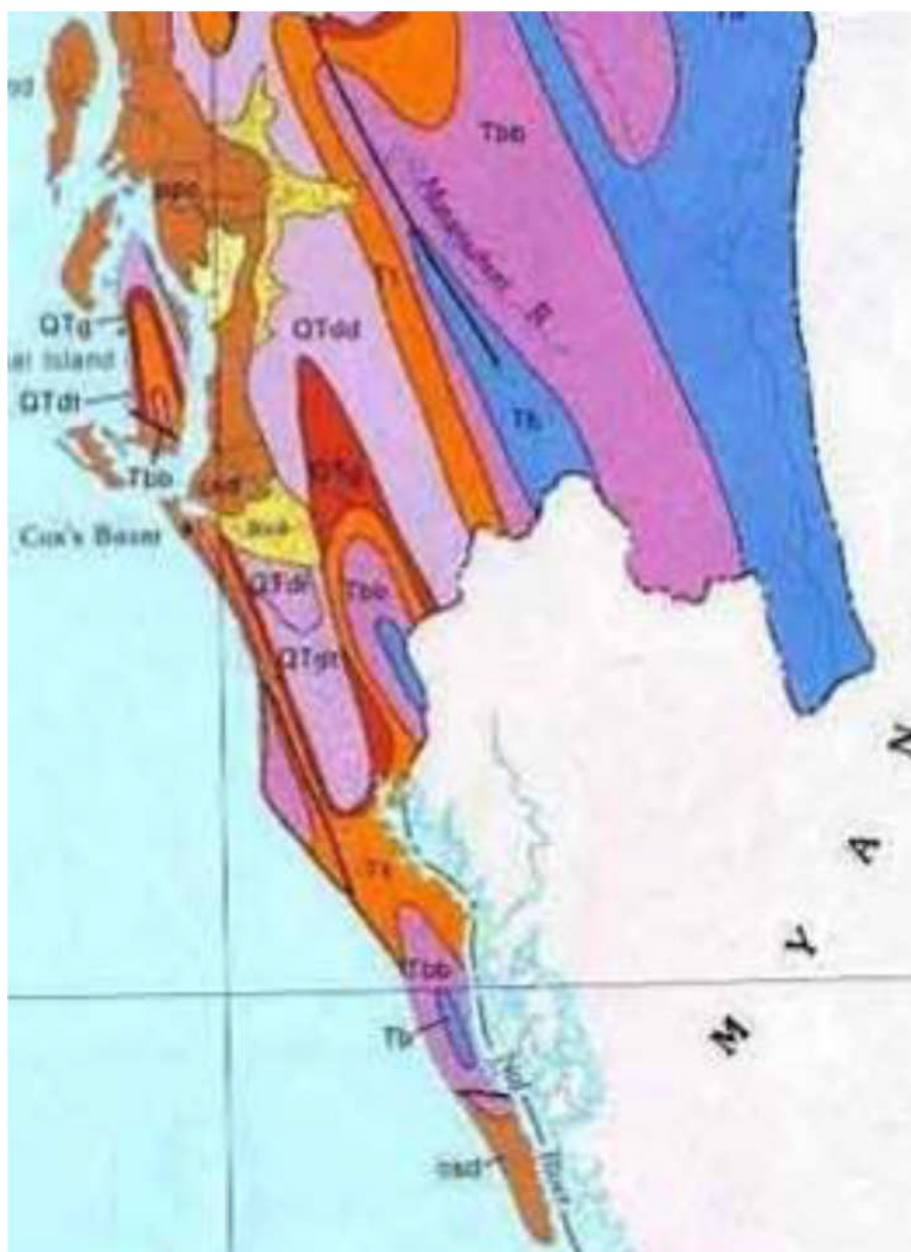


Figure 26: Geological Map of Teknaf

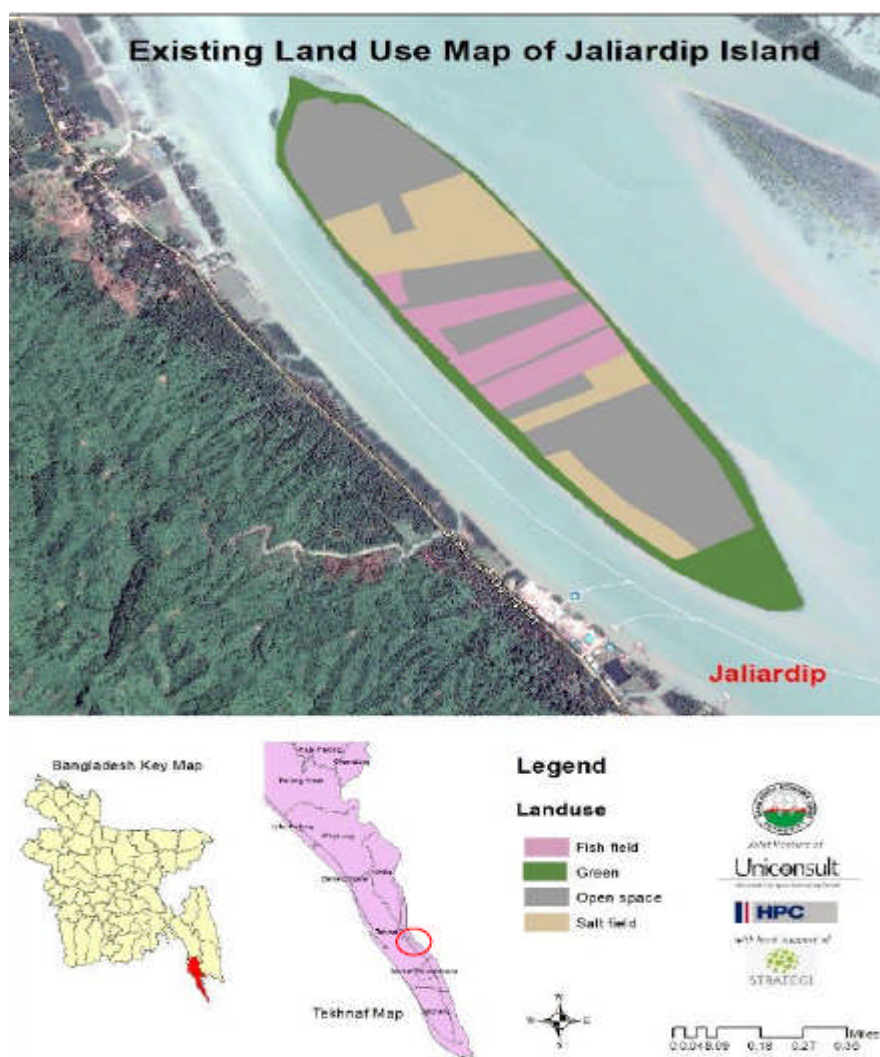


4.13. Master Plan of Jaliardip Economic Zone

4.13.1. Land Use Plan

The proposed area is not a dominant urban center in Cox's Bazar District, but it is in great demand as a recreation site. The proposed site constitutes an open area used by the local inhabitants as fishing-breeding and salt-cropping grounds. Some of the area is cultivated with vegetables. The detailed land use is shown on the below figure.

Figure 27: Updated Land Use of present Jaliardip Island



Source: Feasibility Consultants

As most significant advantage can be stated that no resettlement of resident population will be necessary.

Zone Spotting

The whole area is divided into various zones. The zoning design is done in order to have a smooth visitors' circulation by simplifying the movement patterns and allow any inter-zone movement. Parking and catering for the visitors' vehicles is planned away from the island on the mainland at strategic locations.

Following site parameters are considered while positioning the zones:

- Boundary Shape
- Physical site features
- Area availability
- Environmental consideration
- Micro-climatic conditions
- Compatibility issues
- Surrounding issues

- Accessibility
- Transportation issues
- Visibility

Zoning is a device for regulating or controlling both present and future development and constitutes a vital player for designing facilities. Firstly, a broad zoning of the facilities is laid out where the major zones are frequented by external and internal tourist. As the proposed tourist zone is surrounded by the Naf River, functions were solved to serve the best results.

As the Government has given much emphasis on tourism planning and recreation facilities, the Project aims at achieving the same objective. Circulation is another important aspect in designing a tourism site. Equal emphasis was given on external and internal circulation. Individual entry was provided for each block for the convenience in circulation. Light, air flow, ventilation and community aspect were carefully considered. Different entries for different sectors have been provided with necessary number of stairs. For resort and recreation purposes and for maintaining the natural landscape characteristics, a focus was set on a harmonious interaction of nature, river, land and people, while providing opportunities for public recreation. In this way, the highest possible interlinkage between water and land was achieved, thereby turning an apparent “disadvantage” into an advantage, and consequently lowering any reclamation costs.

The zoning percentage for the proposed Jaliardip EZ tourism site is as follows:

Table 11: Zoning Proportion of Jaliardip EZ

Zoning	Percentage
Accommodation	4.0
Children Park	7.5
Green Area	18.9
Jetty	0.6
Lake	4.5
Restuarant	0.5
Open Space	48.2
Parking	0.6
Road	6.8
Sitting Place	0.8
Swimming Pool	0.1
Utilities	0.9
Water Body	6.5

Source: Feasibility Consultants

Figure below shows the Zoning Plan for the proposed economic zone.

Figure 28: Proposed zoning plan of Jaliardip Economic Zone



Source: Feasibility Consultants

Detailed Design

Detailed master planning is done cluster-wise covering the following components:

- Micro Level Zoning;
- Land Use Plan;
- Detailing the locations and sizes of various land uses;
- Land Parcel Plan;
- Showing the sub-division of the land;
- Phasing;
- Utilities Mapping;
- Greenery and open space plan; and
- Road categories

Design Requirements

The following are the parameters which the Consultants applied for their detailed design:

- Public space per stay-over visitor must be more than 0.1 acre;
- Density standard per day-time visitor of 0.09 acre;
- North South plot orientation;
- This place is in coastal areas, so the height limit for accommodations is G+4;
- **Architectural designs and control:** The guidelines for architecture stresses on suitable landscaping using local materials i.e. thatch and imported building material for resort construction to complement the natural vegetation and island environment. The guidelines restrict the construction of buildings exceeding the treetops or more than two stories. It also limits any construction within a distance of 5 meters from the shoreline.
- **Adequate water supply:** The Guidelines emphasizes on restricted use of limited ground water, roof catchment, storage and desalination using the reverse osmosis technique.
- **Waste disposal system:** It stresses for the utilization of controlled incineration, compaction and disposal in the deep-sea area. The Guidelines prohibit the disposal of plastic material and empty cans in the sea. They also encourage recycling of waste material and underground utility lines.
- **Control over marine ecology:** The guidelines forbid the collection of corals, seashells and rocks from the sea reefs and beaches. Infact purchase on certain size of turtles, young lobsters and female lobsters ready to lay eggs may result in jail and penalty.
- It also prohibits the use of harpoons and guns to kill fish (spear fishing).
- **Control over turtle products:** The guideline prohibits display and sale of stuffed turtles in shops. It also prohibits export of turtle, tortoise shells and black coral.
- **Management:** The Ministry of Tourism (MoT) works in close coordination with private sector for the management of tourism industry. For instance, the MoT and private sector organizes regular meetings with the resort owners, managers and tour operator for proper functioning of tourism industry.
- According to Development Plans establishment of marine conservation areas and reserves has been given the topmost priority. To manage the natural environment BEZA and Bangladesh government has formulated and implemented environment standards, controls and established carrying capacity measures.
- These measure include guidelines for building construction such as, 1) control over tree cutting and restriction on constructing buildings above tree tops or more than two stories. 2) On an island maximum 20% of the total area can be occupied by buildings. 3) All guestrooms face the beach with a minimum of 5 meters from the shoreline. 4) 60% of the total length of beach on the island has been allocated for guestroom frontage, 20% for general resort facilities and remaining 12% for open space.

Based on the above design criterion, the below figure shows the design of the Master Plan.

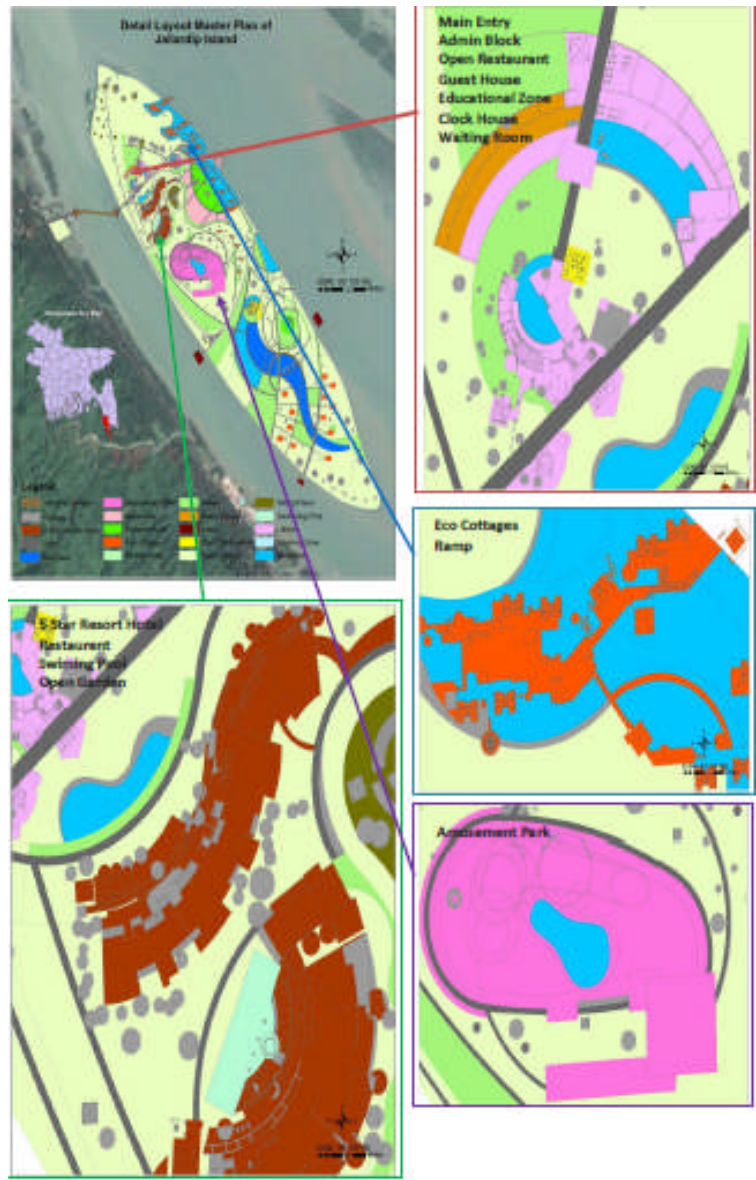
Figure 29: Detailed layout of future Jaliardip Economic Zone (master plan)



Source: Feasibility Consultant

Below figure illustrates or explains the most important details of the Master Plan

Figure 30: Details of Master Plan for Jaliardip EZ



Source: Feasibility Consultants

Consultants intend to achieve a complete separation of the accommodation (stay-over) area from the visiting tourist (day-time) area. Such separation will provide for the highest exclusivity for stay-overs and consequently the basis for higher rents achievable.

5. Description of Environment (Environment and Social Baseline)

This section establishes the baseline environmental and socio economic status of the proposed economic zone and surrounding area to determine the project influence area within which the impacts of the Project are to be assessed.

Establishing baseline helps in understanding the prevailing environmental and socio economic status of the study area. It provides the background environmental and social conditions for anticipating of the future environmental characteristics of the area based on the operation of the new/ expansion activity of the project during its life cycle. It also helps in environmental and social management planning and strategy to minimize any potential impact due to the Project activities on surrounding environment. Field surveys were conducted at the project site to collect the requisite baseline information through discussions with project proponents, and local people. The baseline information was gathered pertaining to:

- The physical environment (air, water, land, noise, flora, fauna, etc.)
- The socio-economic data of the area in which project site is located
- Disadvantaged or vulnerable groups in the project area of influence
- Presence of any indigenous people in the project area of influence
- Presence of any cultural heritage sites in the project area of influence.

5.1. Methodology

The environmental and social baseline has been assessed and a survey of the project area was conducted to identify environmental and social sensitive receptors located within and around the project area.

Environmental and social baseline data was collected through primary surveys as well as secondary sources by literature survey and discussions with the concerned stakeholders.

5.2. Baseline data Collection

Primary baseline data collection involved environmental monitoring and stakeholder consultations to collect the information related to the physical environmental conditions in the vicinity of the proposed site. Stakeholder consultations were carried out to collect information on socio-economic status of the project area. The primary baseline data collected for various social and environmental parameters as detailed out in table below.

Table 12: Primary Baseline Data Collection

S.No	Environmental Attribute	No. of Locations	Frequency	Remarks
1.	Socio- economic Status	Project affected communities	Twice during the study period	Primary consultation was carried out in the impacted villages/ communities to understand the history and

				socioeconomic aspects of the site and surrounding areas.
2.	Monitoring of groundwater quality	Proposed project site and in its vicinity	Once during study period	Survey was undertaken by DoE, Chittagong lab to assess the parameters.
	Monitoring of surfacewater quality			
	Monitoring of ambient air quality			
	Monitoring of ambient noise			

Secondary baseline data collection involved identifying and collecting available published material and documents. Information on various environmental aspects (like soil, geology, hydrogeology, hydrology, drainage pattern, ecology etc.) meteorology, and socio-economic aspects was collected from different government departments, institutions, literatures etc.

5.2.1. Meteorology

Meteorological data is used to anticipate the dispersion and diffusion of pollutants, once disseminated into the atmosphere. The baseline conditions of physical parameters are provided in subsequent sections:

5.2.1.1. Temperature

Monthly minimum and maximum temperatures and average minimum and maximum temperatures for the period 2005-2014 for Cox's Bazar are given in below Tables (data obtained from Bangladesh Meteorological Department).

Table 13: Monthly minimum and average minimum temperature during Jan 2005 to Dec 2014

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	13.5	14.6	19.4	22.0	21.8	24.0	24.5	23.5	23.8	23.4	17.5	15.0
2006	13.5	15.3	18.0	22.5	22.2	23.4	24.3	24.0	23.3	22.0	16.4	12.2
2007	12.5	15.2	17.0	19.2	23.0	23.8	23.2	24.0	22.6	21.4	18.6	13.4
2008	12.7	12.3	17.5	21.1	20.2	23.3	23.4	24.0	23.5	22.6	17.3	14.0
2009	13.5	14.2	19.0	19.0	21.5	22.5	24.0	23.5	23.6	22.0	15.5	13.0
2010	13.5	13.8	20.0	24.0	22.5	23.4	24.2	24.5	23.8	23.4	17.8	14.0
2011	11.0	14.5	17.5	21.4	22.0	23.5	24.5	23.7	23.0	21.0	17.4	13.5
2012	12.5	13.0	18.4	19.0	22.5	22.0	24.0	23.8	24.2	20.5	15.5	11
2013	10.3	14.5	17.0	20.2	21.0	24.2	24.0	23.5	24.4	22.0	16.5	12.4
2014	12.4	15.0	18.8	24.3	24.0	24.0	24.5	24.5	24.3	22.5	17.0	15.0
Average	12.6	14.2	20.1	21.2	21.9	23.4	24.1	23.9	23.6	22.1	16.9	13.3

Table 14: Monthly maximum and average maximum temperature during Jan 2005 to Dec 2014

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	29.5	32.5	33.2	37.5	35.0	35.4	33.0	32.6	34.6	34.4	32.5	31.5
2006	30.5	32.3	37.3	35.0	34.8	33.5	32.8	33.0	33.5	33.6	34.0	31.0
2007	29.4	32.2	35.2	34.8	35.8	34.5	34.2	33.5	33.7	34.8	33.7	30.5
2008	30.0	31.4	35.6	35.0	35.9	34.2	32.6	33.5	34.0	35.1	33.0	31.3
2009	31.8	33.3	36	34.8	36.5	35.0	32.8	34.0	35.0	34.6	34.5	30.5
2010	30.0	34.0	37.0	35.0	36.0	34.0	34.0	33.7	33.5	36.0	33.5	33.0
2011	31.0	32.5	35.0	34.7	34.5	34.0	33.5	33.8	33.5	34.3	32.5	32.2
2012	31.2	34.0	34.5	35.0	35.5	34.8	33.5	33.6	33.8	34.3	33.6	30.4
2013	32.0	33.8	35.0	35.0	34.5	35.0	34.0	33.5	34.2	34.2	32.6	31.0
2014	30.5	31.3	35.0	39.5	35.5	35.5	34.4	33.0	34.7	34.8	34.0	30.5
Average	30.6	32.6	35.5	35.6	35.3	34.7	33.4	33.4	34.1	34.6	33.3	31.1

The data shows that the monthly minimum (average) temperature at Cox's Bazar varies between 10.3°C and 24.5°C and maximum temperature varies between 29.4°C and 37.50°C. The minimum and maximum temperature data indicates that December to February months are relatively cooler and April, May and June are the relatively hotter months.

5.2.1.2. Relative Humidity

The average relative humidity at Cox's Bazar varies between 68 % in the month of February and 87 % in the month of July and August. The average relative humidity for the last 10 years for Cox's Bazar is provided in table below (data obtained from Bangladesh Meteorological Department). The data shows that average humidity is higher throughout the year. June to October months have relatively higher humidity (82% - 85%) as compared to humidity in rest of the year.

Table 15: Monthly average relative humidity during Jan 2005 to Dec 2014

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	70	71	78	76	75	84	87	90	86	82	76	77
2006	72	75	68	72	80	86	89	86	85	81	74	73
2007	72	72	67	76	79	83	89	86	86	83	80	71
2008	72	66	78	71	76	85	89	87	86	81	74	75
2009	70	66	73	76	75	82	89	88	85	80	73	71
2010	71	64	74	75	77	86	85	84	85	84	76	74
2011	67	67	69	77	80	87	85	88	87	82	74	77
2012	66	62	77	77	79	86	89	87	85	82	76	77
2013	70	66	75	77	85	85	86	86	85	83	73	73
2014	73	71	73	76	79	86	85	88	84	79	77	76
Average	71	68	73	76	78	85	87	87	85	82	75	74

5.2.1.3. Rainfall

The average monthly rainfall data for Cox's Bazar (obtained from BMD) is provided in table below. The data shows that rainy season in Cox's Bazar mainly prevails from May to October. The average monthly rainfall in Cox's Bazar for the period Jan 2005 to Dec 2014 varied between 4 mm in the month of January and 903 mm in the month of June. The rainfall follows the general climate pattern with the highest rainfall in the summer from April to October and minimum rainfall in the winter from November to March.

Table 16: Monthly total and 10 years average monthly rainfall during Jan 2005 to Dec 2014

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2005	6	0	27	113	178	848	608	957	342	257	23	25
2006	0	0	0	114	800	662	802	385	678	78	10	0
2007	0	65	0	100	373	640	1274	526	409	492	127	0
2008	15	50	4	0	244	1318	1275	664	387	184	3	0
2009	0	0	0	130	241	324	971	944	485	130	58	0
2010	0	0	15	12	717	982	496	501	257	375	15	68
2011	11	0	4	123	296	926	877	1226	692	280	0	5
2012	0	0	109	148	254	1102	1130	801	302	263	14	0
2013	0	0	0	54	700	876	772	1000	237	420	0	0
2014	0	29	1	4	139	677	717	611	264	41	0	0
Average	4	13	16	79	367	903	892	762	405	252	25	10

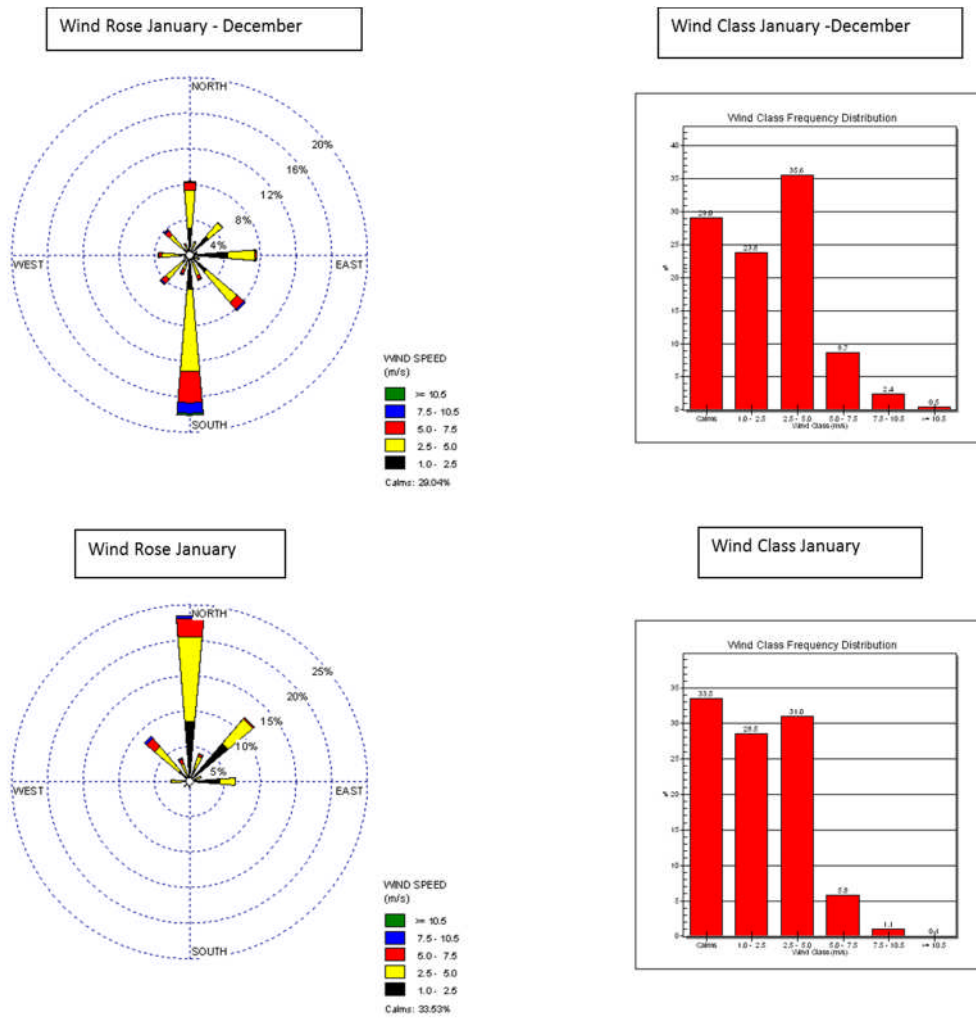
5.2.1.4. Wind Speed and Direction

The wind speed and direction of Cox's Bazar district are depicted by wind rose diagrams. A wind rose gives a very succinct but information-laden view of how wind speed and direction are typically distributed at a particular location. Presented in a circular format, the wind rose shows the frequency of winds blowing from particular directions. The length of each "spoke" around the circle is related to the frequency of time that the wind blows from a particular direction. Each concentric circle represents a different frequency, emanating from zero at the center to increasing frequencies at the outer circles.

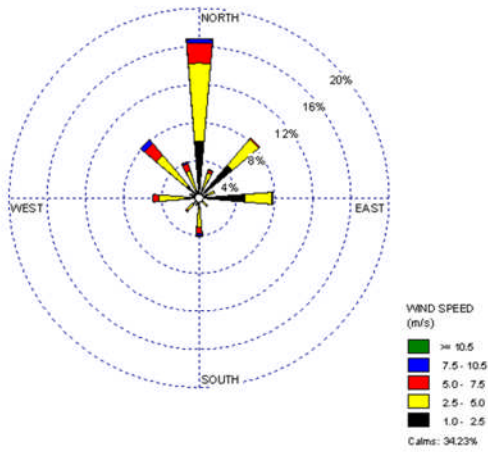
January to December wind rose and monthly wind roses, and wind classes for Cox's bazar (collected from BMD) are presented below. These wind roses and wind classes are average of last 57 years. These wind class and wind rose diagrams show that at Cox's bazar, dominant wind speed is 2.5-5 m/sec. The predominant wind direction from Jan to Dec is south followed by south-east and north.

The monthly wind roses indicate the following trend: Northerly winds prevail in October to February and southerly wind flows from March to September. As indicated in the below wind rose diagram, the area experiences wind speeds lower than 5 m/s for 89% of time. Of this half the time (29% of the time) is calm condition throughout the year, 23.8% of the time with wind speed of 1-2.5 m/s and 35.6 % of the time with wind speed of 2.5-5 m/s. This indicates that weather conditions favours dispersion of air pollutants. Month wise prevailing wind speeds are as follows: predominantly calm conditions prevail during October to February and the remaining months experience lesser calm conditions and wind speeds in the range of 2.5 – 5 m/s.

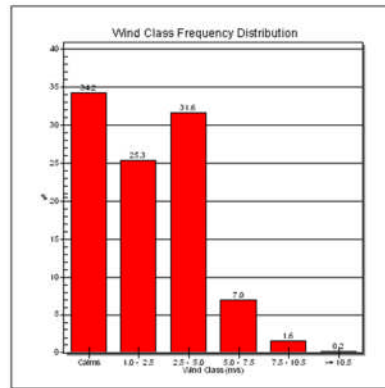
Figure 31: Wind Rose Diagrams



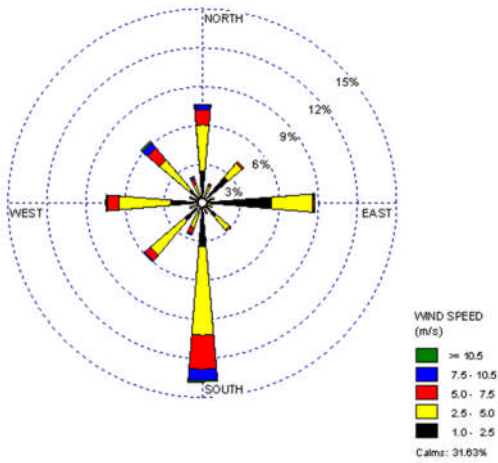
Wind Rose February



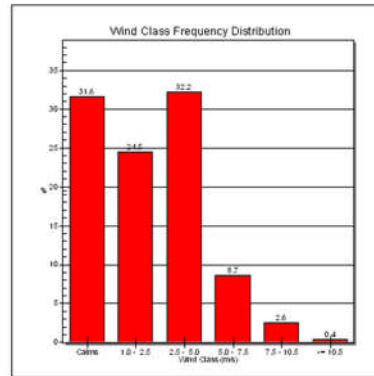
Wind Class February



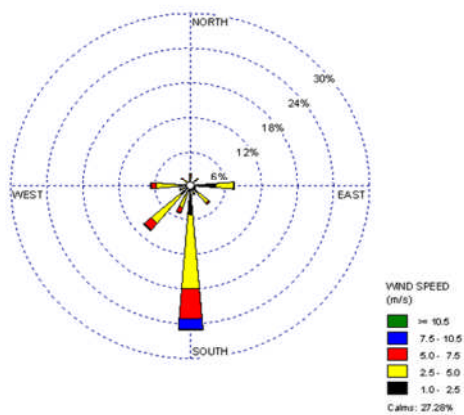
Wind Rose March



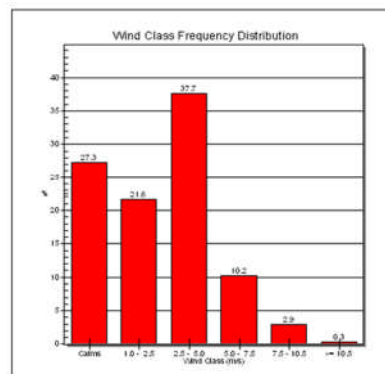
Wind Class March



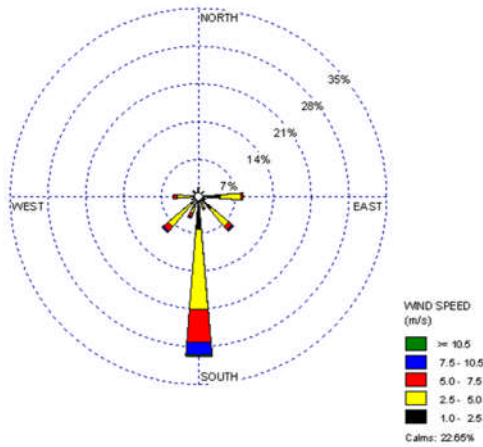
Wind Rose April



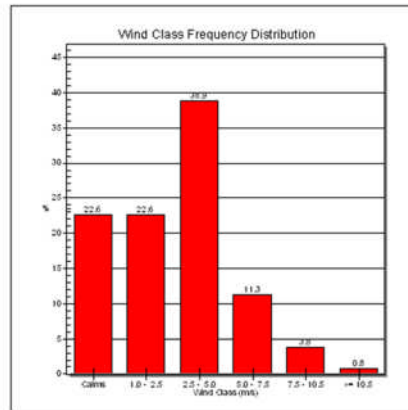
Wind Class April



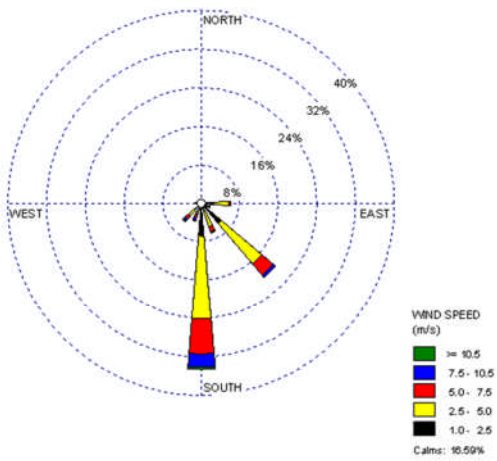
Wind Rose May



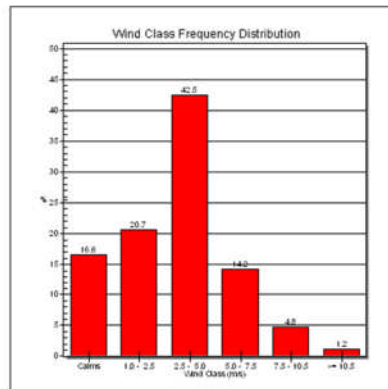
Wind Class May



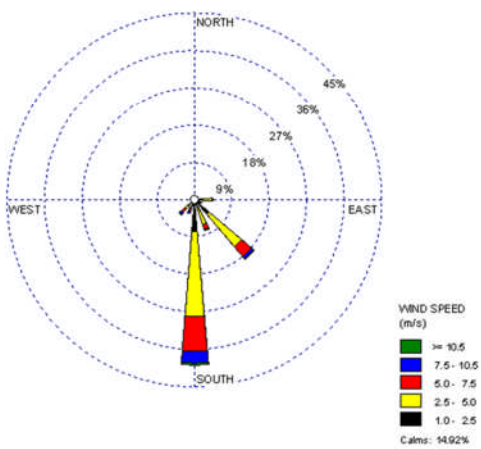
Wind Rose June



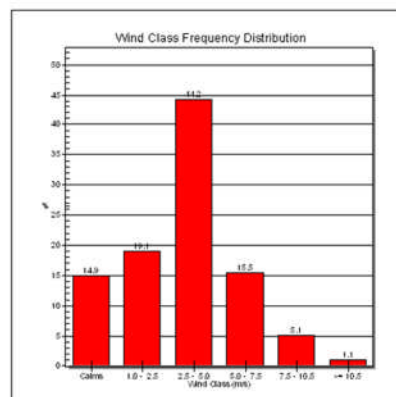
Wind Class June



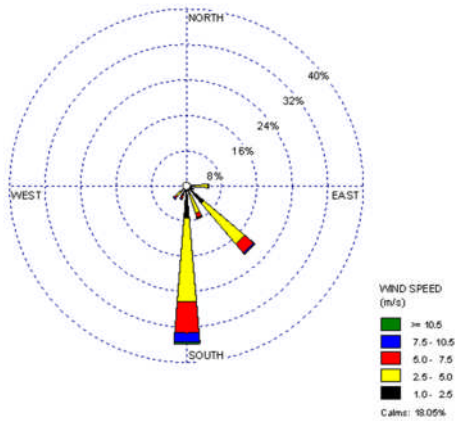
Wind Rose July



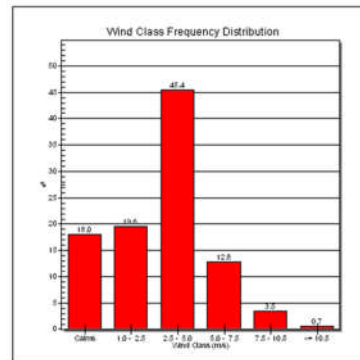
Wind Class July



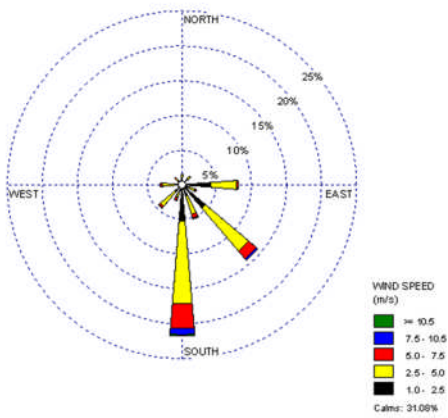
Wind Rose August



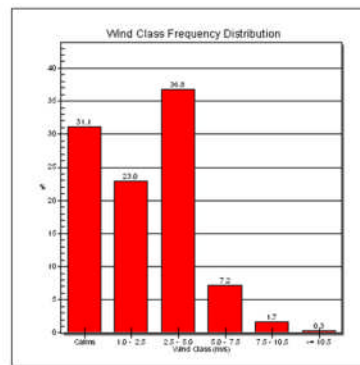
Wind Class August



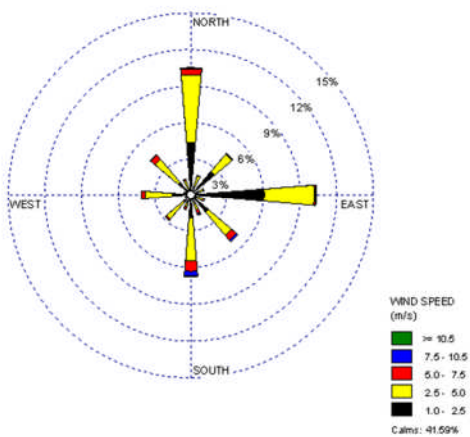
Wind Rose September



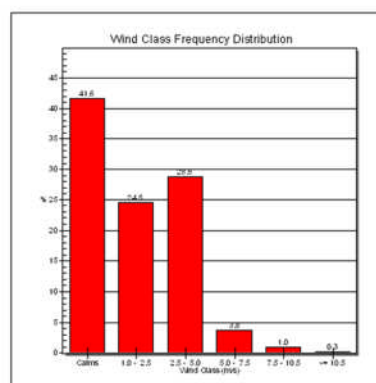
Wind Class September

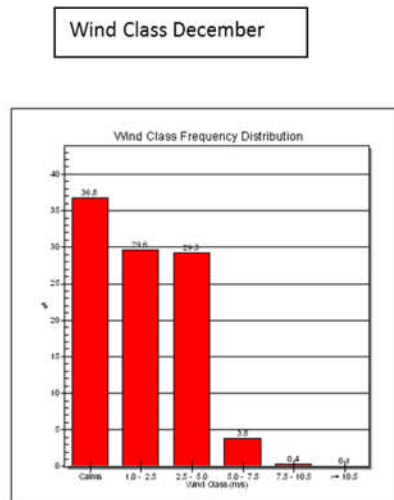
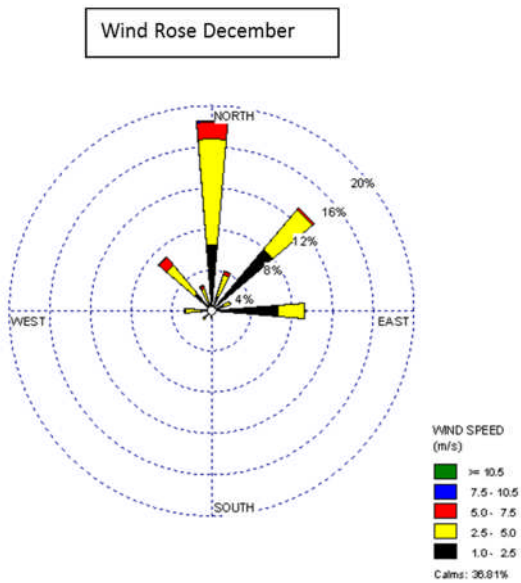
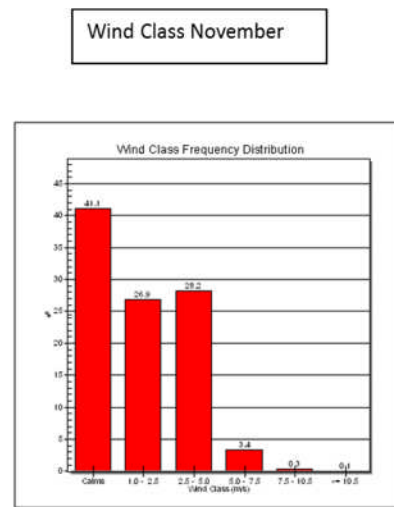
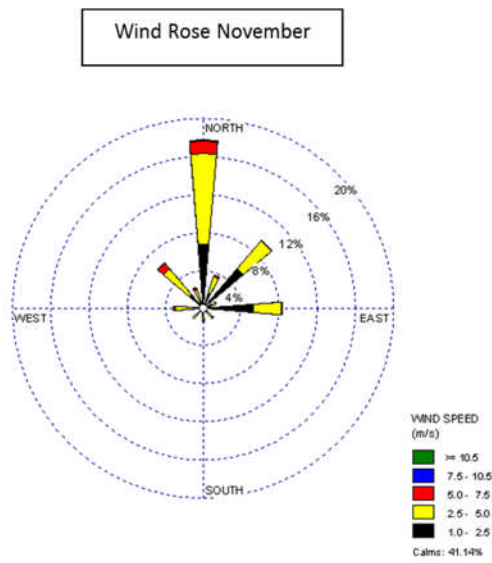


Wind Rose October



Wind Class October

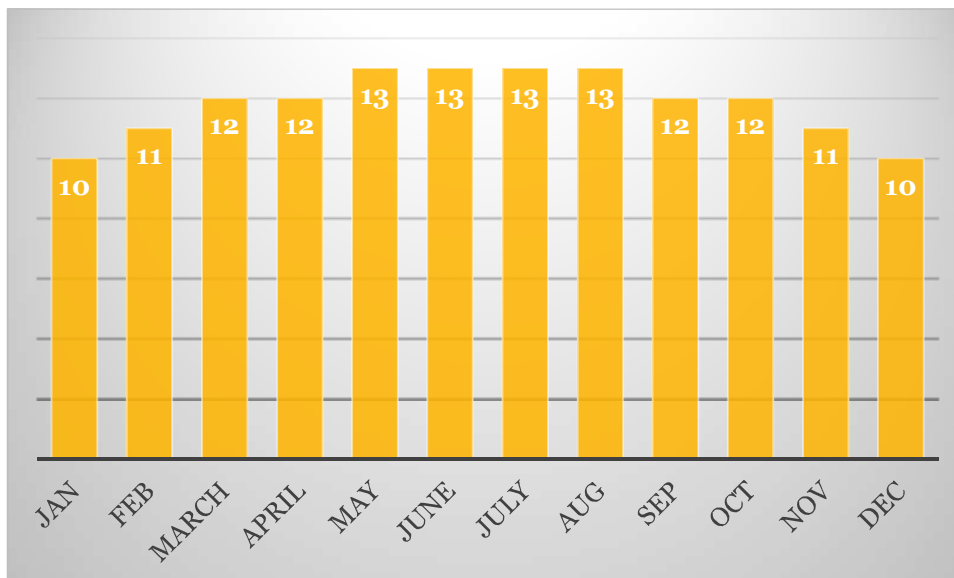




5.2.1.5. Sunshine Hours

The monthly average sun-shine hour in Cox’s Bazar varies from 10-13 hour/day in a year. Highest sunshine hours are recorded in month May, June, July and August. In general, maximum average sun-shine hour of 13 hour in a day is found in May, June, July and August. Figure below shows the average monthly sunshine hours in the year 2015, Cox’s Bazar.

Figure 32: Average monthly sunshine hours in Cox’s Bazar, 2015



Source: <http://dateandtime.info/citysunrisesunset.php?id=1336134&month=12&year=2015>

5.2.2. Water Resources

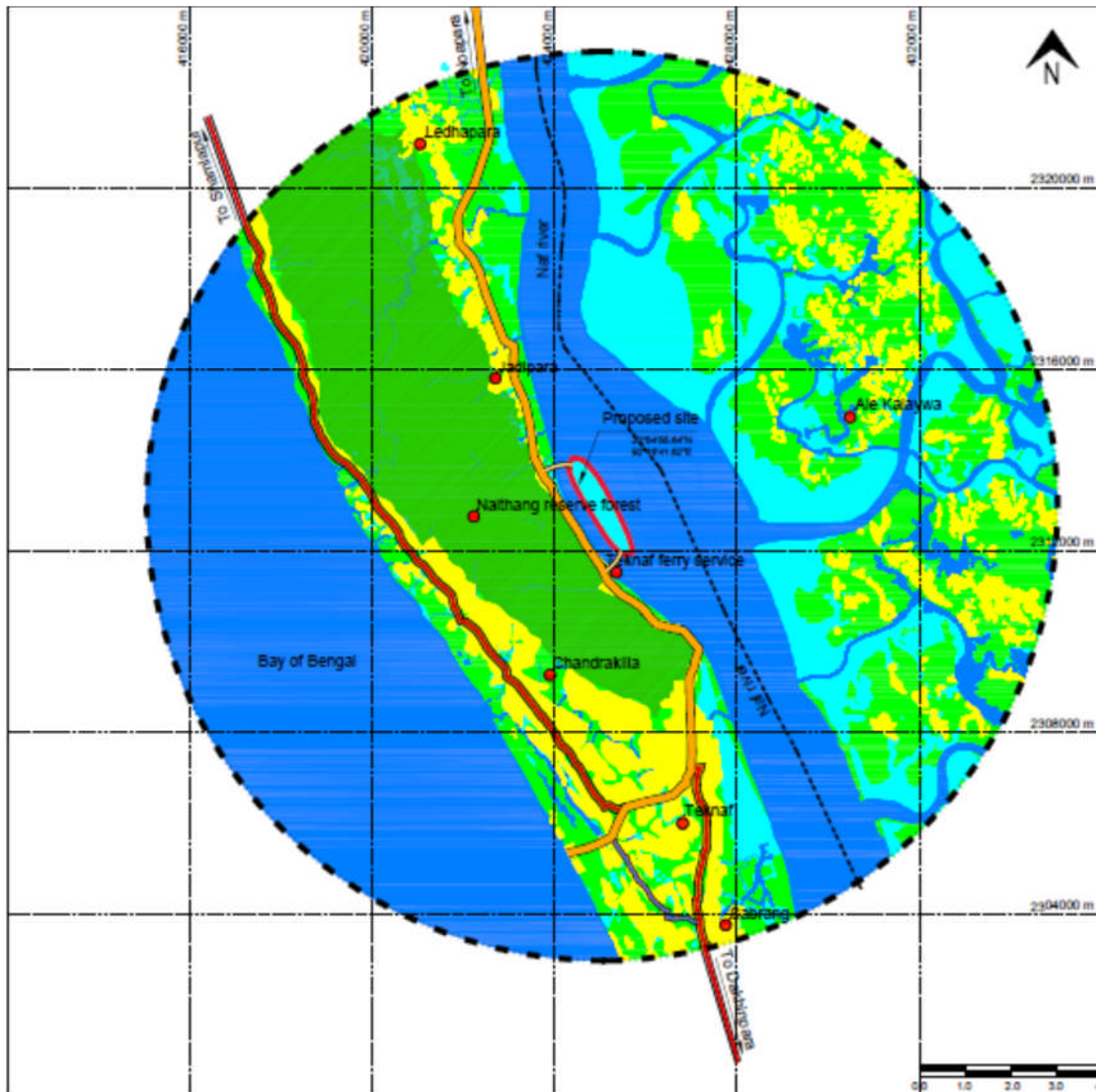
5.2.2.1. Surface Water systems and Drainage

Major water body within 10 km study area is river Naf. Project site lies in the flood plain of Naf River. Bay of Bengal sea is the other major water body within 10 Km radius south of the project site.

Naf River is a transboundary river marking the border of Bangladesh and Myanmar. It is an elongated estuary in the extreme southeast of Cox's Bazar district dividing the district from Arakan (Myanmar). It rises in the Arakan hills on the southeastern borders of the district and falls into the Bay of Bengal. Its width varies from 1.61 km to 3.22 km. The Naf River's average depth is 128 feet (39 m) and maximum depth is 400 feet (120 m). Akyab in Myanmar is on the left bank and Teknaf upazila of Cox's Bazar district is on the right bank of the river. The river is influenced by tidal activity. Shrimp cultivation is extensively practiced on the floodplains of the river.

The Dakhin Nhila hill range lies between the Naf River on the east and the Bay of Bengal on the west. The Naf River flows along with the Bangladesh-Myanmar International Border and also runs roughly parallel to the hill range. Most of the streams observed are of consequent type and locally named chara. The streams are intermittent and dendrite in pattern. These streams are in youthful stage and demonstrated by their characteristic erosion features. The vertical erosion has been much faster than the lateral erosion and making the streams narrow and straight due to the strong current. Random orientation of boulders, pebbles, cobbles suggest that the erosion processes are active in the Teknaf area. The streams of the eastern flank of the hill range flow into the Naf River and the streams of the western flank of the hill range flow into the Bay of Bengal. Ladhakhal, Rangikhalichara, Dumdumiakhal, etc. are flowing to the Naf river whereas Dakchara, Noakhalichara, Rajarchara are flowing to the Bay of Bengal. Figure below shows the drainage map of the subject site.

Figure 33: Drainage Pattern of the Project Site



5.2.2.2. Salinity

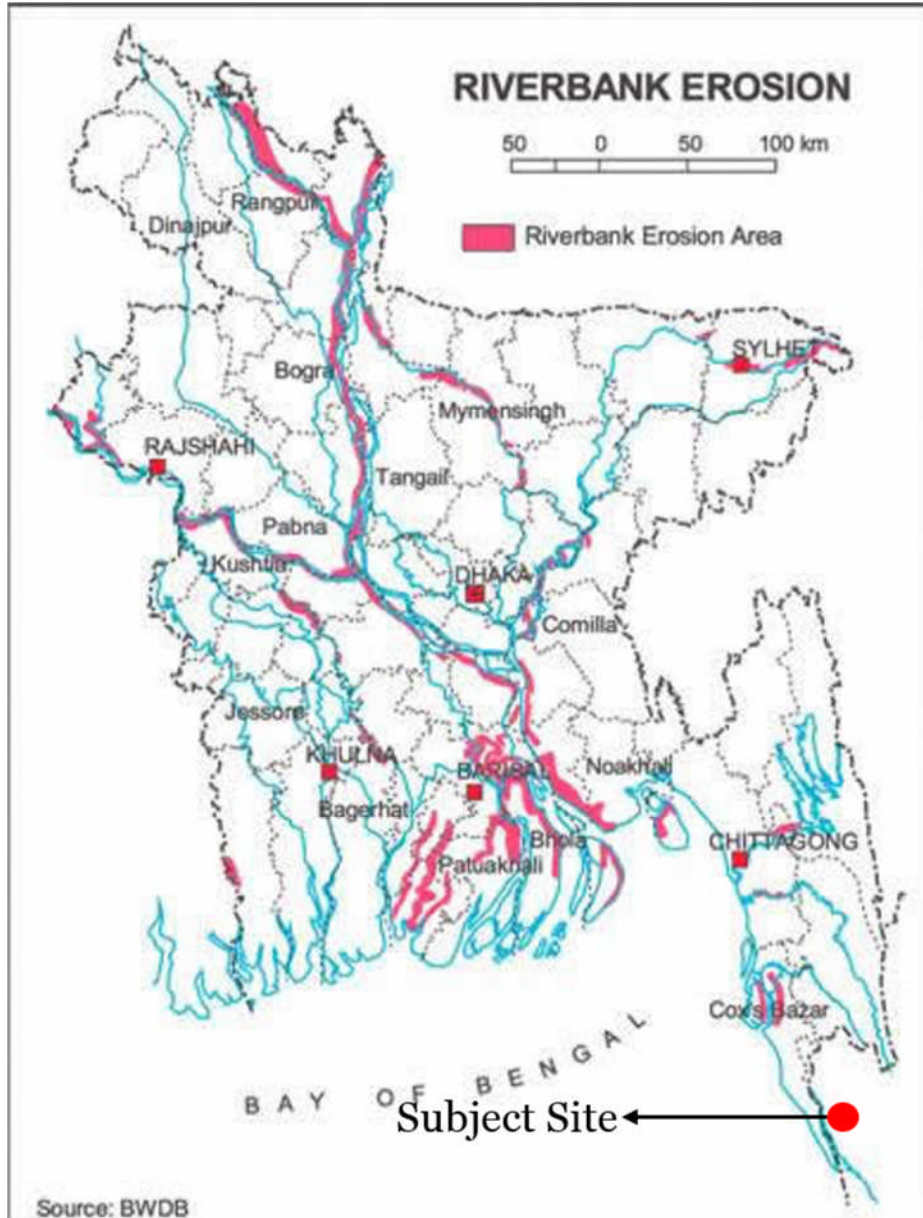
The salinity of the Naf River as compared with the rivers in Greater Chittagong Region is relatively very high. As reported in the paper “**Physicochemical Assessment of Surface and Groundwater Quality of the Greater Chittagong Region of Bangladesh**” by Ahmed et.al; *Pak.J. Anal. Environ. Chem. Vol. 11, No 2 (2010) 1-11*, the Electrical Conductivity of sample collected from Naf River is in the range of 4,930 $\mu\text{S}/\text{cm}^2$ with the TDS concentrations in the range of 2,470 PPM. The data shows that the TDS is high so as the EC, which indicates that the concentration of Na and Cl ions which contributes to moderately to high salinity of the river. Though TDS fairly provides the concentration of all the soluble ions present in the sample collected from the river water. The percentage of NaCl analysed in the sample collected was reported to be 96.4% which clearly indicates that the salinity of the Naf River is high which also invariably results in high TDS and EC.

The reason that could be drawn which could probably contributes to increase salinity of the water from Naf River is the close proximity of the river with the Bay of Bengal. Sea Water intermixing with the river water during the course of high tides could possibly cause the increase concentration of NaCl in Naf River.

5.2.2.3. Erosion and Sedimentation

No erosion site at EZ site and at river bank is observed. Map showing areas prone to river bank erosion is given below in the below figure.

Figure 34: Riverbank Erosion Pattern in Bangladesh



Source: <http://www.livingwiththejamuna.com/essayintroduction.html>

5.2.2.4. River Morphology

River Naf with respect to the project site is morphologically stable. The river course since 2005 is presented in the following figure

Figure 35: Google imagery of the river course in 2005



Figure 36: Google imagery of the river course in 2010



Figure 37: Google imagery of the river course in 2016



5.2.2.5. Navigation

The withdrawal of water beyond the border and within Bangladesh for irrigation and other purposes has resulted in decreased navigability of rivers during dry season resulting in gradual channel decline. The river network connects almost all the country's major cities, towns and commercial centres. Moreover, being cheap, safe and environmentally friendly, inland water transportation is often the only mode that serves the poor, proving especially useful during periods of widespread flooding.

Currently, container feeder service is available from Chittagong Port to Port Klang (daily); Port of Singapore (daily); and Colombo Port (every 2-3 days) for connecting the mother vessels serving international destinations. More than 5 feeder vessel operators with vessels capacity of 1,000 -1,500 boxes (containers) have deputed their feeder vessels in this circuit. The transit time is about 3-4 days from /to Chittagong Port to the hub ports. All international Shipping Lines have their presence in Bangladesh and some even operate their own feeder vessels.

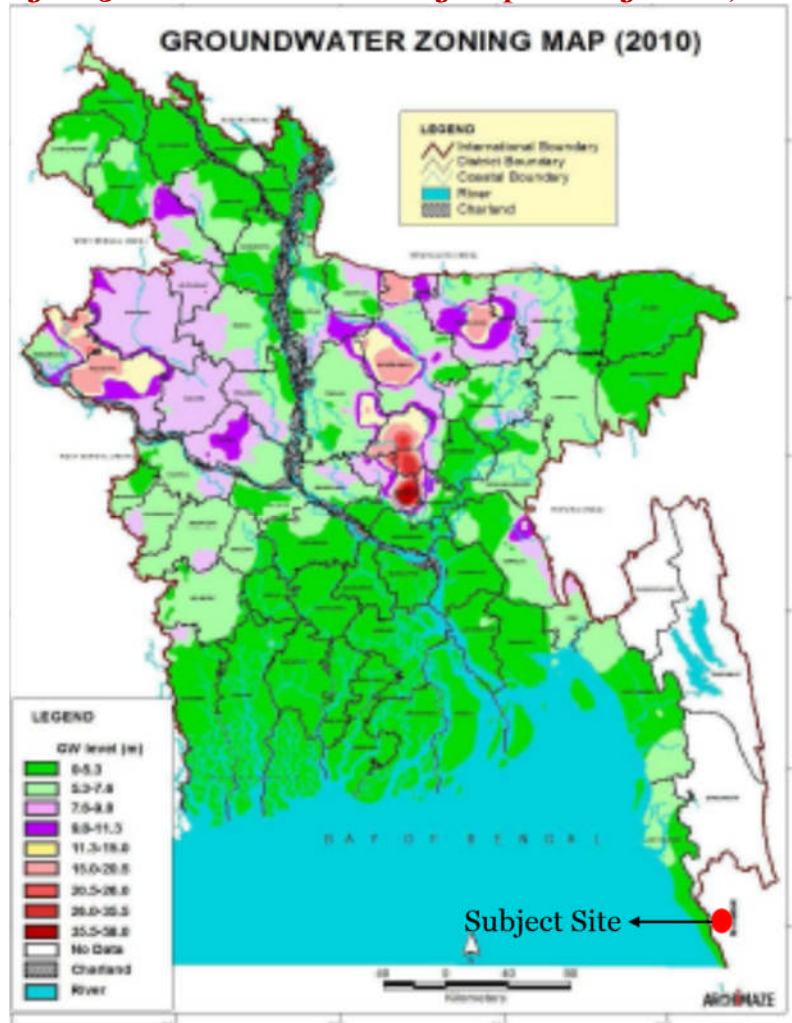
Due to the steady growth in traffic volume, Chittagong Port performs well on the financial front. It is financing its 3rd Port development project at Paikra Bandar with its own resources. Statistics of cargo handled at the Chittagong Port is given in the annex. The third port, Paikra Seaport, was inaugurated by the Prime Minister on 19th November 2013. It is on Rabnabad channel - which is 31 Km from the sea boundary, 316 Km from Chittagong, 130 Km from Mongla port and 340 Km from the capital. This port shall have draft of 8 -10 m when in operation. In addition to the Pangaon ICT, the Government of Bangladesh granted approval to establish a container port on the bank of the Meghna River in Narayanganj District to the Ananda Group in November 2013. It will be the fifth inland container terminal (ICT) in the private sector. Approvals for establishing ICTs have already been granted to the Rupayan Group, Kumudini Welfare Trust, AK Khan and Company and Cemcor. Meanwhile, the Ministry of Shipping, GoB, is finalising a draft of guidelines for establishing ICTs under private sector investment. A deep sea port is also proposed to be constructed at Sonadia, Cox Bazar. To develop inland waterway transportation, a jetty is also required to be proposed for the project.

5.2.2.6. Groundwater Systems

The study of the groundwater demand from different parts of the country shows that northwest and north central region depend on groundwater a lot for the supply of the water. Groundwater resources are determined by properties of groundwater storage reservoir and volume of annual recharge. Mainly rainfall, flooding and stream flow in rivers penetrate earth surface and recharge groundwater reservoirs. Although

Bangladesh has been considered rich in groundwater resources, the total groundwater storage data is absent. National Water Plan Phase-II estimated average groundwater as 21 cubic kilometres (cu km) in 1991. However, with the increased trend of urbanisation and irregular rainfall behaviour, surface run-off has increased in recent times, which reduces groundwater recharge considerably. Figure below is the groundwater zoning map in Bangladesh, 2010. From the map it could be seen that the groundwater level in and around the subject site is shallow. The groundwater level as reported by the figure below is somewhere between 0.5m-3m below ground level (bgl).

Figure 38: Groundwater Zoning Map in Bangladesh, 2010



Source: "A Briefing Paper on the State of Groundwater Management in Bangladesh" by Sengupta et al., September 2012

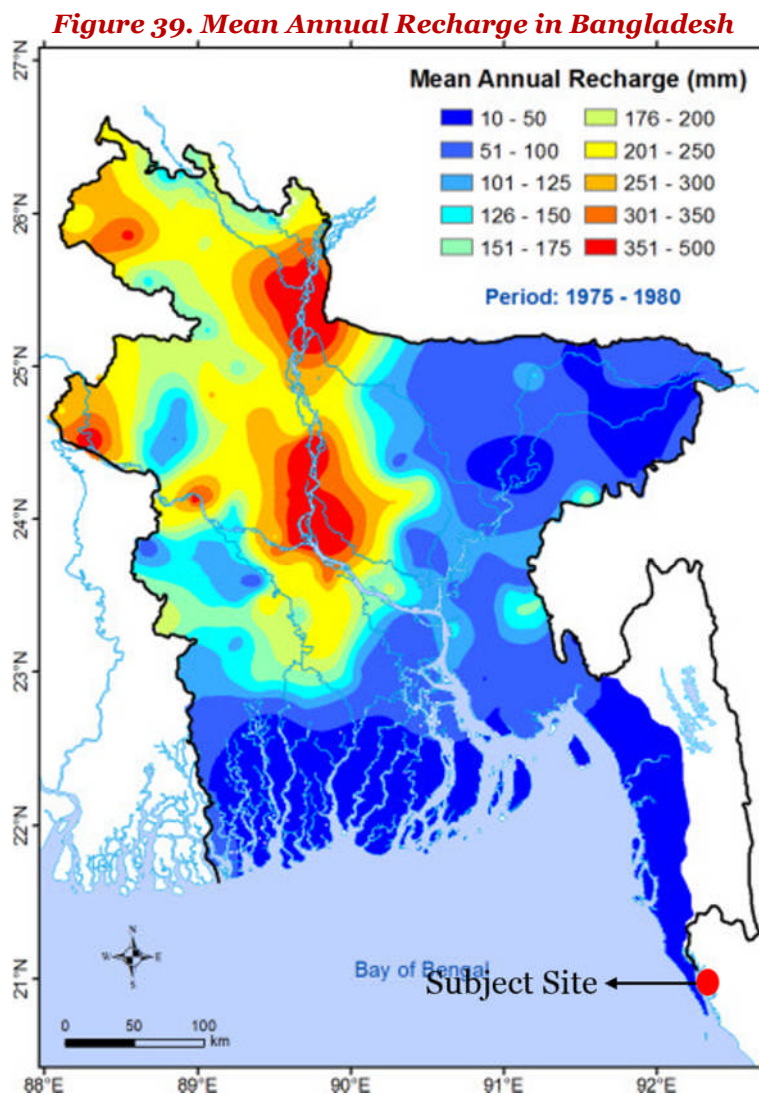
Groundwater storage reservoirs are composed of three aquifers in Bangladesh:

1. Upper aquifer or composite aquifer
2. Main aquifer (it is at depths six meters in north-west and to 83 m in the South) and
3. Deep aquifer

The transmission property of the main aquifer is good to excellent over most of the country but it is deteriorating towards the south and the east. Underlying the main aquifer, there is a deeper water bearing unit separated by one or more clay layers of varied thickness referred as the deep aquifer that has been exploited by tube wells in Dhaka and in the coastal areas. In the areas near the coast the water table is descending due to over extraction or salinity contamination of upper or main aquifer⁷. Strong declining trends (0.5–1 metre/year) in dry-period groundwater levels are observed in the central part of the country surrounding the Dhaka city. Moderately declining trends (0.1–0.5 metre/year) occur in western, northwestern, and northeastern areas. In the northern table land areas and floodplains of the major rivers, magnitudes of declining trends are low (0.01–0.05 m/yr). Stable or slightly rising trends (0–0.1 metre/year) are generally observed from the Meghna estuary to the southern coastal areas in the country.

A similar overall pattern is seen during wet periods except in the northern table land areas, southwestern delta plains and southern coastal areas where wet period trends are slightly rising or stable.

The subject site is abutted by river in all the directions. Along the southern tip of Bangladesh because of the turbulence and disturbances reported in Bay of Bengal, sporadic spell of rainfall is often observed. Along with the sporadic spells of rainfall in summers and winters, the location also experiences 3 months of monsoon season. Due to the reasons, rechargability of groundwater is reported to be very high. Below figure shows the high recharge capacity of groundwater in and around Teknaf.



Groundwater Status in Teknaf

DPHE conducted Vertical Electrical Sounding (VES) at 4 locations in the month of December, 2012. The idea was to have an understanding of the geological strata of the area, what kind of an aquifer is there and what is the depth of the aquifer.

The interpretation of the VES survey conducted by DPHE is presented in the table below. The DPHE VES analytical reports are attached in annexure A.4.

Table 17: VES survey interpretation at Teknaf

S.No	VES survey ID	Location	Interpretation
------	---------------	----------	----------------

1	VES-01	Beside a brick field along north south direction at the north-west corner of the lada Khal Rohinga Camp	<ul style="list-style-type: none"> • Alluviul strata with fine to medium graded sand with trace silt was reported between the depths 1.4m to 62.6m. • Presence of 60 m thick sandy strata clearly indicates the presence of an confined or unconfined aquifer.
2	VES-03	Nayapara, Teknaf Sadar	<ul style="list-style-type: none"> • Alluviul strata with fine to medium graded sand was reported between the depths 27.3m to 95.2m. • Presence of 68 m thick sandy strata clearly indicates the presence of a confined aquifer (as the strata starts from 27m). • DPHE has reported in their report that the particular strata could be a resource for fresh water.
3	VES-04	Nayapara, Whykong Union	<ul style="list-style-type: none"> • Alluviul strata with fine to medium graded sand was reported between the depths 19m to 73.5m. • Presence of 54.5 m thick sandy strata clearly indicates the presence of a confined aquifer (as the strata starts from 19m). • DPHE has reported in their report that the particular strata could be a resource for fresh water.

5.2.2.7. Seismicity

Bangladesh and the north eastern Indian states have long been one of the seismically active regions of the world, and have experienced numerous large earthquakes during the past 200 years. A seismicity map of Bangladesh and its adjoining areas has also been prepared by BMD and GSB. Bangladesh has been classified into three seismic zones with zone-3 the most and zone-1 the least vulnerable to seismic risks as indicated in figure below. Jaliar Dip lies in Zone-2 which shows intermediate level of seismic activity.

Figure 40: Seismicity Map of Bangladesh



Source: BMD

In the earthquake zoning map of 1993, 26 percent of Bangladesh falls in high risk, 38 percent moderate and 36 percent in low risk zone in terms of earthquake vulnerability. The distribution of recorded earthquakes indicate a major clustering of seismicity around the Dauki Fault and scattering of other events along other major fault systems of Bangladesh. The magnitude of the earthquakes are moderate (4-6) and majority of them are shallow depth.

Tectonically, Bangladesh lies on the northeastern Indian plate, near the edge of the Indian craton and at the junction of three tectonic plates - the Indian plate, the Eurasian plate and the Burmese microplate. These form two boundaries where plates converge- the India Eurasia plate boundary to the north forming the Himalaya Arc, and the India Burma plate boundary to the east forming the Burma Arc. The Indian plate is moving at a rate of 6 cm per year in a northeast direction, and subducting under the Eurasian and the Burmese plates in the north and east, at a rate of 45 mm per year and 35 mm per year, respectively (Sella et al., 2002; Bilham, 2004; Akhter, 2010).

The other major active tectonic belt of Bangladesh is at the eastern side. The Arakan subduction-collision system involves oblique convergence of the Indian and Burma plates. It has produced the N-S trending Indoburman range and a broad belt of folds along the western edge of the Bay of Bengal (Curry, 2005; Wang and Sieh, 2013). These lie above a mega thrust that dips moderately eastward beneath the Indoburman range but is nearly flat-lying beneath the folds. Beneath the 500-km long fold belt the mega thrust is also referred to as a decollement, because it is parallel or nearly parallel to sediment bedding

within the Canges Brahmaputra delta. Many of the folds within the western 100 to 200 km of the fold belt appear to be actively growing, which implies that the underlying decollement is relaying slip onto thrust faults beneath these folds as it dies out westward toward a poorly defined deformation front. The proposed site location is also on the eastern side of Bangladesh. Hence, there is risk of earthquake due to the Arakan fault.

List of the major earthquake that hit Bangladesh are listed in following table below.

Table 18: List of Major Earthquakes in Bangladesh

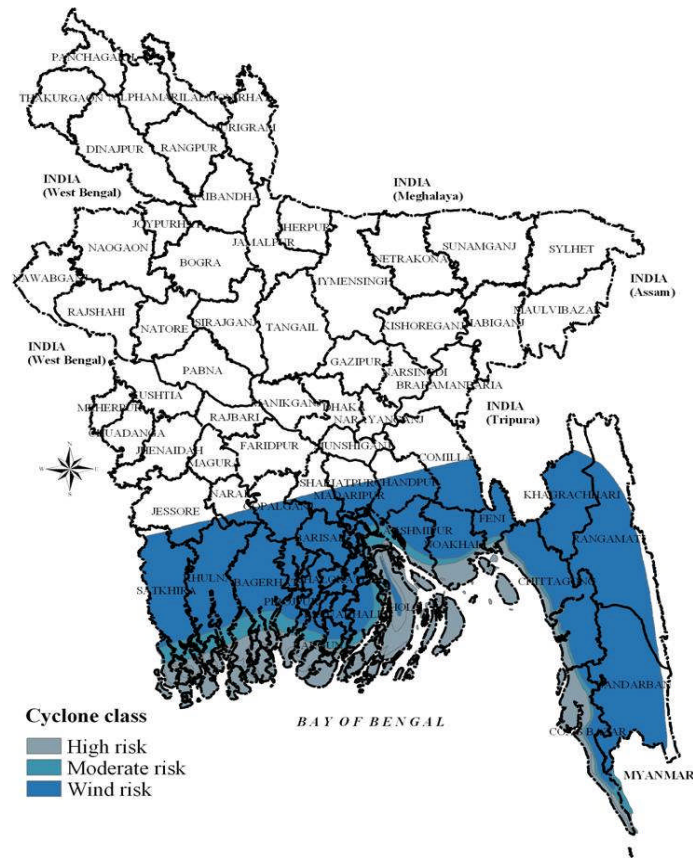
Date	Name	Magnitude (Ritcher)
10 th January 1869	Cacher Earthquake	7.5
14 July 1885	Bengal Earthquake	7.0
12 June 1897	Great Indian Earthquake	8.7
8 July 1918	Srimongal Earthquake	7.6
2 July 1930	Dhubri Earthquake	7.1
15 January 1934	Bihar-Nepal Earthquake	8.3
15 August 1950	Assam Earthquake	8.5

Source: Department of Disaster Management

5.2.2.8. Tropical Cyclones

Devastating cyclones hit the coastal areas of Bangladesh almost every year usually accompanied by high-speed winds, sometimes reaching 250 km/hr or more and 3-10 m high waves, causing extensive damage to life, property and livestock. Cyclones in the Bay of Bengal occur in two seasons, April-May and October-November – i.e. before and after the monsoon. Cyclones enter the Bay as the remnants that originate in the South China Sea. They gain moisture and latent heat from the Bay of Bengal, and consequently rejuvenate into full-blown phenomenon. Following a curvilinear path, they reach the coast of Myanmar, Bangladesh or East Coast of India. Because of the funnel shaped coast, Bangladesh repeatedly becomes the landing ground of cyclones formed in the Bay of Bengal. The Bay cyclones also move towards the eastern coast of India, towards Myanmar and occasionally into Sri Lanka. But they cause the maximum damage when they come into Bangladesh and West Bengal of India. This is because of the low flat terrain, high density of population and poorly built houses. Most of the damage occur in the coastal regions of Khulna, Patuakhali, Barisal, Noakhali and Chittagong and the offshore islands of Bhola, Hatiya, Sandwip, Manpura, Kutubdia, Maheshkhali, Nijhum Dwip, Urir Char and other newly formed islands. The cyclone affected area map of Bangladesh is shown in Figure below. The proposed Jaliardip EZ is severely affected by cyclones.

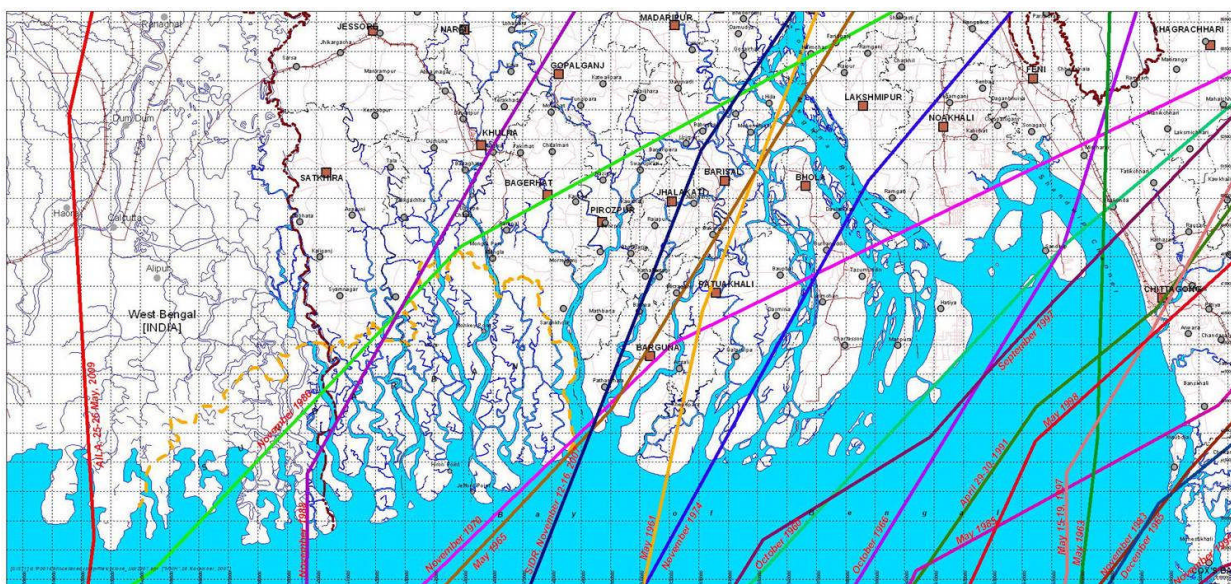
Figure 41: Cyclone affected area map of Bangladesh



Source: Department of Disaster Management

The tracks of few major cyclones that hit Bangladesh are shown in figure below.

Figure 42: Cyclone tracking map of Bangladesh



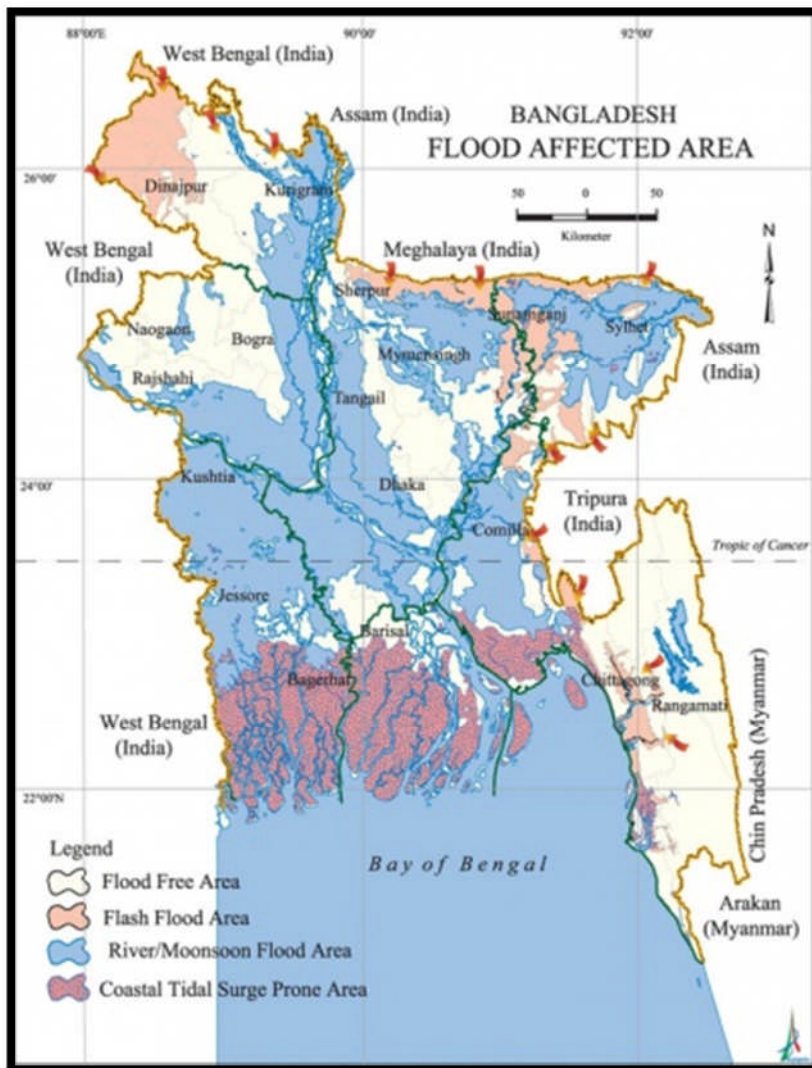
Source: Department of Disaster Management

5.2.2.9. Tidal Floods

Floods are the most significant natural hazard in the country causing extensive damage to human life and property. The country lies on the downstream part of three major river basins: Brahmaputra, Ganges and Meghna and thus is frequently flooded. There have been many destructive floods in Bangladesh, including very severe floods of 1987, 1988 and 1998. The flood damage potential in Bangladesh is increasing due to the possible causes of climate change, urban concentration in the three river basins, encroaching of settlements into flood prone areas, and overreliance on the safety provided by flood control works such as levees, reservoirs.

There are two types of floods which occur in Bangladesh: annual floods (barsha) that inundate up to 20% of the land area; and low frequency floods of high magnitude that inundate more than 35% of the area (bonna). The major floods that occurred in 1954, 1955, 1974, 1984, 1987, 1988, 1993, 1998, 1999, 2000 and 2007 have been very destructive and caused serious threat to lives and economy. In the context of human exposure in flood hazard zones, nearly 19,279,960 people are present in these zones and Bangladesh ranks 1st among 162 nations. Similarly, the modelled amount of GDP in seismically hazardous zones puts Bangladesh 3rd among 162 countries. The flood affected area map of Bangladesh is provided in figure below. The map shows that Jaliar Dip lies in flood free area. As per the stakeholder discussions, the water level during monsoon season varies from 2 meters to 3 meters depth inside the proposed EZ area.

Figure 43: Flood affected area map of Bangladesh



Source: Department of Disaster Management

5.2.2.10. Tornado

It is the pre-monsoon period when most of the abnormal rainfall or drought conditions frequently occur in different parts of Bangladesh. Also there are severe local seasonal storms, popularly known as nor'westers (kalbaishakhi). Severe nor'westers is generally associated with tornadoes. Tornadoes are embedded within a mother thundercloud, and moves along the direction of the squall of the mother storm. The frequency of devastating nor'westers usually reaches the maximum in April, while a few occur in May, and the minimum in March. Nor'westers and tornadoes are more frequent in the afternoon. Nor'westers may occur in late February due to early withdrawal of winter from Bangladesh. The occasional occurrence of nor'westers in early June is due to the delay in the onset of the southwest monsoon over the region (Karmakar, 1989). List of the nor'westers and tornadoes is given in table below.

Table 19: List of Tornadoes had hit the Bangladesh

Date	Location
14 th April, 1969	Demra (Dhaka)
17 th April, 1973	Manikganj (Dhaka)
10 th April, 1974	Faridpur
11 th April, 1974	Bogra

9th May, 1976	Sabrang
1st April, 1977	Faridpur
26th April, 1989	Saturia (Manikganj)
14th May, 1993	Southern Bangladesh
13th May, 1996	Tangail
4th May, 2003	Brahmanbaria
21st March, 2005	Gaibandha

5.2.3. Land Resources

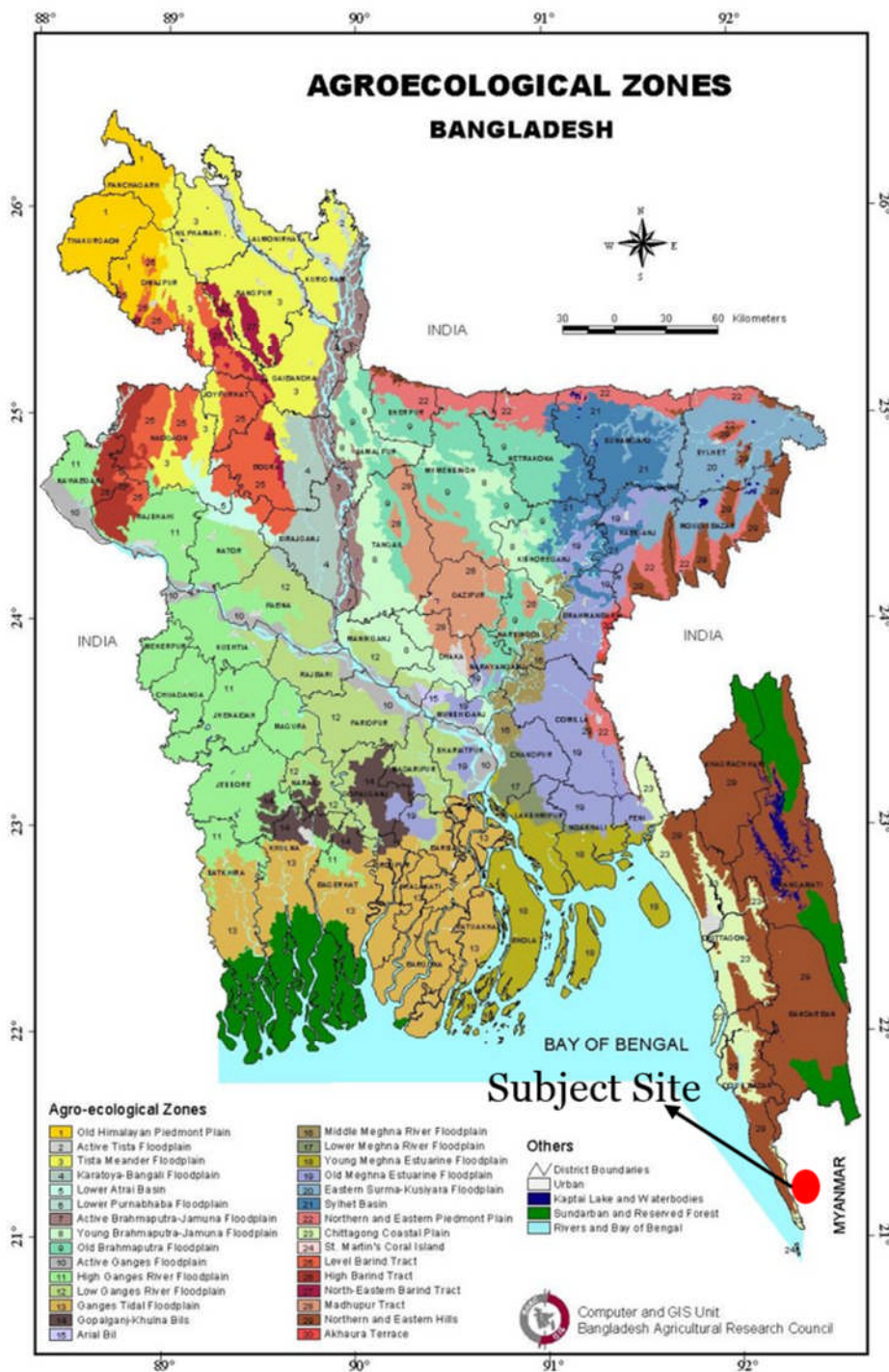
5.2.3.1. Agroecological Regions

An Agroecological Region is a zone which has unique combination of physiographic, soil, hydrological and agroclimatic characteristics. Thirty agroecological regions and 88 subregions and 535 units have been identified by adding successive layers of information on the physical environment which are relevant for land use and for accessing agricultural potential. These layers are:

1. Physiography
2. Soils
3. Depth and duration of seasonal flooding
4. Length of rainfed kharif and rabi growing periods
5. Length of pre-kharif period of unreliable rainfall
6. Length of cool winter period
7. Frequency of occurrence of extremely high (> 40 degrees) summer temperature.

The physiographic unit of the project is: Northern and Eastern Hills (AEZ# 29) (shown in figure below). The land type of this area comprise of 33% high land, 31% medium high land, 16% medium low land and 80% others. The soil is medium in organic matter content with low to medium fertility levels.

Figure 44. Agroecological Regions of Bangladesh



5.2.3.2. Land Types

The landforms of Bangladesh can be divided into three major classes:

- The northern and eastern hills
- The Holocene floodplains
- The Pleistocene terraces

The sediments deposits of Bangladesh mainly consists of those laid down by the Ganges, Brahmaputra and Meghna (GBM) river systems. Holocene floodplain deposits cover most of the surface area of present-day

Bangladesh. According to geographic and geomorphic distribution, the Holocene floodplains are divided in four classes:

- Piedmont plains
- Meander floodplains
- Tidal floodplains
- Estuarine floodplains

Land types are classified depending upon the depth of inundation during monsoon season due to normal flooding in an average year. SRDI has made the land type classification into five types, i.e. High land (Above flood level), Medium highland (Flooding depth 0-90 cm), Medium lowland (Flooding depth 90-180 cm), Lowland (Flooding depth 90-270 cm) and very lowland (Flooding depth >270 cm). Land type classification based on flooding during Monsoon Season by SRDI is given below in table.

Table 20: Land Type Classification

Land Type	Description	Flooding Depth	Flooding Characteristics
F0	Highland	0-30 cms	Non Flooded to Intermittent
F1	Medium Highland	30-90 cms	Seasonal
F2	Medium Lowland	90-180 cms	Seasonal
F3	Lowland	180-270 cms	Seasonal but remains wet in early dry season
F4	Very Lowland	>270 cms	Seasonal but remains wet in most of the dry seasons

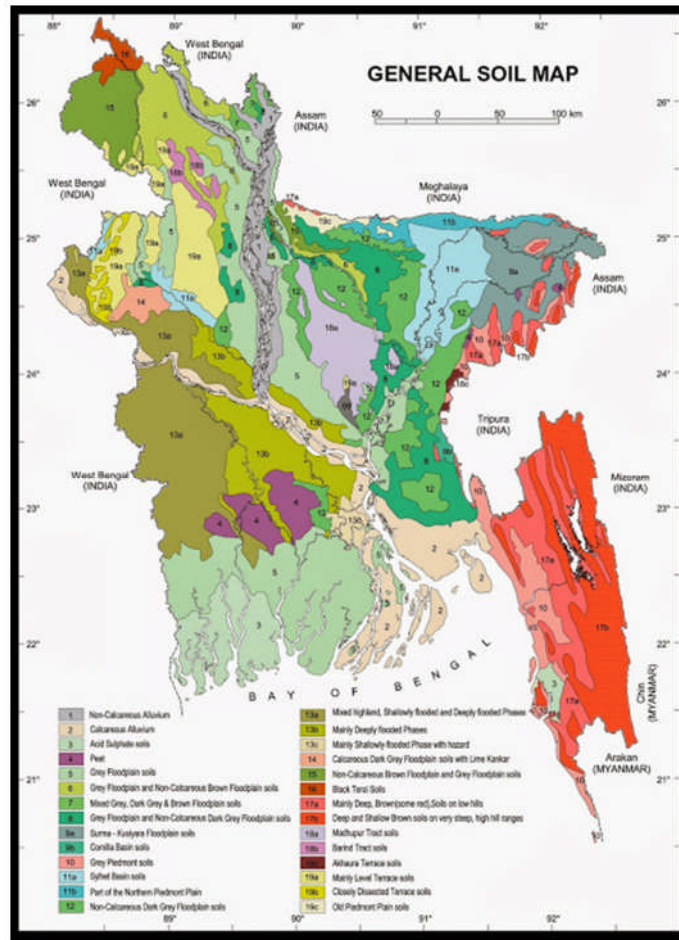
Source: SRDI

As per the classification, project site will be covered under medium lowland.

5.2.3.3. Geomorphology/ Soil Texture

As per the geological map of Bangladesh, the Teknaf area mainly consists of mainly deep brown (some red soil) with a mixture of fine sand of the same color and nodules containing a large percentage of sesquioxides. The geological map of Bangladesh is provided in figure 21 and geological log of Teknaf upazila is shown in figure.

Figure 45: General Soil map of Bangladesh



Source: Soil Resources and Development Institution (SRDI), Dhaka, Bangladesh

Figure 46: Geological log for Teknaf Upazila

Sample No	Depth (ft)		Depth (m)		Thickness (m)	Color	Lithology
	From	To	From	To			
1	0	10	0.00	3.05	9.15	Brown	Very Fine Sand, Trace LDM
2	10	20	3.05	6.10		Brown	Very Fine Sand, Trace LDM
3	20	30	6.10	9.15		Brown	Very Fine Sand, Trace LDM
4	30	40	9.15	12.20	3.05	Grey	Very Fine Sand, Trace LDM
5	40	50	12.20	15.24	3.05	Grey	Clay, Some Silt
6	50	60	15.24	18.29	3.05	Grey	Clay, Little Silt
7	60	70	18.29	21.34	6.10	Grey	Clay, Silt
8	70	80	21.34	24.39		Grey	Clay, Silt
9	80	90	24.39	27.44	6.10	Grey	Clay, Trace Silt
10	90	100	27.44	30.49		Grey	Clay, Trace Silt
11	100	110	30.49	33.54	15.24	Grey	Clay, Little Silt
12	110	120	33.54	36.59		Grey	Clay, Little Silt
13	120	130	36.59	39.63		Grey	Clay, Little Silt
14	130	140	39.63	42.68		Grey	Clay, Little Silt
15	140	150	42.68	45.73	9.15	Grey	Clay, Little Silt
16	150	160	45.73	48.78		Grey	Clay, Trace Silt
17	160	170	48.78	51.83		Grey	Clay, Trace Silt
18	170	180	51.83	54.88	3.05	Grey	Clay, Trace Silt
19	180	190	54.88	57.93		Grey	Clay, Little Silt
20	190	200	57.93	60.98	3.05	Grey	Clay, Trace Silt
21	200	210	60.98	64.02	30.49	Grey	Clay
22	210	220	64.02	67.07		Grey	Clay
23	220	230	67.07	70.12		Grey	Clay
24	230	240	70.12	73.17		Grey	Clay

25	240	250	73.17	76.22		Grey	Clay
26	250	260	76.22	79.27		Grey	Clay
27	260	270	79.27	82.32		Grey	Clay
28	270	280	82.32	85.37		Grey	Clay
29	280	290	85.37	88.41		Grey	Clay
30	290	300	88.41	91.46		Grey	Clay
31	300	310	91.46	94.51	3.05	Grey	Clay, Trace Silt
32	310	320	94.51	97.56	9.15	Grey	Clay
33	320	330	97.56	100.61		Grey	Clay
34	330	340	100.61	103.66		Grey	Clay

Source: BWDB

The geological log for Teknaf upazila shows that 12 m bgl fine sand is present but as we go further deeper from 12 m to 103 m clay is present in the strata.

5.2.3.4. Land Use

Land Use pattern at Jaliardip:

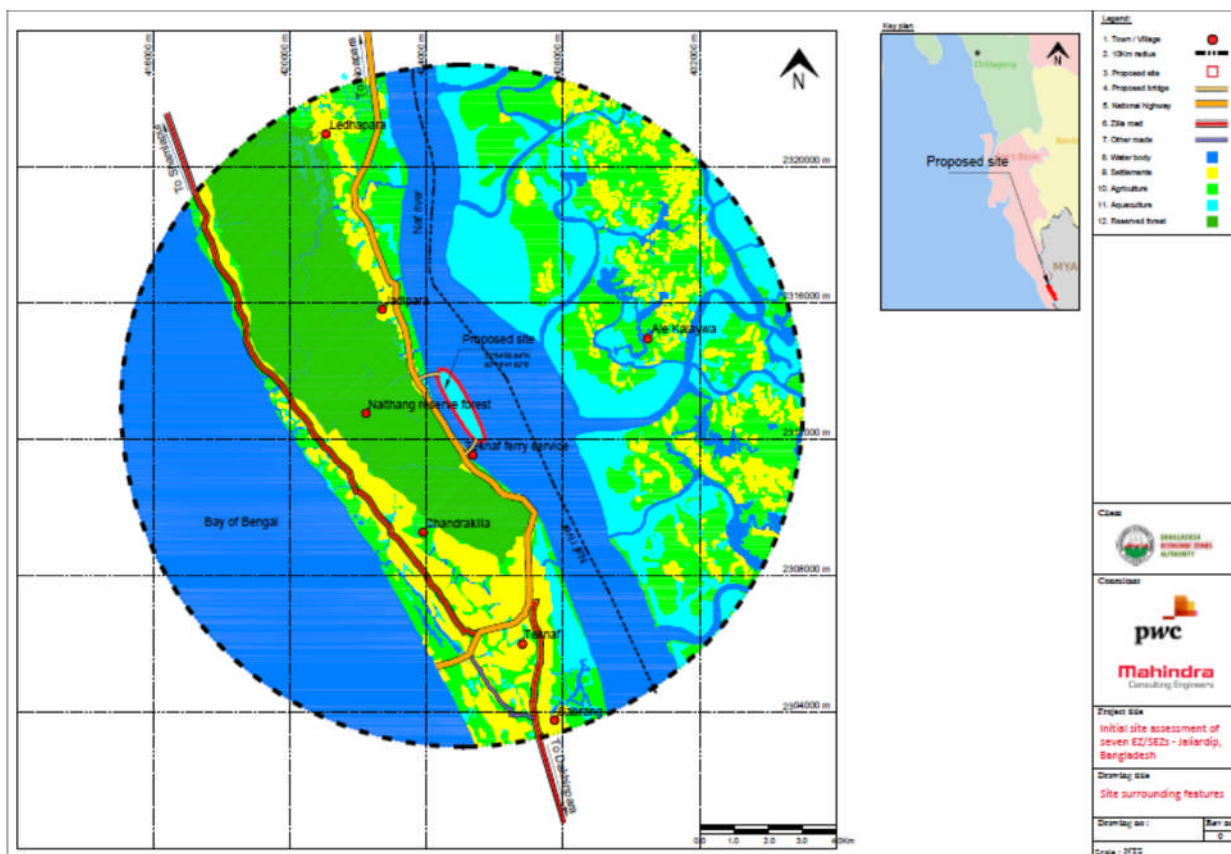
The proposed EZ is planned on an area of 271.93 acres which has been transferred by DC to BEZA on 31st May 2016. The land is presently not used for any other activity.

Land use pattern around the vicinity of the subject site at Jaliardip:

The proposed EZ is abutted by Naf River on all sides and Naithang River Forest is located at approximately 2 km from the proposed EZ location in the western direction. Agriculture is being practiced in small land parcels located around 5 Kms from the project site in the north-western direction. Land around the southwest of the project site is mainly marshy land where boat operators park their boats.

Figure below shows the land use pattern of the area surrounding the subject site.

Figure 47. Land Use Pattern around 10 Kms of the subject Site, Jaliardip



5.2.4. Ambient Air Quality

Primary monitoring has been conducted on 29th – 30th May 2016 at the proposed site in Jaliar dip to collect the data on ambient air quality. The analysis results of ambient air monitoring are provided in table below. The air quality data below shows that the concentrations of all the parameters are below the national ambient air quality standard.

Table 21: Ambient air quality monitoring results at Jaliar dip EZ

Sample Location	PM _{2.5}	PM ₁₀	SPM	SO ₂	NO ₂
Hrilla mouja near Neval embankment	16.5	462	86.32	3.1	8.2
100m North from Neval embankment	18.8	44.6	78.12	3.0	7.6
100m South from Neval embankment	15.2	42.6	84.5	-	-
100m East from Neval embankment	13.5	45.8	82.30	-	-
National ambient air quality standard, Bangladesh	<65 in average time 24 h	<150 in average time 24 h	<200 in average time 8 h	<80 in average time annual	<100 in average time annual

Table 22: World Bank Group General EHS guidelines (Ambient Air quality guidelines)

Parameter	Guideline Value (µg / m ³)
PM _{2.5}	25 (24-hour averaging period) 10 (1-year averaging period)
PM ₁₀	50 (24-hour averaging period) 20 (1-year averaging period)
SO _x	500 (10 min averaging period) 20 (24 hour averaging period)

NOx	200 (1 hour averaging period) 40 (1 year averaging period)
-----	---

5.2.5. Ambient Noise Quality

The noise monitoring data collected during site survey shows that ambient noise levels during day time at Hrilla mouja near Neval Embankment and 100 m north from Neval embankment exceed the national standard. The ambient noise levels during night time exceeds the Bangladesh Standard at all the monitoring locations. One of the factor contributing to exceedance of noise levels is the sound due to Naf river waves. The ambient noise monitoring data is presented in table below.

Table 23: Ambient noise quality monitoring results at Jaliar dip EZ

Sample Location	Sound level in dB (day time)	Sound level in dB night time)	Note
Hrilla mouja near Neval embankment	61	60.3	Naf river waves sound exists all the time of sampling
100m North from Neval embankment	55	53.8	
100m South from Neval embankment	51	50.2	
100m East from Neval embankment	52	51	
DOE standard limit for Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60	50	
World Bank Group General EHS guidelines (Noise guidelines) for Industrial; Commercial	70	70	One Hour L _{Aeq} (dBA)

5.2.6. Water Environment

The project site is an island and it is located approximately 10 kms from the center of Teknaf Upazila. The proposed EZ is abutted by Naf River on all sides. The local people in the nearby villages carry out fishing activities in the Naf river surrounding the site. Groundwater sample and surface water samples have been collected to get the baseline information.

5.2.6.1. Surface Water Quality

The surface water quality analysis data collected during site survey is provided in table below.

Table 24: Surfacewater quality monitoring results at Jaliar dip EZ

Parameter	Unit	Surface water from Hrilla mouja of Jaliar dip	DOE for surface water	Standard inland water
1. pH		7.91		6.5-8.5
2. EC	μS/cm	4880		2250
3. TDS	ppm	2710		-
4. TS	ppm	2860		-
5. DO	Ppm	6.20		>5
6. BOD ₅	Ppm	73		<10
7. COD	Ppm	240		-
8. Arsenic (As)	Ppm	ND		-
9. Iron	Ppm	1.48		-
10. Oil & Grease	Ppm	2.2		-
11. Temperature	°C	31		-

The data shows that EC and BOD₅ for both the locations exceeds the prescribed standards. Generally nitrates and phosphates contribute to high BOD levels and also signifies organic waste in the water.

5.2.6.2. Ground water

The groundwater quality data results shows that BOD and COD exceeds Bangladesh standard for drinking water. The other analysed parameters are within the limits prescribed by Bangladesh standard. The high BOD levels signifies organic contamination in ground water which shall be due to shallow groundwater table. The groundwater monitoring results are provided in table below.

Table 25: Groundwater quality at at Jaliar dip EZ

	Parameter	Unit	Deep Tubewell of Sabrang Mauza	Bangladesh Standard for drinking water
1.	pH		7.99	6.5-8.5
2.	EC	µS/cm	721	-
3.	TDS	ppm	312	1000
4.	TS	ppm	372	-
5.	DO	ppm	3.10	6
6.	BOD ₅	ppm	2.1	<0.2
7.	COD	ppm	16.8	4
8.	Arsenic (As)	ppm	ND	0.05
9.	Iron	ppm	0.68	0.3-1
10.	Oil & Grease	ppm	0.01	0.01
11.	Temperature	°C	30.8	20-30

5.2.7. Agriculture Resources

Teknaf area falls under Northern and eastern Hills agriculture zone. Two seasoned crop generally are being cultivated here. One is Rabi and another is Kharif. Rabi crop which are generally cultivated in this particular agricultural zone are Boro Rice, Potato, Sweet Potato, Cucumber, Swet Gourd, Snake Gourd, Bitter Gourd, Ridge Gourd, Brinjal, Country Bean, Coriander. Kharif crops majorly includes *B. aus*, *T. aman*, Jhum cultivation.

The proposed site area is not used for agriculture purposes. The proposed EZ is planned on an area of 271.93 acres which has been transferred by DC to BEZA on 31st May 2016. The land is not under any use presently.

5.2.8. Livestock and Poultry

There is no livestock and poultry at the proposed site location and in the area of influence.

5.2.9. Fisheries

The area demarcated for the development of the EZ has had 100 acres of land leased for undertaking pisciculture to 9 lease holder and subsequent to the expiry of the lease period, the land was transferred to BEZA on 31st May 2016. The land is not under any use presently.

Fishes: A wide variety of indigenous and exotic fishes including carps catfishes and many smaller species are available in the area of influence. Fish is an essential staple and plays a very important role in the economy of the area. In the fresh water, the popular species are ruhi (*labeo rohita*), katla (*Catla catla*), mrigel (*Cirrhinus mrigala*), kalabaush (*labeo calbasu*), airh (*Mystus aor*), ghonia (*Labeo gonius*), shoil (*Channa striatus*), boal (*Wallagonia attu*), gazar (*Channa marulius*), gulsha (*Mystus bleekeri*), koi

(*Anabas testudineus*), shing (*heteropneustes fossilis*) and magur (*Clarias batrachus*) hilsha (*Hilsa ilisa*) etc.

The surrounding area is the most important marine fisheries centre in Bangladesh. Popular among marine fishes are Ilisha or hilsa, rupchanda (*Pampus chinensis*), hail chanda (*Parastromateus niger*), luckwa (*Polynemus indicus*), lotya (*Harpodon nehereus*), churi (*Lepturacanthus savala*), poa (*Pama pama*), ekthoate (*Hemiramphus georgii*), bargau (*Bagarius yarrellii*), datina (*Acanthopagrus latus*), tullar dandi (Whiting), bata and khorshul (*Mugil corsula*), phansha (anchovy), tophshil (*Polynemus paradiseus*), guchhiya and bhetki are popular. Prawn farming is an important economic activity of this area.

Other aquatic fauna: Invertebrates like sponges, jelly fish, corals and sea-anemone are common also crabs, king crabs and equilla, molluscus like shells (*Gastropods*), maine borers (*teredo*), oysters (*pelecypods*), squids, octopuses (*Phylum echinodermata*) like star fish, sea-urchin and sea-cucumber are also found in good number in the coastal area.

5.2.10. Ecological Resources

The proposed EZ is abutted by Naf River on all sides and Naithang River Forest is located at approximately 2 km from the proposed EZ location in the western direction. The primary field survey, secondary information available and stakeholder discussions, indicated that there are mangroves at the periphery of the site location. Mangroves support the habitat of different varieties of fishes. Mangrove forest occurs in Teknaf peninsula both as natural forest with planted stands and mostly distributed in the intertidal zone. Teknaf peninsula mangroves support the habitat of different species of fish. Mangroves trap and stabilize sediment and reduce the risk of shoreline erosion because they dissipate surface wave energy. Mangrove vegetation is extremely important for maintaining ecological balance, nutrient flow and productivity, supports important fisheries and supplies detritus and nutrients. Mangroves also have an important buffering function, acting as silt traps, filtering pollutants from freshwater runoff and minimising adverse effects on aquatic life forms (DoE, 1996). There are trees of other species as well at the proposed site location. These are:

Table 26: Trees at the proposed EZ site

Tree Name	No of trees
Akashi	531
Jhau	215
Neem	6
Peepal	30
Cocount	94
Mango	1
Bam	4

Figure 48: Mangroves surrounding the site

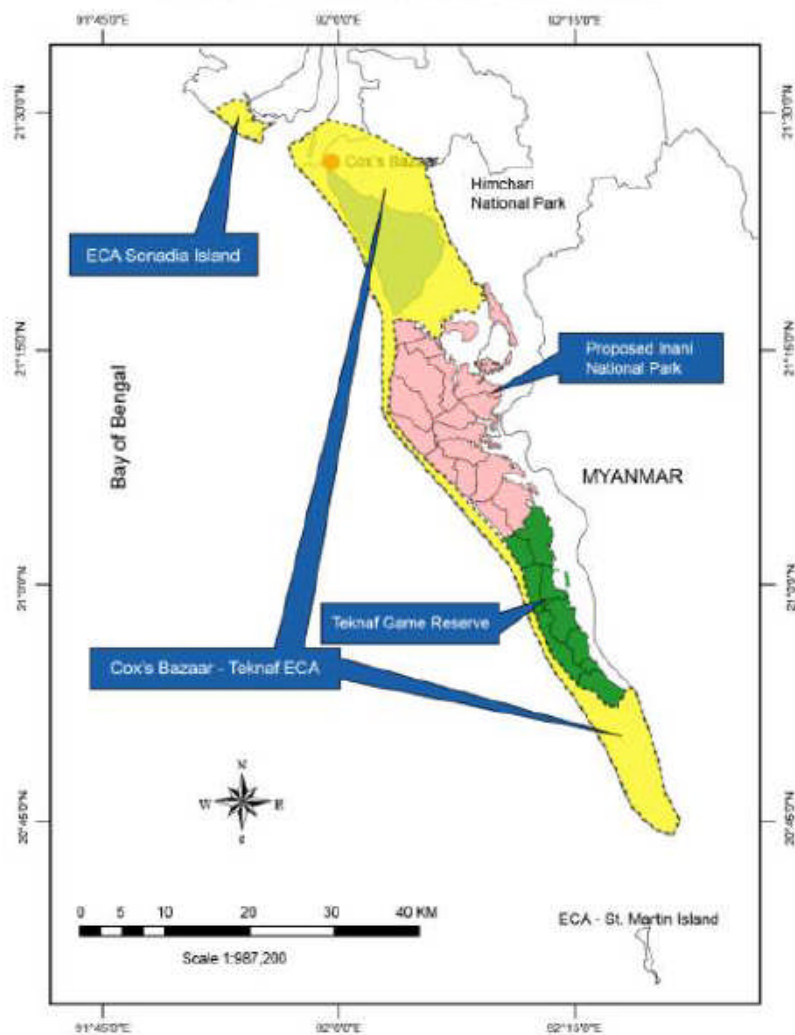


5.2.10.1. Protected areas

Teknaf wildlife sanctuary is approximately 2-3 km from the proposed EZ. It comprises an area of 11,615 hectare. This is one of the few places in Bangladesh where Elephants can be seen in the wild. It was established in 1983 as a sanctuary to protect wild Asian Elephants. This vast sub-tropical forest has several other attractions like Nitong Hill, Kudum Cave, Kuthi Hill etc..There are no elephants in the Jaliardip Island.

Naithang Reserve forest is approximately 2 km from the proposed EZ location. Himchari National Park is approximately 55 km from the proposed EZ. It is 5 kilometers south of Cox's Bazar and is a 1729-hectare reserve bordering the Bay of Bengal. It is well-known waterfalls. The several sites in Himchari National Park have been concessioned for management by the private sector, including the waterfall with a footfall of close to a lakh tourists every year. It is managed by the Forest Department. Jaliardip Island does not have elephants. The Teknaf Peninsula protect area map is shown in figure below.

Figure 49: Teknaf Peninsula Protected Areas map



Source: USAID report on Teknaf peninsula community-based ecotourism strategy

Secondary information has been collected on flora and fauna in the study area and is presented in the subsequent sections. As per the district handbook 2011, the flora and fauna details in the Cox's Bazar district are below.

5.2.10.2. Flora

The forests of Cox's Bazar broadly represent five categories of natural vegetation. These are: i) Tropical wet evergreen ii) Tropical moist semi-evergreen iii) Tropical moist deciduous iv) Bamboo brakes and v) grassland.

The upper storey of the forest comprises mostly dhali garjan (*Dipterocarpus turbinatus*), kali-gorjun (*Dipterocarpus turbinatus*) boilam (*Anisoptera scaphula*), buchananiasp, narikeli (*Cocos nucifera*), bonshimul (*Bombax insigninis*), chundul (*tettameles nudiflora*), telsur (*Hopea odorata*), segun (*Tectona grandis*), chapalish (*Artocarpus chapalish*), dhup (*Canarium resiniferum*) etc.

Common trees found in the second storey of the forests of Cox's Bazar are gamar (*Gumelina arborea*), jarul (*Lagerstroemia speciosa*), hartaki (*Terminalia chebula*), bahera (*Terminalia bellirica*), hargaza (*Dillenia pentagyna*), pitraj (*Aphanamixls polystachia*), chalmoogra (*Hydnocarpus kurjii*), jalpai (*Elaeocarpus tectorius*), rudrakia (*E ganitrues*), tatua (*Albizia odoratissima*), deohal (*Garciria xanthochymus*), bon sonalu (*Cassia nodosa*), mango (*Mangifera indica*), and dumur (*Ficus sp.*), bazna

(*Zanthophyllum flavescens*), harphata (*baccaurca sapida*), barela (*Holigarna caustica*), nageswar (*Mesua nagassarium*), kiabong (*Carallia lucida*), kasturi (*Cinnamomum cecidodaphne*) and ashok (*saraca indica*), Jam (*Eugenia jambolanavav*) etc.

Various types of climbers, lianas and epiphytes consisting of ferns, mosses and orchids are abundant in these forests. Due to overfilling and poor regeneration capacity, bamboo brakes are fewer in Cox's bazar and grow sporadically in the farther hilly areas. Common species of bamboos found in these forests are mooli (*Melocanna bambusoides*), lola bans (*Melocanna compactiflorus*). Different types of canes namely bandori (*Calamus tenuis*), etc, are also found in these forests. Recently the Forest Department has successfully introduced eucalyptus, acasam, pine, mahogany, rubber etc. in these forests.

Common plants that grow in the swampy areas along the Bay are chalta (*Dillenia indica*), pitali (*Trewia nudiflora*), sheora (*Streblus asper*), and cane (*Calamus viminalis*).

A district feature of Cox's Bazar forest are clearly exhibited by the occurrence of mangrove vegetations, especially in the delta of the Matamuhuri river (Chokaria Sundarban) and on the west bank of the Naf river. The littoral forests of these areas degenerate due to erosion and constant felling. These differ mainly from those of Patuakhali-Khulna Sundarban in having dominant colonies of *Dalbergia spinosa* and *Aegiaets rotundifolia*.

As per the IUCN list of endangered species in Bangladesh, there are no endangered flora species in the Jaliardip Island.

5.2.10.3. Fauna

Mammals: Elephants are found in the forests of Cox's Bazar. Kheda operations a kind of operation for catching wild elephants with the help of a special type of stockade, were used to be organized by the forest department during winter season; now-a-days these operations have been stopped as the number of elephants have dwindled critically. Elephant (*Elephas maximus*) small cats like the fishing cat (*Felis viverrina*) and the jungle cats (*Felis chaus*) are relatively common but leopards (*Panthera pardus*) are getting rare day by day. The big deer like the sambars (*Cervus unicolor*) and the bisons are now rarely found. Wild shukar (*Sus scrofa*) are found in large number but bears (*Selenaretos thibetanus*) are not very common and may only be encountered in the hills near the Cox's Bazar-Myanmar border. The primates in the district include the white-browed gibbon, the slow lemur, long tailed langur etc.

Rodents are represented by different species of squirrels, rats and mice and porcupines. Gayals (*Bos fontalis*), foxes (*Vulpes bengalensis*) and jackals (*Canis aureus*) are also found. Among the aquatic mammals, porpoises and dolphins are found in the estuaries of Cox's Bazar and its coastal area.

Birds: Most of about 600 species of birds that are seen in Bangladesh are also found in Cox's Bazar. Charadriidae, accipites, falcons, pheasants, pastridges, quails, columbids. cuckoos (*Cuculus microplerus*), owls (*Tyto albo*), woodpeckers, and kingfishers (*alcedo atthis*) of different species are present in this area. Muscicapids (babblers), thrushes, flycatchers, warblers, chats, fork tail etc are found all over the district; it is this group which has the most beautiful songbirds, sunbirds, flowerpeckers, drongos and sparrow (*Passar domesticus*), finches are also common. Large number of migratory birds come to visit this area during winter. Of the seabirds, different species of gulls, terns, Indian skimmers and pelicans are also found.

Reptiles are abundant in the district. The common cobra and the krait are the chief venomous varieties of snakes, cobra (*Naja naja*) and python (*Molunrus tivittatus*) are the cause of frequent fatalities. Turtles and tortoises abound in the rivers. Lizards (*Hemidactylus prooki*) are seen everywhere.

Other aquatic fauna: Invertebrates like sponges, jelly fish, corals and sea- anemone are common also crabs, king crabs and equilla, molluscus like shells (*gasteropods*), maine borers (*teredo*), oysters (*pelecypods*), squids, octopuses (*Phylum echinydermata*) like star fish, sea-urchin and sea- cucumber are also found in good number in the costal area of Cox’s Bazar.

As per the IUCN list of endangered species in Bangladesh, there are no endangered fauna species in the Jaliardip Island.

5.2.11. Socio-economic

The key parameters that are required to establish a baseline socio-economic profile of population within the project’s area of influence include gender, ethnicity, social structure, employment patterns, sources of income, local tenure and property rights arrangements, use of community and natural resources. Primary information gathered by undertaking the screening survey, individual consultations and other stakeholder interaction and secondary information sourced from published references has been analyzed to establish the socio-economic baseline.

5.2.11.1. Teknaf Upazilla

Teknaf is an Upazila located in Cox’s Bazar district. Jaliar dip is an island which comes under the jurisdiction of Teknaf Upazila. Teknaf forms the southernmost point in mainland Bangladesh. It is located in between 20 degrees - 23 minutes and 21 degrees - 9 minutes north latitude and in between 92 degrees - 5 minutes and 92 degrees - 23 minutes east longitude. The district is abutted by a river vis-à-vis Naf River on its east and Bay of Bengal on its west and south. The upazila covers a total area of 388.66 square kms with a land cover of 137.77 acres, forest cover of 155.14 acres. The below figure depicts the layout map of the Teknaf.

Figure 50: Layout Map of Teknaf



Source: ISA report

According to the Bangladesh Bureau of Statistics, 2011 census of Teknaf Upazila, the total population of Teknaf is 2,64,389 of which 1,33,106 are males and 1,31,283 are females. There has been substantial growth in the population of Teknaf which increased by 31.79% during the decade 2001 to 2011. The

population density is 680 per km². As per the Bangladesh Bureau of Statistics, the literacy rate of Teknaf upazila is 26.7% with 29.7% of males and 23.6% of females being literate.

The project area of influence comprises of the Teknaf Upazilla and two mauzas namely Teknaf and Dakshin Nhillia Mouzas. The Socio-Economic profile of Teknaf is represented in the below table

Table 27: Socio-Economic Profile of Teknaf Upazilla

Indicators	Quantity
Area (Sq.Kms)	388.66
Union/Wards (No.)	6
Mouzas/Mahallas (No.)	12
Villages (No.)	146
Households (No.)	46,328
Population (No.)	2,64,389
Population density (per Sq. Km)	680
Male (%)	50.34
Female (%)	49.65
Sex Ratio (Females/ 1000 males)	101
Number of Child Birth (No.)	9,533
Literacy (7+)	
Overall (%)	26.7
Males (%)	29.7
Females (%)	23.6
Religious Institutions	
Mosques	183
Temples	7

Source: District Statistics 2011, Cox's Bazar

5.2.11.2. Demographic Details of Teknaf Upazila

The following sections presents the demographic details of the Teknaf Upazila in which the proposed site is located. The demographic profile of all the unions under Teknaf Upazila is represented in the below table. As evident from the table, there are 46,328 households with a total population of 2,64,389 comprising of 1,33,106 males and 1,31,106 females with the sex ratio being 101 males for every 100 females. The average number of people per household for the Teknaf Upazila works out to be 6.0. The lower sex ratio indicates the absence of gender bias which augurs well with the planned development and the skill upgradation programmes which are planned as an integral component of the proposed project.

Table 28: Demographic profile of the Unions under Teknaf Upazila

Union	Area in Acres	Households	Population Total	Sex		Sex Ratio (Male/Female)*100
				Male	Female	
Teknaf	25,018	8,467	47,708	24,076	23,632	102
Baharchhara	3783	4,832	28,805	14,481	14,324	101
Jaliar Dip	16486	9970	58,358	29,126	29,232	100
Whykong	31,582	8,867	50,863	25,296	25,567	99
Nhillia	17,125	8,271	46,896	23,360	23,536	99
St. Martins Dwip	835	1169	6,703	3471	3232	107

Source: Bangladesh Bureau of Statistics, Census 2011

5.2.11.3. Literacy Rate

The literacy rates in all the 6 unions in the Teknaf Upazilla, sourced from the Bangladesh Bureau of Statistics, Census 2011 ranges between 12.7% and 34.4%. The maximum difference of literacy rate between male and female was observed at St Martins Dwip Union while the minimum was noted at Whykong Union. The below table represents the union wise literacy rates in Teknaf.

Table 29: Literacy Rates Segregated by Unions in Teknaf (Census 2011)

Name of the Union	Area (Acres)	Populations		Literacy Rate (%)	
		Male	Female	Male	Female
Teknaf	25,018	24,076	23,632	34.4	27.9
Baharchhara	3783	14,481	14,324	24.1	21.2
Jaliar Dip	16486	29,126	29,232	20.1	13.7
Whykong	31,582	25,296	25,567	29.3	26.6
Nhilla	17,125	23,360	23,536	30.6	26.5
St. Martins Dwip	835	3471	3232	24.1	12.7

Source: Bangladesh Bureau of Statistics, Census 2011

5.2.11.4. Education

The educational system in Teknaf upazilla has improved gradually within the last 10 years. The list of educational institutes that are present in Teknaf upazila are:

- 4 government colleges;
- 17 non-government colleges;
- 6 government high schools;
- 107 non-government high schools;
- 8 junior high schools;
- 150 Madrassas;
- 376 government primary schools;
- 235 non-government high schools;
- 22 NGO operated primary schools;
- 1 primary teacher's training institutes.

5.2.11.5. Source of Income at Teknaf

The primary source of income for the inhabitants of Teknaf include: fishing and salt farming. The sale of fish in the local as well as markets in Dhaka, Chittagong and Cox's Bazar acts as a major means of livelihood for the local people of Teknaf and Dakshin Nhilla Maouza of Teknaf upazila. In the Nhilla Union of Teknaf, fishing and pisciculture serves as the main source of livelihood.

6. Identification and Analysis of Key Environmental Issues

6.1. Environmental Sensitivity Investigation

Environmental impact assessment has been carried out considering the impacts of proposed interventions with associated activities on important components of the environment and society. Firstly, all of the environmental components sensitive to proposed activities were identified during reconnaissance field visit based on expert observation, local people's perception and worldwide practice of EIA. The scoping process, followed to identify the environment and social sensitive features included professional judgments of the multi-disciplinary EIA team members and public consultation. The preliminarily identified environmental and social sensitive components are listed in sections below.

6.2. Valued Environmental Components

Valued Environmental Components (VEC's) identified in the study area are listed below:

1. Air Quality of the area
2. Noise level of the area
3. Water Quality of the area
4. Transportation system of the area
5. Ecosystem of study area
 - a. Naithang River Forest
 - b. Naf River
 - c. Aquaculture pond

Identified VEC's of the project are likely to be impacted due to development of the off-site facilities during the the pre-construction, construction and operation stages of the project along with the Project activities which may have an impact on the VEC's and the associated impacts are listed below. The detailed impact identification and mitigation measures are given at Chapter 7.

Table 30: Environmental Assets of the project area

S. No.	Environmental Assets	Impact	Related Project Activity
Pre-Construction & Construction Phase			
1	Air Quality of Study Area	Degradation	Site clearance/ preparation Construction activities Excavation Exhaust from construction vehicles/machinery
2	Noise Level of Study Area	Increase in Noise levels	Construction activities Movement of construction vehicles/machinery
3	Transportation System	Traffic congestion	Increased nos. of vehicles carrying construction raw material and construction debris
4	Fisheries of Study Area	Filing up of the aquaculture ponds/small water bodies Increased sedimentation of water body	Construction of borewells Increase in run-off from construction/excavated site
5	Biodiversity study of project area	Increased sedimentation of water body	Increase in run-off from construction/excavated site

Operation Phase (For Off-site Developments Only)			
1	Noise Level of Study Area	Increase in Noise levels	Increased traffic movement and tourism activities
2	Transportation System	Traffic congestion	Increased nos. of vehicles due to tourism activities till the inland port. There will be a construction of hanging bridge which can be used for movement of people from inland port to site location.
3	Fisheries of Study Area	Degradation of fisheries	The construction activities may impact fisheries in the project area of influence. The construction activities shall also lead to filling up of aquaculture ponds present in site area.
4	Eco-system of Study area	Degradation of Water Quality & Aquatic ecology	Discharge of untreated solid and liquid waste

6.3. Environmental Hotspot

The proposed EZ is abutted by Naf River on all sides and Naithang River Forest is located at approximately 2 km from the proposed EZ location in the western direction. The primary field survey, secondary information available and stakeholder discussions, indicated that there are mangroves at the along the periphery of the site location. There are trees of other species as well at the proposed site location. These are:

Table 31: Trees at the proposed EZ site

Tree Name	No of trees
Akashi	531
Jhau	215
Neem	6
Peepal	30
Cocount	94
Mango	1
Bam	4

Teknaf wildlife sanctuary is approximately 2-3 km from the proposed EZ. It comprises an area of 11,615 hectare. This is one of the few places in Bangladesh where Elephants can be seen in the wild. It was established in 1983 as a sanctuary to protect wild Asian Elephants. This vast sub-tropical forest has several other attractions like Nitong Hill, Kudum Cave, Kuthi Hill etc.

Naithang Reserve forest is approximately 2 km from the proposed EZ location. Himchari National Park is approximately 55 km from the proposed EZ. It is 5 kilometers south of Cox's Bazar and is a 1729-hectare reserve bordering the Bay of Bengal. It is well-known waterfalls. The several sites in Himchari National Park have been concessioned for management by the private sector, including the waterfall with a footfall of close to a lakh tourists every year. It is managed by the Forest Department.

6.3.1. Mangroves fringing the Island

The island consists of clay and sand, and the only protection from being eroded by river currents are the mangrove trees that surround the island. At some parts at the southern end of the island, the mangroves are already depleted (cut by fishermen who need to access their fish ponds), thus exposing the earthen dam.

6.4. Likely Beneficial Impacts

The project involves development of EZ and off-site facilities. It is proposed to develop tourism at the proposed EZ. Vicinity of the site to other tourist places such as Saint Martin island, Sabrang beach etc. further adds to economic development of the area. The likely benefits from the proposed development are listed as below:

1. Rapid Economic development
2. Large scale direct and indirect employment generation
3. Development of infrastructure facilities
4. Technological enhancement for management of environmental management (like water treatment, waste management, environmental monitoring)

6.5. Community Recommendations and Alternative Analysis

The details of the community recommendations and alternative analysis options are detailed in SIA report and brief summary of the same is provided in chapter 8.

7. Impacts Assessment

The environmental impact assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities. The proposed project involves development of EZ for tourism and off-site facilities. Potential environmental impacts associated with EZ and each of the proposed off-site facility are classified as:

- impacts during design and construction phase and
- impacts during operation phase

Sensitive environmental components were identified during the site visits and qualitative and quantitative techniques have been applied for direct and indirect assessment of impacts on these components. The classification of environmental components is provided in Table below.

Table 32: Classification of Social and Environmental Components

Components	Sub-component	Parameters
PHYSICAL		
Water	Surface water	Hydrology, water quality
Air	Ground water	
Land	Air, noise	Air quality, noise level
	Soil	Erosion, soil quality
ECOLOGICAL		
Aquatic	Fisheries/ Aquatic species	Species, diversity, economic value
Terrestrial	Aquatic Biology	Density, species
	Forests, Vegetation	Species, population
	Wildlife	Species, population
INFRASTRUCTURE		
Water Supply	Surface/ground water	Frequency, quality
Electricity	—	Generation, Transmission, requirement,
Transport	Highways/Roads	Access, availability, type, utility of each mode
Land use	Rail	
Drainage	Air	
	Water	—
		Flooding, drainage

7.1. Impact Identification

During the site visit, various environmental sensitive features were identified which may potentially be impacted by the project at various stages. Identified impacts of the project activities on the environment components are given below along with the associated activities.

Table 33: Impact Matrix for Proposed Off-site Infrastructure

S. No.	Activities	Impacts	Negative Impact		Positive Impact		Not Applicable
			Short Term	Long Term	Short Term	Long Term	
A	Pre-Construction Phase						
i	Land Acquisition	• Impact on livelihood					√

ii	Site Preparation	Removal of Vegetation. Loss of tree cover and Impact on aesthetic aspects	√				
B Construction Phase							
i	Development of EZ and Construction of embankment, admin building, electrical and water supply system	Loss of Top soil		√			
		Soil contamination due to spillage of material	√				
		Surface water contamination	√				
		Air pollution	√				
		Noise pollution	√				
		Increase in traffic	√				
		Un pleasant view	√				
		Impact on Health & safety	√				
		Social impact	√			√	
		Impact on biodiversity			√		
		Felling of Trees		√			
C Operational Phase							
i	Development of Off-site Infrastructure, i.e. hanging bridge, embankment, water supply system, electrical supply line and administration building and tourism development	Impact on the ambient Air Quality	√				
		Noise Pollution	√				
		Potential for surface water pollution due to waste discharge		√			
		Impact on river hydrology due to construction of long embankment along the river		√			
		Economic Development				√	
		Accessibility				√	
		Groundwater depletion		√			
		Potential for land contamination due to tourism activities	√				
		Improved drainage				√	
		Electrification of the area				√	
		Improved health and sanitation facilities				√	
		Increased Run-off		√			
		Generation of Employment				√	
		Natural drainage pattern	√				
Impact on biodiversity		√					
ii	Green Buffer development around each industrial plot	<ul style="list-style-type: none"> Improved Ecology Air Quality Improvement Aesthetics 				√	√
						√	

7.2. Impact on Air Environment

7.2.1. Impacts on Air Environment during Pre-construction Phase

The pre-construction phase will involve site clearance activity for development of EZ which will lead to fugitive emissions. But these emissions will be localized and have impact for short duration only during clearance activity.

To minimize the dust generation, water should be sprinkled regularly at the site and low sulphur diesel should be used in land levelling equipments to control the SO₂ emissions.

7.2.2. Impacts on air environment during Construction Phase

The proposed project involves construction activities which includes:

- site development (land filling, earth work);
- civil construction;
- construction of embankment along the river;
- Construction of hanging bridge;
- construction material handling and stockpiling; and
- Transportation of construction material, equipment and labours.

The roadway will be used for transport of material till the neval embakment and the last mile transport will be through waterway. Air quality will be impacted from the following sources during the construction phase:

- Fugitive dust emissions from site clearing, excavation work, cutting and levelling work at sites and access/ internal roads, stacking of soils, handling of construction material, transportation of material, emission due to movements of vehicles, plying of heavy construction machinery etc.;
- Vehicular emissions during transportation by roadway;
- Engine emissions during transportation by waterway;
- Exhaust emissions from construction machineries, other heavy equipment as bull dozers, excavators, compactors; and
- Emissions from diesel generator required for emergency power during construction period.

Gaseous emissions containing PM₁₀, PM_{2.5}, SPM, CO, HC, NO_x, SO₂ and lead will be released from the vehicles, construction equipment and dredger exhaust. The movement of heavy trucks also increase the potential for road accidents.

Mitigation Measures to be implemented are:

To mitigate the construction phase impacts, BEZA should have contract agreements with contractors as well as sub-contractors to implement the measures provided in EMP.

- Sprinkling of water at construction site and haul roads
- Minimizing stockpiling by coordinating excavations, spreading, re-grading, compaction and importation activities
- Cease or phase-down work if excess fugitive dust is observed, investigate source and take suppression measures such as water spray
- Adequate parking space should be provided for the construction vehicles so as to prevent idling of the vehicles and the emissions generating from them
- Vehicles carrying construction material and debris should be covered with tarpaulin cover

- Raw materials, excavated soil and other debris should be stored under covered sheds or cover with tarpaulin
- Green buffer should be developed all along the EZ boundary
- Provision of face mask to workers to minimize inhalation of dust particles
- Construction vehicles and machinery should be regularly serviced and check for pollution control
- Low sulphur diesel should be used for running construction equipment and vehicles
- Covering the scaffolding (in case of administration building) to reduce the dust emission in outside environment
- Speed of vehicles on site is recommended to be 10-15 km/hr which will help in minimizing fugitive dust emissions due to vehicular movement
- Vehicles should be checked regularly for PUC as per DoE standards
- During transportation of materials and equipments by waterway, low sulfur fuel should be used. The boat should not be kept idle and be implemented with latest emissions control technologies.
- During loading and unloading of material and equipment at the ship, the engine should be switched off.

7.2.3. Operation Phase

Post development of the EZ, the major source of air emissions will be the emissions from DG set and increase in vehicular movement. Generally, DG sets and vehicular emissions emit high level of NO_x, carbon monoxide (CO), hydrocarbons, and particulate matter. However, the nearest settlement is far away from the proposed site location and hence the impacts will not be significant.

Mitigation Measures

- Provision should be made for peripheral green belt all along the EZ boundary. Green belt should have minimum of three rows of local variety of tree. Tree species should be selected such that first inside row is of smaller height, middle row of tree is of medium height and last row of tree is of higher height so that green belt formed appears like a canopy.
- Power Generators should be provided with stacks of adequate height ((calculated by $H = h + 0.2 * \text{Sqrt}(kVA)$ where h = height of building where generator set is installed and kVA is total generator capacity)) to allow enough dispersion of emission.
- Air pollution monitoring should be carried out quarterly at the EZ to check the air pollution level.
- Preference of usage of clean fuel like LPG, low sulphur diesel should be explored
- Energy conservation should be adopted by opting the alternate energy options like solar power
- Open burning should be prohibited.
- Vehicular checkpost should be established approximately 100 m from the proposed EZ to check PUC of vehicles. Heavy fines should be imposed for non-voilence.

7.3. Impact on Noise Environment

7.3.1. Impacts on Noise Environment during pre-construction and construction phase

Pre-construction phase will involve site clearance activity for development of EZ and utilities. The site clearance will involve removal of vegetation and land levelling activities. Operation of different machineries and equipments for construction activities, and regular traffic movement may generate noise during construction period. The heavy equipment, machineries, transportation and earthworks used for the construction activities are the major sources of noise. The roadway will be used for transport of

material till the naval embankment and the last mile transport will be through waterway. The naval embankment is approx. 400-500 m from the proposed EZ. It is envisaged that there will be an increase in traffic and thereby noise impacts on the receptors from the transportation of equipment, construction materials. The impact of noise generation on the settlements is not significant as the nearby settlement is far from the site area. However, the generation of noise shall impact the marine life. Studies show that intense sound produced by human-generated noise in the marine environment can induce a range of adverse effects on marine mammals. These effects include death and serious injury caused by hemorrhages or other tissue trauma, strandings, temporary and permanent hearing loss or impairment, displacement from preferred habitat and disruption of feeding, breeding, nursing, communication, sensing and other behaviors vital to survival.

Table below shows the typical noise levels generated by some of the construction equipment expected to be used during the construction phase. As seen from the Table, the local peak noise level for non-continuous construction activity may reach to as high as 96 dB(A), depending on the type of equipment. The impact, however, is expected to be temporary and localised.

Table 34: Noise levels generated by construction equipments (measured at 1 m distance)

Equipment	Noise Level (dB(A))
Earth Movers	
Front Loaders	72-84
Backhoes	72-93
Tractors	76-96
Scrapers, Graders	80-93
Pavers	86-88
Bull dozer	86-88
Excavator	84-86
Trucks	82-94
Material Handlers	
Concrete Mixers	75-88
Concrete Pumps	81-83
Cranes	75-86
Winch	85-88
Stationary	
Generators (in canopy)	71-82
Electric Saw	81-85
Wood Planer	81-85

Noise levels will have compounding effect when multiple equipments and trucks operate at the same time. Thus the actual noise level at the site and surroundings would be much more than given in the above table. However, due to the linear shape of site the large-scale concentration of construction equipment may not happen. Thus, compounding effect may not be very high.

Mitigation Measures

The following mitigation measures will be implemented to minimize potential noise impacts during the construction phase:

- Regular maintenance of equipment such as lubricating moving parts, tightening loose parts and replacing worn out components should be conducted;
- Machinery and construction equipment that may be in intermittent use should be shut down or throttled down during idle time;
- Acoustic enclosure will be provided for the DG set;
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby sensitive receptors as far as practicable;
- Honking should be avoided;
- Construction activity near the periphery should be avoided;
- Construction work should be carried out only during day time (from 8.00am to 6 pm); and
- Machinery to be used should comply with the noise standards prescribed by DoE.

To deal with noise exposure by construction workers in construction site, pocket guide by OSHA is helpful.

The following noise reduction measures are suggested in the pocket guide.

Reduce It: Reduce the noise by using the quietest equipment available. For example, choose a smaller, quieter generator.

Move It: Move the equipment farther away with the use of extension cords, additional welding leads, and air hoses. Noise levels go down as we increase our distance from a noisy object. Move the generator (example) farther away or face it in a direction that is away from where most people are working. If you are not required to be in a high noise area, move to a quieter area.

Block It: Block the noise by building temporary barriers of plywood or other on-site materials to keep the noise from reaching workers. Place a five-sided, oversized wooden box over the generator. Add fire-resistant acoustical absorbing material (foam) inside the box. If the generator sits on soil or sand, that will help absorb some of the noise.

At individual worker level, the construction contractor should be insisted to provide earmuffs to the workers exposed to high noise levels.

7.3.2. Impacts on noise environment during operation Phase

After development of offsite infrastructure and economic zone, the noise levels may rise due to vehicular movement upto naval embankment and tourism activities. The construction of hanging bridge will aid in movement of people from neval embankment side to proposed EZ. The major source of noise generation during the operation phase will be due to DG sets used for power back up and water pumps on the project site.

Mitigation Measures

- Pumps should be fitted in close room, preferably acoustic enclosure to reduce the noise generation
- Green buffer of 10 m should be developed all along the project boundary. Green buffer should compose of the 2-3 rows of plants of variable height and thick canopy so as to form continuous barrier. This will help in reducing the noise level significantly.
- Noise regulators must put a strong mandate and fine on vehicle operators which are not properly maintained, produce noise (silencers not proper).
- Proper greasing, periodic checkups for frictionless movements
- Workers exposed to excessive noise (operating engines in ships) should use appropriate PPE including ear plugs, muffs, or both when engineering or administrative controls are not feasible to reduce exposure.

7.4. Impacts on Water Environment

7.4.1. Impacts on water environment during pre-construction and construction phase

Impacts on Ground & Surface Water Resources

It is envisaged that the initial water demand of approx. 1-2 MLD will be obtained from two borewells planned to be installed at the site location. Based on the VES (Vertical Electrical Sounding) assessment done by DPHE in Teknaf on December 2012, DPHE identified a well grained fined to medium graded sand in deeper depths in Teknaf Upazila. The depth of these zones varied between 60-70m. Fresh water has been reported by DPHE in these depths. Deep pumping wells shall be installed puncturing these depths to abstract the initial demand of water. The tourism industry generally overuses water resources for hotels, swimming pools, golf courses and personal use of water by tourists. This can result in water shortages and degradation of water supplies, as well as generating a greater volume of waste water. Excess withdrawal of ground water may lead to depletion of aquifers. Thus, measures should be taken to minimize the water extraction by reducing water consumption and wastage.

The establishment of artificial embankments may impact the tidal flow. Thus, mitigation measures should be taken to minimize this impact.

Mitigation Measures

- Water for curing can be saved by carrying out curing in early morning or late evening and covering structures with gunny bag so as the moisture can be restored for longer time.
- Regular inspections at site to monitor leakages in water storage tanks
- Care should be taken that construction of embankments will not alter tidal flow

Impact on Surface Water and Ground water Quality

The major source of wastewater generation during construction phase is from the labour camp, which will be established for project construction activity. There is a potential for contamination of surface and groundwater resources resulting from improper management of sewage. The quality of water bodies could also be affected due to surface runoff from contaminated soil (soil contamination due to oil/ fuel spillage and leakages), particularly during monsoon season. The surface runoff carrying the loose top soil will lead to increased sedimentation in the receiving water bodies. Contamination to water bodies may also result due to oil spilling during construction activities and/or surface runoff from the construction site to the adjacent water body. Thus measures are required to be taken to minimize the surface water pollution.

Mitigation Measures

- Avoid excavation activities during rains
- Prevent piling up of excavated soil, raw material and construction debris at site by proper management and disposal
- Minimize run-off by using sprays for curing
- Maintaining appropriate flow of water sprinklers at site
- Construction of storm water drains along with sedimentation tanks with sand bags as partition as barrier for direct flow of run off to river.
- Construction of adequate nos. of toilets and proper sanitation system for workers to prevent open defecation along the river banks/water supply lines

- Construction of soak pits/septic tanks to dispose-off the domestic waste water generated from labour camps to prevent disposal of sewage in water bodies. Alternatively, collect labour camp sewage and connect to nearby municipal sewers;
- Proper collection, management and disposal of construction and municipal waste from site to prevent mixing of the waste in run-off and entering the sea
- Use of licensed contractors for management and disposal of waste and sludge;
- Labourers should be given training towards proactive use of designated areas/bins for waste disposal and encouraged for use of toilets. Open defecation and random disposal of sewage will be strictly restricted;
- Spill/ leakage clearance plan to be adopted for immediate cleaning of spills and leakages.
- There should be a containment tank installed of 1.5 times the HFO storage capacity in order to prevent accidental leakage of oil (source: fuel-oil piping and storage – ICC)
- Adequate management of the spent lubricant collection and disposal through contractors who are authorized to recycle or dump in landfills.
- Care should be taken that during transportation of construction material and equipments by waterway, there should not be any spills or leakages in the Naf river.

Impacts of dredging

BEZA has proposed to carry out landfilling with dredged material from the adjacent rivers. The dredged material is mostly sand except thin top layer. During the site visit, at certain places sand extraction (dredging) has been observed from the river. This material is stored on the banks of the river, which will be ultimately used as construction material. This sand has lot of demand and has economic value.

The possible physical impacts due to dredging on water quality are as follows:

- Resuspension of bottom sediments, thereby increasing turbidity
- Dispersion from and accumulation into bottom sediment of toxic substances
- Depletion of oxygen due to oxidation of organic matter
- Reduced primary productivity due to decrease in the depth of the euphotic zone
- Temperature alteration
- Increased nutrient levels

Earlier studies on effect of dredging in the estuarine environment indicate the following:

- Impact on fisheries, due to bottom disturbances and consequent increase in turbidity
- Bottom sediment disturbance: release of toxicant due to resuspension
- Increase in turbidity due to agitation in dredged sites is generally short-term, hence effects are localised and transient

Another Study indicates that there is a marked increase in metal concentrations in the sediments of downstream region of the dredging site in a water body, due to migration of suspended sediments along the water current. On the other hand, the build-up of metal concentrations in water due to resuspension of sediments is not reported to be appreciable, except for metals which form soluble sulphides.

The extent of impacts due to dredging activity is highly varied and site specific, depending upon a number of factors shown below:

- Method of dredging and disposal
- Channel size and depth
- The size, density and quality of the material
- Background levels of water and sediment quality, suspended sediment and turbidity

- Current direction and speed
- Rate of mixing
- Presence and sensitivity of animal and plant communities (including birds, sensitive benthic communities, fish and shellfish)

Mitigation Measures

The project proponent is advised to find out alternative filling material to avoid impacts due to dredging and save economic value.

In case where dredging is unavoidable, the following mitigation measures are proposed:

- Dredging should not impact natural drainage courses
- Dredging sites should be located away from sensitive locations
- Permission from concerned local body should be taken before finalizing the location
- Magnitude and frequency of dredging activity should be monitored to avoid impacts on the natural drainage
- Prior to dredging activity, analyse the soil sample to prevent impacts on the receiving environment as a result of mismatch in soil characteristics;
- During dredging activity, physical barriers such as silt screen/ curtains should be employed to prevent the spread of suspended sediments;
- Maintain the extent of the turbidity plumes close to the dredging and disposal areas to minimise impacts on marine fauna habitat;
- Visually inspect for any marine life and terrestrial organisms and stop dredging activity in case of any organism in the vicinity;
- Monitoring should be done continuously during dredging to observe impacts on the marine life and in case of visible impacts, stop the dredging activity;
- Dredging should be carried out during day time to minimize impacts on marine life

7.4.2. Impacts on water environment during operation Phase

It is decided to construct 2 bore wells within the site to meet the initial demand of 1 to 2 MLD. The development of economic zone shall lead to generation of mainly domestic effluent due to tourism activities. The direct discharge of untreated effluent shall lead to impacts on ground water quality. As per the stakeholder consultations, the groundwater level is shallow and toilets and soak pits depth penetrate the aquifer which further contaminates ground water. It can lead to increase in BOD which would further impact marine life. Also, it is anticipated that surface run-off may significantly increase post development of economic zone which may impact surface water quality. The following measures should be adopted during operation phase to minimize impacts of development of Economic zone on water quality:

Mitigation Measures

- No leachate, waste water and waste material should be stored in pervious unlined area/pond.
- STP should be installed onsite to treat sewage from all the units developed in the proposed EZ.
- Soak pits/ toilets should not penetrate aquifer and thereby contaminate ground water.
- Proper management of waste should be done to prevent any contact between the waste and storm water
- Storm water drains should be lined to separate from effluent drains
- Storm water system should be inspected & cleaned before monsoon every year
- Peripheral drain shall also be lined and shall not be connected to internal storm water drainage system.
- The top soil shall be preserved and used for covering the sand layer at EZ site. Vegetation turffing shall be made at the side slopes of the EZ areas to prevent erosion and siltation in the river.
- River water quality shall be monitored periodically

- Ground water quality shall be monitored periodically.
- Sludge should be dried into cakes and used as manure for green belt.
- Water recycling units should be installed to recycle grey water generated in the EZ.
- Eco-tourism should be promoted. Eco-tourism minimizes environmental impact as possible and helping to sustain the indigenous populace, thereby encouraging the preservation of wildlife and habitats when visiting a place. This is the responsible form of tourism and tourism development, which encourages going back to natural products in every aspect of life. It is also the key to sustainable ecological development. The development of eco-tourism will help to minimize the impacts on water resources.
- There shall be no concrete structures in the Jaliardip Economic Zone. High density of concrete structures releases heat which will impact the localized ambient temperature and can further impact the local biodiversity and most importantly the mangrove cover.
The economic zone shall have limited number of cottages for tourist to stay and relax. The material of construction selected by the developer shall be cognizant with the present ecological ambience of the island. It is recommended to have an ecological expert especially for this site to validate the materials selected by the developer.

7.5. Impacts on Land Environment

7.5.1. Impacts on land environment during pre-construction and construction phase

The impacts on soil due to the project are as follows:

- Dredging and landfilling activity
- Soil erosion due to vegetation clearance and excavation activities;
- Topsoil degradation
- Generation of waste (hazardous and non-hazardous) from site clearance, excavations, civil works and activities of construction workers (general waste and sewage); and
- Possible contamination of soil due to potential spills of lubricating oil, fuel oil, concrete etc.

7.5.1.1. Soil Erosion

During the pre-construction and construction phase, the site clearance activities including clearing of vegetation, construction of the earth structures, labour camps, storage area, toilets will involve removal of top soil which will result in slope destabilization and the land will be more susceptible to soil erosion. The Boat docking/harbouring also leads to erosion of embankments.

The soil erosion will result in the run-off of the silt to surface water impacting aquatic ecosystem of receiving water bodies with increased suspended sediment load and associated nutrients.

7.5.1.2. Landfilling with Dredged material

The project site is located in low lying area and landfilling will be done during site development activity. Generally in Bangladesh, landfilling is done with dredged material. Dredging activity may be carried out near the site location or away from site. Dredging activity will have two fold impacts - firstly as a result of the dredging process itself and secondly as a result of the landfilling of the dredged material.

The soil quality in the dumping site may be affected if the dredged material is deposited on the banks or on low-lying areas for land reclamation. Analysis of dredged material at the upper stretch of the River, however, showed that it did not contain appreciable quantities of heavy metals or radioactive elements, minimizing the potential adverse impacts on the dumping site.

In case the soil quality at dumping sites is different from the sediment from the dredging sites, the ultimate soil quality of the disposal site can be affected.

The soil used for landfilling should be free of any type of contamination and have similar characteristics as that of native soil to avoid impacts on the soil quality.

7.5.1.3. Waste Generation

The construction waste generated onsite comprises of materials such as excavated soil, rocks, concrete, wooden pallets, steel cuttings/filings, packaging paper or plastic, wood, metals etc. Municipal domestic wastes consisting of food waste, plastic, glass, aluminum cans and waste paper will also be generated by the construction workforce and labor camp site. The waste generated during the construction phase will also include hazardous waste such as used oil, hydraulic fluids, waste fuel, grease and waste oil containing rags. If improperly managed, solid waste could create impacts not only to land but also to local air quality, water quality, and human health. It is expected that the generation of the waste oil will be insignificant as the DG sets will be used during the construction phase and the waste oil will be generated only during the maintenance of DG sets.

7.5.1.4. Soil Contamination

Soil contamination during the construction phase may result from filling activity, leaks and spills of oil, lubricants, or fuel from heavy equipment and wastewater. Such spills could have a long-term impact on soil quality, but are expected to be localized. The soil at project site is clay. The soil strata has higher permeability, thus allowing contamination at greater depth. Storm water run-off from the contaminated area can pollute the downstream soil and water quality of receiving water body. Spill control measures such as the storage and handling of chemicals and fuel in concrete areas with secondary containment will be implemented to minimize impacts in the event of a spill.

The soil characteristics of the native soil may also be changed due to import of soil for filling and levelling purpose. It is envisaged that the filling activity may impact the native soil due to spillages during transportation of soil and run-off during filling and compaction. Apart from the embedded controls to be included in project design, the following mitigation measures will reduce the negative impacts of construction activities on soil environment:

Mitigation Measures

- Stripping of topsoil should be scheduled as the last mile activity (maintain vegetation cover for as long as possible) in order to prevent the erosion (wind and water) of soil;
- Care should be taken to minimize percolation of soil used for filling to adjacent rivers during filling operations. Proper embankment may be provided in the downstream areas to minimize soil percolation to rivers.
- Vegetation should be planned and maintained for slope stabilization and to prevent soil erosion after construction period;
- The disturbed areas and soil stock piles should be maintained moist to avoid wind erosion of soil;
- The routes for movement of heavy machinery should be designated to avoid the soil compaction in other areas;
- A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board, will be maintained;
- Transport vehicles and equipment should undergo regular maintenance to avoid any oil leakages; designate routes for bringing construction material and outside soil;
- Construction contractor should designate the sites to be used for disposal of hazardous wastes including waste oils, solvents, paint and batteries. The Contractor should ensure that no unauthorized dumping of hazardous waste is undertaken from the site;

- Fuel and other hazardous substances should be stored in areas provided with roof, impervious flooring and bund/containment wall;
- For landfilling, dredging should be carried out considering above mentioned factors in dredging section and cause least impact on the environment;
- The soil used for landfilling should have similar characteristics to the native soil and free of any type of contamination;
- Prior to dredging activity, analyse the soil sample to prevent impacts on the receiving environment as a result of mismatch in soil characteristics;
- During dredging activity, physical barriers such as silt screen/ curtains should be employed to prevent the spread of suspended sediments;
- Maintain the extent of the turbidity plumes close to the dredging and disposal areas to minimise impacts on marine fauna habitat;
- Visually inspect for any marine life and terrestrial organisms and stop dredging activity in case of any organism in the vicinity;
- Monitoring should be done continuously during dredging to observe impacts on the marine life and in case of visible impacts, stop the dredging activity;
- Dredging should be carried out during day time to minimize impacts on marine life.
- There should be well demarcated zones for boat harbouring/ docking.
- No soil cutting activity should be allowed at the periphery of the proposed EZ.
- After landfilling, if the land is kept for long without further development, it leads to soil erosion due to loose top soil.

7.5.2. Impacts on land environment during operation Phase

7.5.2.1. Impact on Soil Quality

During operation phase, tourism will lead to generation of solid waste comprising of biodegradable, non biodegradable, hazardous and inert waste. The sewage sludge will also be generated from the sewage treatment plant and needs to be disposed off. The improper disposal of solid waste shall cause contamination of soil, ground water, surface water and air quality. Solid waste, if disposed improperly shall cause following impact on the environment.

- Ground water contamination by leachate generated due to improper dumping
- Surface water contamination by the run off from the waste storage in the EZ
- Bad odor, Pests, rodents and wind blown litter in and around the waste dumping site
- Generation of inflammable gases (e.g. Methane)
- Fires within the waste dumping
- Erosion and stability problem relating to slope of the dumping site
- Epidemic through stray animals
- Increased concentration of acidity in the surrounding soil
- Release of green house gases
- Impacts may also result from improper siting, inadequate design and poor operation

Mitigation Measures

- Provision should be made for proper storage and disposal of waste generated due to tourism and maintenance activities.
- Waste should be segregated at source into hazardous and non hazardous waste. Further the waste should be segregated into recyclable and rejected waste. Options should be explored for using the recyclable waste in the processes to close the loop.
- Any hazardous waste generated shall be stored at designated place and then disposed through the TSDF using high temperature incineration or any other chemical, thermal, biological, and

physical methods. Chemical methods include ion exchange, precipitation, oxidation and reduction, and neutralization.

- Sludge generated in effluent treatment plant should be sold to authorized recyclers.
- A site waste management plan should be prepared prior to project commencement. This should include designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site, and system for supervision and monitoring.
- Vegetation and combustible waste must not be burnt on the site.
- Eco-tourism should be promoted. The development of eco-tourism will help to minimize waste production and pollution, thereby minimizing the impact on land environment.
- There shall be no concrete structures in the Jaliardip Economic Zone. High density of concrete structures releases heat which will impact the localized ambient temperature and can further impact the local biodiversity and most importantly the mangrove cover.
- The economic zone shall have limited number of cottages for tourist to stay and relax. The material of construction selected by the developer shall be cognizant with the present ecological ambience of the island. It is recommended to have an ecological expert especially for this site to validate the materials selected by the developer.

7.6. Impacts on Biodiversity

The proposed site is abutting the Naf river at all the sides. During site visit, mangroves were observed at the periphery of the site. Different species of fishes are also observed in the river abutting the site boundary. The disposal of waste or disturbance to natural ecosystem shall impact the fishes and mangroves.

There are different varieties of trees found at the proposed EZ location. For site development, it is required to fell some trees and bushes. The cutting of the trees shall disturb the eco-system and the natural habitat of the organisms. Also, discharge of waste in the Naf river, shall also impact the marine life. Transportation through waterway shall generate noise and air emissions which will also impact marine life.

Post development of the economic zone, tourism activities shall also impact the ecosystem of the area. Tourism activities will involve generation of some emissions, effluents and waste. These altogether may have overall negative impact on the eco-system of the site and the nearby areas as the air pollutant will impact the existing vegetation and avifauna in the area. If appropriate measures for preventing air, water, soil and noise pollution are taken there will be no significant impact on the eco-system of the area. Therefore, appropriate mitigation measures should be taken to minimize the impacts on biodiversity.

Mitigation Measures

- EZ development should be planned in such a way to avoid or minimize tree cutting
- Twice the nos. of trees to be fell should be planted as compensatory plantation in affected areas to minimize the impact on the eco-system
- No littering of waste should be allowed and waste should not be discharged in water bodies
- Avoid construction activities on the periphery of the island
- Do not carry out any construction activity during night time
- Green buffer should be planned all around the project site which should include the native plant species to the extent possible, which will significantly improve the ecology of the area.
- Periodic monitoring should be carried out as per the monitoring plan for air, water, noise and soil and ensure that no impact due to project activities.
- Tree survival rate should be monitored
- Non-native species should not be introduced in the Naf river
- Tourist activities should be stopped after 7 pm.
- Reduction or banning of over/destructive fishing, extending alternative fishing and rehabilitation and exploitation of mangroves

- Cutting of mangrove should be prohibited. Heavy fines should be levied for cutting of mangroves
- No use of push nets in mangrove core protection
- Mangrove habitats should be separated from human activity
- Restricted vehicular entry in mangrove habitats.
- Limited use of destructive fishing gear in estuarine and near-shore area of the site
- The disposal of untreated waste water, oily water from boats or solid waste into the Naf river be should be strictly prohibited.
- The development of EZ should not impact the natural characteristic of Naf river both during construction and operation phase.

7.7. Impacts on Agriculture resources

7.7.1. Impacts on agricultural resources during pre-construction and construction Phase

No agriculture land is proposed to be acquired for development of proposed off-site activities as well the economic zone. Thus no significant impact on agriculture activities/resources is anticipated due to the project development.

7.7.2. Impacts on agricultural resources during operation phase

No impact on agriculture resources is anticipated from off-site infrastructure during operation phase.

7.8. Impacts on Fisheries

7.8.1. Impacts on fisheries during pre-construction and construction phase

The area demarcated for the development of the EZ has had 100 acres of land leased for undertaking pisciculture to 9 lease holder and subsequent to the expiry of the lease period, the land was transferred to BEZA on 31st May 2016. The land is not under any use presently.

Construction work including land filling by dredging, sand lifting, site clearance and physical construction of plant setup, may have impacts on open water fish habitats, fish diversity and hence to some extent on capture fisheries production. The project adopts waste management plan, so impact on fish habitat due to waste discharge would be minimum.

7.8.2. Impacts on fisheries during operation phase

The fisheries may get severely impacted due to untreated disposal of both solid and liquid waste in the river. Therefore effluent management system shall be implemented strictly. Fish kill may happen due to contamination of water due to discharge of untreated effluent. Effluent may contain toxic components like heavy metals etc which leads to fish poisoning and may lead to large scale fish death. Also fishes contaminated with these pollutants if consumed may affect the consumer health (birds/bigger fishes/humans).

Mitigation Measures

- Adoption of adequate wastewater and industrial effluent management technology so no untreated sewage is discharged into surface waterbody
- Industrial, municipal and hazardous waste should be managed such that no waste is dumped or disposed in surface water body

7.9. Impacts on Occupational Health and Safety

The lack of adequate mitigation measures on the health and safety of the workers will result in accidents and injuries leading to loss of life or property. It is proposed to implement the following mitigation measures to ensure safe work place for the construction labor.

Mitigation measures to be implemented are:

- The project owner should ensure that the contractor (make part of contractors contract) have and occupational health and safety plan. The contractor should provide for all the workers accidental insurance and medical insurance.
- The contractor should conduct daily tool box meeting for all workers to discuss potential work related hazards and other safety aspects.
- The contractor should conduct training for all workers on safety and environmental hygiene at no cost to the employees.
- The contractor should maintain first aid facilities for the workers and will instruct and induct all workers in health and safety matters (induction course) including construction camp rules and site agents/foremen will follow up with toolbox talks on a weekly basis. Workforce training for all workers starting on site will include safety and environmental hygiene.
- Fencing on all areas of excavation greater than 1m deep and sides of temporary works should be done. Workers should be careful while going to the beach area.
- Workers should be provided with appropriate personnel safety equipment such as safety boots, helmets, gloves, protective clothes, dust mask, goggles, and ear protection at no cost to the workers.
- Contractor should at all-time keep the first aid kit at the construction sites.
- Contractor should be responsible for evacuation injured person to the nearest medical center
- Pertinent H&S trainings should be provided to all the workers with respect to hazards linked to the activities. Additionally, the workers will be informed of precautions to be taken to avoid impacts to the local community;
- Monitoring of the PPE usage can be strengthened, in that, a mechanism can be adopted whereby defaulters receive a warning on non-usage and stringent actions can be taken on subsequent offences;
- Maintain H&S records of occupational H&S incidents, accidents, diseases and dangerous occurrences
- Ensure that PPE is available at all times at site;
- In event of accidents, the contractor will be responsible for immediate evacuation of injured person to the nearest medical center. The contractor should bear medical and other expenses of the injured person.
- Undertake daily tool box talk and proper training of the workers regarding health and safety procedures related to solar projects, PPE usage, and regulatory provisions;
- The contractors should ensure H&S standards of labour camps. The labour camps will be established in the proposed site area. Additionally, the PIU team should conduct random spot checks to determine any issues related to improper waste disposal or the living conditions in these camps (i.e. presence of secure shelter and flooring, number of persons per room, number of toilets for the manpower, water availability etc.);
- Additionally a “Code of Conduct” can be instituted for the operational phase that takes into account (a) health & safety aspects; (b) restrictions on activities – Dos and Don’ts; (c) labour camp regulations; (d) zero tolerance of illegal activities by construction personnel including: unlicensed prostitution; illegal sale or purchase of alcohol; sale, purchase or consumption of drugs; illegal gambling or fighting which will be shared with all contractors for induction of their employees/supervisors/workers;

- Strong protocols should be built as part of contractual obligations around zero tolerance of child labour or harassment of women workers and even health and safety aspects. These should also be monitored by supervision and monitoring team; and
- A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board, will be maintained

7.10. Community Health and Safety

Public safety, particularly of pedestrians and children can be threatened during construction activities. The health and safety (H&S) impacts related to the project can be categorized into two types- occupational health and safety and community health and safety. It is anticipated that the construction (including transport and handling), erection and commissioning and operational activities will have medium risks on both occupational H&S and community H&S aspects. The transportation of construction material and equipments via waterways shall also lead to accidents. The hanging bridge of 450 m will be constructed from naval embankment side to Jaliar dip. The plinth of the hanging bridge for anchorage is proposed to be on the ground at naval embankment side to jaliar dip. As per the information available from BIWTA, the depth of Naf river varies from 1-7 m near the proposed EZ location.

The mitigation measures that can be adopted are as follows:

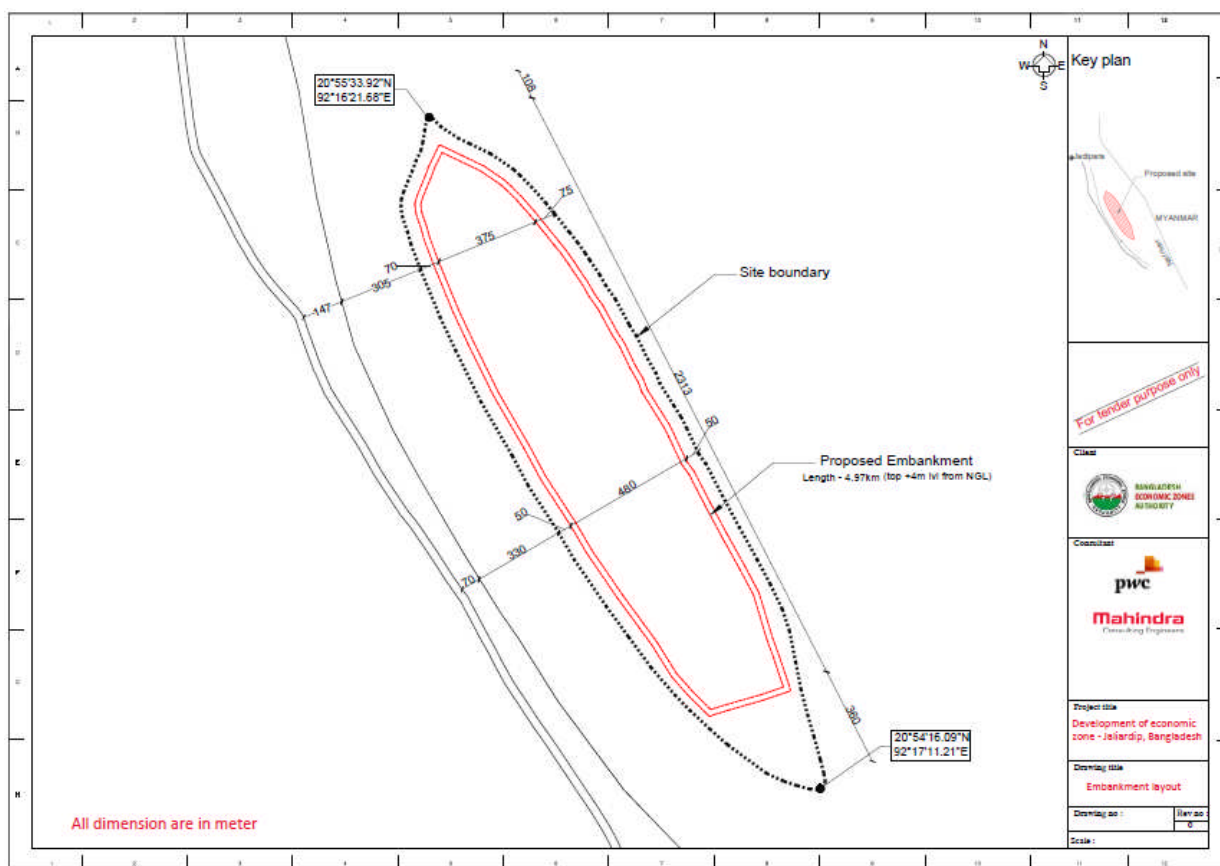
- Excavated trenches/ditches and freshly cut steep side slopes should be clearly marked and fenced for the safety of passersby and workers alike.
- The stability of the hanging bridge should be checked annually.
- There should be 2-3 m high fencing on both riverfacing sides of hanging bridge
- There should be security patrolling both during construction and operation phase
- There should be provision of emergency preparedness for rescuing from the river.
- The community must be informed of the type of activities being undertaken for the project and the health and safety measures that can be undertaken by them as a precautionary measure. Additionally, the emergency response plan must also be communicated to the villages in the vicinity
- Linkage of Communication, Disclosure and Grievance Redressal Mechanism should also cover labourers so that any concerns on working conditions and/or contractor mal-practices can be managed.

7.11. Cyclone Risk

The project site is an island and is abutted by Naf river at all its sides. As per the secondary information available, the site is prone to cyclone risk. As per the stakeholder discussions, during the pre-monsoon period, high speed winds flow at in the coastal region. As per ISA report, cyclonic storms occurring in the Bay of Bengal in April-May and October-November rarely penetrate as far as Comilla, but may cause serious damage to crops, livestock, assets, etc. Monsoon rains are generally not stormy. Rainfall of 50-75 mm per day are common and more than 250mm per day is occasionally experienced. The coastal region of Bangladesh is prone to mitigate multi hazard threats such as cyclones, storm surges and floods, as well as earthquakes and above all, climate change. It is frequently visited by the cyclone-induced storm surge.

Bangladesh very often becomes the landing ground of cyclones formed in the Bay of Bengal. This is because of the funnel shaped coast of the Bay of Bengal. Most of the damage occurs in the coastal regions of Khulna, Patuakhali, Barisal, Noakhali and Chittagong and the offshore islands of Bhola, Hatiya, Sandwip, Manpura, Kutubdia Maheshkhali, Nijhum Dwip, Urir Char and other newly formed islands. The coastal zone of Bangladesh is disaster prone. As observed during site visit, the proposed EZ has a level difference of 5 to 7 m (approx.) with a gentle slope towards South East direction with minor undulations. The entire site is located below the Maximum flood level. The embankment length of 5.60 km is proposed to be provided. The top level shall be +4 m from NGL as shown in figure below.

Figure 51: Embankment layout details



7.12. Sanitation and Disease Vectors

Potential sanitation and impacts from disease need to be controlled by maintaining hygienic conditions in the EZ area throughout the operational phase as well during construction by implementing appropriate social and health programs for the Project. BEZA should ensure that improvements are made to site sanitation and should implement the mitigation measure below for all operational activities and also that the contractor ensures that:

- Measures to prevent malaria should be implemented by installation of proper drainage to avoid water stagnation, etc.
- Standing water should not be allowed to accumulate in the drainage facilities or along the warehouse sides to prevent proliferation of mosquitoes.
- Temporary and permanent drainage facilities should be designed to facilitate the rapid removal of surface water from all areas and prevent the accumulation of surface water ponds.
- Malaria controls should be implemented in line with social plans for the Project.

HIV/AIDS awareness and HIV/AIDS education and prevention program should be implemented in line with social plans under the social development work stream.

7.13. Impacts due to Climate Change

Bangladesh is one of the most vulnerable countries to Climate change. The coastal region of Bangladesh is prone to multi hazard threats such as cyclones, storm surges and floods, as well as earthquakes and above all, climate change. It is frequently visited by the cyclone-induced storm surge. The site is abutting Naf river on all its sides, which possess cyclone risk alleviated by the impact of the climate change. As observed

during site visit, the proposed EZ has a level difference of 5 to 7 m (approx.) with a gentle slope towards South East direction with minor undulations. The entire site is located below the maximum flood level.

Global warming as a consequent of the Climate change will most likely increase the precipitation levels in the region thereby heightening the flood risk at the proposed site location. A warmer atmosphere can hold more moisture, and globally water vapour increases by 7% for every degree centigrade of warming. The impact of these changes on global precipitation has not yet been correlated academically, but the total volume of precipitation is likely to increase by 1-2% per °C of temperature increase. To mitigate the risk of flooding it is proposed to provide an embankment along the periphery of the project site.

Existing Mangrove forests at the periphery of the site are valuable ecosystems for environmental protection by playing an important role in disaster prevention and socio-economic development. Mangrove forests along the fragile coastline act to reduce the negative impact of flooding and other harsh weather conditions. These forests also mitigate the negative impacts of climate change, which is predicted to be especially severe for Bangladesh according to climate change specialists

7.14. Cumulative Impacts

The cumulative impacts of the development of EZ will be both negative and positive. The cumulative positive impacts of the project will result in increased mobility, employment generation, and above all better economic integration of the area with the major market and trade centers within and outside the districts. The project will also help in increase of Government revenue. The negative impacts of the project will include pollution as tourism can cause air emissions, noise, solid waste and littering, releases of sewage, oil and chemicals, even architectural/visual pollution. It can also lead to destruction and alteration of Ecosystem. The habitat of flora and fauna can be degraded by tourism leisure activities. For example, cruise activities can bring about stress for the marine life and alter their natural behavior when tourists come too close.

7.15. Impactss on socio-economic environment

The impacts on socio-economic environment are negligible as the proposed project will not entail any resettlement or livelihood loss.

8. Public Consultation and Disclosure

8.1. Introduction and Objectives

This section provides the stakeholder identification and analysis as well as a brief understanding of the engagement process for the project. “Stakeholder Analysis” is understood as the process of identifying the individuals or groups that are likely to affect or be affected by a proposed project, and sorting them according to their impact on the project and the impact the project will have on them. This information is then used to assess the manner in which the interests of the stakeholders should be addressed in the project plan, policy, program, or other action.

The identified stakeholders comprise of project beneficiaries, executing agency, especially the officials in BEZA, Upazilla office, Union office, UNO office, Upazila/Union Chairman and Land Acquisition Officer at the DC office, Cox’s Bazar.

8.2. Methodology of Stakeholder Consultations

Different techniques of consultation with stakeholders were used during project preparation, viz., in-depth interviews, public meetings, group discussions, Individual Consultations etc. to understand the socio-economic profile of the community and the affected families, questionnaires were designed and information was collected from the individuals on one-to-one basis. Stakeholder consultations within the subject site and the project area of influence are an important method of involving various stakeholders particularly, local community with reference to the proposed development initiatives. It provides a platform and also an opportunity to share and express mutual views, concerns and apprehensions that might affect positively or negatively. The effectiveness of participation and consultation is directly related to the degree of involvement by the local stakeholders and the local community and integration of outcome of consultations wherever feasible in the proposed development initiatives. Detailed planning is required to ensure that local stakeholders, local community, interested groups, non-governmental organizations, civil society organizations; local government, line departments, etc. are consulted regularly, frequently and purposefully during different stages of the project including project preparation.

Individual discussions was conducted with 4 person who were available for interview in the vicinity of project site. The discussions indicated the support of the local stakeholders for the development of the EZ hoping the development of the EZ shall provide them some sort of a permanent source of earning livelihood. They expressed their requirement for a job which is secured and permanent. They were in support of the development of this EZ as it can fulfill their basic requirements of safe and secured permanent earning source.

8.3. Details of Public Consultations Meetings

The public consultations in the form of local and focused group discussions were carried out during site visit. The extent of likely adverse impacts was one of the major criteria for deciding the locations of public consultations. Types of consultations done with various participants using various tools including, interviews with government officials, individual consultations, and stakeholder consultations which are presented in below table:

Table 35: Types of Consultations

Level	Type	Key Participants
Individual	Local level Consultation	People staying in the vicinity of the project site
Group	Stakeholder Consultations	People who are important stakeholder of this project and the proposed activity proposed

Suggestion obtained from people and their representatives have been analyzed based on technical and economic feasibility.

Table 36: Details of Consultation

Location	Date	Participants	Issues Raised	Suggestion form Participants	Mitigation Measures
Project Site	14/05/2016	4	<ul style="list-style-type: none"> Will there be any preference in the employment opportunities and the permanent source of livelihood for the local stakeholders. Will the source of livelihood also assure job security? Will be there any scope of employment from the time of construction phase of the project for females also security especially for the female workers 	<ul style="list-style-type: none"> Starting from the construction phase, local stakeholders should be prioritized for employment Women should be provided with equal employment opportunities; Proper arrangements of lights, security guards both males and females should be ensured 	<ol style="list-style-type: none"> Trainings shall be provided. Depending on person's talent and interest, choice shall be provided for person to choose; Women members should be provided with equal opportunities. There should be policy for close to equal gender systems in the working group. Security systems needs to be really good. Identity cards shall be issued to each and every working person with an unique identity numbers. The security system shall have equal numbers of male and female guards. The area starting from the Bandar area shall be properly lighted up.
Boat Operators (project influence area)	14/05/2016	4	<ul style="list-style-type: none"> What will be the impact of the hanging bridge on the livelihood of boat operators? Will they be also eligible for employment opportunities 	<ul style="list-style-type: none"> The hanging bridge should be used only for pedestrians The boat operators should be eligible for opportunities to work in the different phases of the EZ The resorts need to have tie-up with the boat operators for ferrying the tourists 	<ol style="list-style-type: none"> The connector bridge will be opened for only pedestrians. Transfer of construction materials, food items and other logistics will require the use of mechanized boats Tourists will also be interested in having a round trip of the island on a boat and also there

					<p>will be many tourists who will like to cross the river to the island on boats</p> <p>3. The resorts will be encouraged to engage with the existing boat operators for ferrying of the tourists</p>
<p>Youths of Teknaf and Nhilla Union</p>	<p>14/05/2016</p>	<p>6</p>	<ul style="list-style-type: none"> The youths questioned about their chances of getting employment There were people who are educated and will like to approach for administration related work profile What are the various opportunities that they can approach for 	<ul style="list-style-type: none"> The youths were concerned that whether people who doesn't have any experience will get an opportunity to get trained and then work in par with the people who have experience They youths enquired whether there will be different work profile for people are educated and if someone has some prior experience 	<ol style="list-style-type: none"> The youths will be provided earning opportunities. They will be provided the opportunity to get trained. Experienced and learned people from different sectors shall be appointed to provide classroom lectures and on-field applications to these people so as to make them competent and trained for a particular work profile The jobs provided shall not be under contract phase. Permanent employment shall be provided with a valid identity card
<p>Upazila Parishad Chairman and Upazila Nirbhaya Officer, Teknaf</p>	<p>15/05/2016</p>	<p>4</p>	<ul style="list-style-type: none"> The expected commencement of operation of the EZ How the electrical connections and arrangement for water be made The EZ should be developed keeping in mind the opportunities for local stakeholders Impact on the Mangrove Trees which are present all around the peripheral area of the site 	<ul style="list-style-type: none"> The Upazila Parishad Chairman extended full support for this project. The officials requested the facilitator to keep them updated about the developments happening on the EZ planning activities. Specially appointed night guards should be ensured for the security. Planning shall be made to isolate the mangrove tree cover. Mangroves are rare and the officials demanded to design the infrastructure in such a manner that will cordon the sheath of mangrove 	<ol style="list-style-type: none"> The local government bodies shall be timely informed about the project developments Employment opportunities commensurate with the skill of the local workers The planning design shall be prepared in such a manner such that the impacts on mangroves are minimal

				trees around the peripheral zone of the site	
Women Population at Teknaf and Nhilla Union	15/05/2016	7	<ul style="list-style-type: none"> • Will the women of the community get equal opportunity like the men to get involved in the developmental activities of EZ • With the construction activity will result in influx of many migrants from outside stations. How their security be assured • Will they be also get an opportunity to learn, get trained and work during the beginning of the construction activities of EZ 	<ul style="list-style-type: none"> • The safety and security of the people especially the women shall be assured. There will be so many migrants during the activities of EZ, safety and security should be ensured • Women shall be trained. They shall be provided equal opportunities for employment from the beginning • There shall be no gender bias and people belonging to the Teknaf and the Nhilla Union shall be given priority 	<ol style="list-style-type: none"> 1. The safety and security of the women population from tourists will be of the utmost priority. Male and female police shall be deployed to do patrolling when the activities begin in the EZ 2. Women shall be provided with equal opportunities. No gender bias shall be made. Trainings shall be provided based on person's interest. 3. Priority for employment shall be provided to the local Teknaf and Nhilla Union men and women.

8.4. Consultation outcomes

The stakeholders during the consultation were found to be enthusiastic and none of the associated were apprehensive with the onset of an EZ project at Jaliadip. The stakeholders expressed that the development of the Economic Zone will bring social and economic development in the region providing permanent source of income along with job security. There is paucity of employment opportunities and health facilities in the region and villagers tend to travel long distances to Chittagong for better medical facilities which is affecting overall social and economic development. The leaseholders being aware of the fact that their lease period is getting over by the end of this year were also positive with the onset of this EZ as it could open new and better opportunities of businesses for them.

Caretakers expressed their desire to get a permanent and secured source of livelihood for them as well for their families. They also mentioned whether they will be trained and whether they will be eligible for skill development oriented training program etc. The concerns were answered during the consultation process. Further, the analysis of the key positive impacts, apprehensions and the suggestions/recommendations as documented during stakeholder consultations are detailed in below table.

Table 37: Positive Impacts perceived by the Stakeholders

Positive impacts perceived by the stakeholders
<ul style="list-style-type: none"> • Increase in direct and indirect employment opportunities for both the genders
<ul style="list-style-type: none"> • Enhancement of basic amenities
<ul style="list-style-type: none"> • Improvement in access to market centers, educational institutions, healthcare facilities, and offices located in Teknaf Upazila
<ul style="list-style-type: none"> • The cumulative positive impacts of the project will result in increased mobility, employment generation, and above all better economic integration of the area with the major market and trade centres within and outside the Upazila

- The setting up of a resort or a hotel will attract more tourists and it would invariably result in higher demand for fresh water food. Thus, with the influx of the tourists will boost the supply of fresh water fishes and thus improve the socio-economic status of the local people

The negative impacts perceived by the stakeholders are provided in below table.

Table 38: Negative Impacts perceived by the Stakeholders

Negative impacts perceived by the stakeholders	
•	With the onset of construction activities especially on an island abutted by a river, the ecology of the river might have an impact
•	With the onset of construction activities, many construction materials shall be transported to the inland. Stakeholders expressed their concern for the peripheral cover of Mangroves..
•	The developmental activities could also pollute the Naf River. Presently the river doesn't have much sources of pollution but with the beginning of the construction activities and finally with the operational phase, the water quality parameters of the Naf river can degrade which will impact the river ecosystem upon which many people depend.

Figure 52: Photographs of Stakeholders Consultation

Individual Consultations, Stakeholder Interactions and FGDs were conducted for this project with people linked directly with the project and the site and indirectly associated. Looking at the future set of work and activities, youths and women population were also targeted.

Individual discussions



Stakeholder consultation being conducted with the Upazila Nirbhaya Officer, Teknaf at his office.



Stakeholder consultation being conducted with head of Bangladesh Fisheries Research Institute, Cox's Bazar



Stakeholder consultation being conducted with District Forest Officer, Cox's Bazar.



Stakeholder consultation with the Upazila Nirbhaya Officer, Teknaf at his office.



Stakeholder consultation with Land Acquisition Officer, District Commissioner's Office, Cox's Bazar.



FGD with the youths of the Teknaf and Nhilla Union people



Individual discussions with the Taknaf Union People



Stakeholder consultation with the Upazila Parishad Chairman, Teknaf at his office



9. Environmental Management Plan and monitoring indicators

9.1. Introduction

This section outlines the suggestive mitigation measures, monitoring and management responsibilities during the construction, and operational phases of the project.

The purpose of EMP is to:

- List all suggested mitigation measures and control technologies, safeguards identified on generic understanding of the impacts;
- Provide an institutional mechanism with well-defined roles and responsibilities for ensuring that measures identified in EIA designed to mitigate potentially adverse impacts, are implemented;
- Provide project monitoring program for effective implementation of the mitigation measures and ascertain efficacy of the environmental management and risk control systems in place; and
- Assist in ensuring compliance with all relevant legislations at local, state and national level for the Project.

The EMP will reduce adverse environmental impacts and help BEZA in complying with environmental standards and regulations of the Department of Environment, Bangladesh.

9.2. Mitigation Plan

9.2.1. Preconstruction Operations

Trees lost during land clearance: There are many trees in the site area. BEZA should make lay out plan such that cutting of maximum number of trees is avoided. To compensate the cutting of trees, plantation activity shall be planned. The plantation should be more than twice the number of trees cut in the site. The types of trees to be planted should be similar trees which are existing on the site at present. The tree plantation should be followed by maintaining for at least 3 years.

Disposal of debris resulting from tree cutting will also pose problem. BEZA has to obtain permission to fell trees from appropriate authorities. The contractor has to auction the felled trees and clear the debris.

Cut and fill operations: As mentioned earlier BEZA has proposed to carry out landfilling with dredged material from the adjacent rivers. Since sand is used in construction industry and has economic value, BEZA should carry out a cost benefit analysis between dredged material and outside filling material before finalising on dredged material.

In case of the dredged material is used for filling, ships will carry the dredged material to the site area. In any case, the following general measures may be adopted:

- In both cases, shortest possible route should be selected for transporting the material and densely populated settlements may be bypassed as far as practicable.
- If the material is dusty the containers should be covered
- The trucks used for transportation should meet exhaust (Schedule 6 – ‘Standards for Emission from Motor’ of The Environment Conservation Rules 1997 (Amended 2002); and noise emission standards

as per Schedule 5 – ‘Standards for sound originating from Motor Vehicles or Mechanised Vessels’ of The Environment Conservation Rules 1997 (Amended 2002).

- To avoid fugitive dust, water may be sprayed at the places where vehicles are moving

The exposed soil after cut and fill operation in the site may pose soil erosion danger. The run off through exposed soil may increase suspended solid levels in adjacent Naf River. The cut surface which is not covered with construction is expected to be naturally stabilised over time. However, to reduce short term impacts, hard grass may be grown on the cut surfaces.

9.2.2. Construction Activity

The following are the major construction activities:

- Construction of embankment along the river
- Construction of Hanging Bridge
- Construction of administrative building
- Bore holes and pumping station
- Construction of power lines and substation

Air Environment

Major sources of air and noise pollution are already mentioned in Impact Assessment Section. The above activities, vehicles transporting men and materials to and from construction sites, and movement of construction equipment will cause gaseous emissions which include PM10, PM2.5, CO, HC, NOx, and lead/benzene.

To mitigate the foreseen impacts, BEZA will ensure through construction contractors, as well as sub-contractors, execute construction activities in accordance with environmental management plan. Furthermore, such impacts would be perceived during only construction period which is temporary. Having implemented the EMP during the project construction and being supervised by BEZA/ contractor personnel, would minimise the emissions.

These impacts can be minimised by proper planning and by adopting simple steps. The fugitive dust emission can be minimised by spraying water. BEZA should insist the construction contractor to use standard equipment which meet exhaust and noise standards (Schedule 5 and 6 of The Environment Conservation Rules 1997, amended 2002, 2010); generator (DG set) exhaust and noise standards; and other construction equipment standards such as US Federal Highway Administration Standards or any relevant standards.

For trucks and other vehicles, insist truck operators who are operating on access roads and also entering EZ to carry out regular maintenance and engine tuning. Insist the drivers to show truck servicing records at the entry gate. Take appropriate action if the vehicle is not maintained reasonably long time.

Noise Environment

The potential for construction noise impact varies by location and land use. Rural and residential areas surround the present construction sites. Noise impact from nighttime construction would be much more extensive, which emphasizes the importance of avoiding nighttime construction which is noise generating near residential areas. Thus, noise generating operations should be planned only during day time.

To deal with noise exposure by construction workers in construction site, pocket guide by OSHA is helpful. The following noise reduction measures are suggested in the pocket guide.

Reduce It: Reduce the noise by using the quietest equipment available. For example, choose a smaller, quieter generator.

Move It: Move the equipment farther away with the use of extension cords, additional welding leads, and air hoses. Noise levels go down as we increase our distance from a noisy object. Move the generator (example) farther away or face it in a direction that is away from where most people are working. If you are not required to be in a high noise area, move to a quieter area.

Block It: Block the noise by building temporary barriers of plywood or other on-site materials to keep the noise from reaching workers. Place a five-sided, oversized wooden box over the generator. Add fire-resistant acoustical absorbing material (foam) inside the box. If the generator sits on soil or sand, that will help absorb some of the noise.

The following are the further measures to reduce noise exposure. Proper maintenance of equipment and tools can result in lower noise levels. Changing seals, lubricating parts, using sharp blades and bits, installing mufflers, and replacing faulty or worn equipment or parts can reduce the noise levels significantly on the job site.

Standards for Sound Originating from Motor vehicles or Mechanised Vessels – Schedule 5 of The Environment Conservation Rules 1997		
Motor vehicles (all types)	85 dB(A)	As measured at a distance of 7.5 mtrs from exhaust pipe
	100 dB (A)	As measured at a distance of 0.5 mtrs from exhaust pipe
Mechanised Vessels	85 dB(A)	As measured at a distance of 7.5 mtrs from vessel which is not in motion, not loaded and is at two thirds of its maximum rotating speed
	100 dB (A)	As measured at a distance of 7.5 mtrs from vessel which is in the same

At individual worker level, the construction contractor should be insisted to provide earmuffs to the workers exposed to high noise levels.

The following table gives general mitigation measures:

Table 39: Environmental Impacts and Mitigation Plan for site preparation, embankment and construction of Administration Building

Impact	Mitigation Measures	Time Frame	Implentation of Mitigation Measures	Supervision & Monitoring
Removal of Vegetation	<ul style="list-style-type: none"> When clearing the site, care shall be taken to keep vegetation clearing at a minimum Removal of as little vegetation as possible during the development and re-vegetation of bare areas after the project. 	Pre-construction phase	Contractor	BEZA/PMC
Setting up of construction camps/labour camps	<ul style="list-style-type: none"> The construction camps should be constructed on the land side, at least 500 m distance from habitations from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. Location for stockyards for construction materials will be identified at least 1 km from water sources The living accommodation and ancillary facilities for labour 	Pre-construction phase	Contractor	BEZA/PMC

	<p>shall be erected and maintained to standards and scales approved by the resident engineer</p> <ul style="list-style-type: none"> • All sites used for camps will be adequately drained. There should not be any risk of periodic flooding, nor located within 300 feet of pools, sink holes or other surface collections of water • The camps will be located such that the drainage from and through the camps will not endanger any domestic or public water supply • All sites will be graded, ditched and rendered free from depressions to avoid water stagnation. • Construction camps shall be provided with sanitary latrines (1 per 25 pax), bathing facility and urinals. • Sanitary latrines shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings • Adequate and suitable facilities for washing clothes and utensils shall be provided and maintained for the use of contract labour employed therein. • Sewerage drains will be provided for the flow of used water outside the camp. • Drains and ditches will be treated with bleaching powder on a regular basis. • The sewage system for the camp will be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. • The soak pits/ toilets should not penetrate the aquifer and thereby contaminate ground water • Clean potable drinking water facility should be provided at the site and the water quality should be monitored regularly • Crèche facility should be provided for children if female workers are employed • First aid facilities should be made available at construction camp. First aid box should contain small, medium and large sized sterilized dressings, sterilized burns dressings, 2 % alcoholic solution of iodine, 			
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	<p>bottle containing salvolatile, snakebite lancet, , bottle of potassium permanganate crystals, scissors, Ointment for burns & surgical antiseptic solution</p> <ul style="list-style-type: none"> • 1 first aid box should be available for every 50 labour • A person trained in first-aid treatment should be made in charge who will always be readily available during emergency • A suitable motor transport shall be kept readily available to carry injured or ill person to the nearest hospital. • The access to the island at night time should be strictly prohibited. 			
<p>Landfilling</p>	<ul style="list-style-type: none"> • Residential facility or sensitive facilities like hospitals, schools etc shall not be located in downwind direction of the identified sites for getting landfilling material. • The soil used for landfilling should have similar characteristics to the native soil and free of any type of contamination. <p>In case of dredging activity for landfilling purposes:</p> <ul style="list-style-type: none"> • Dredging should not impact natural drainage courses • Dredging sites should be located away from sensitive locations • Permission from concerned local body should be taken before finalizing the location • Magnitude and frequency of dredging activity should be monitored to avoid impacts on the natural drainage • Prior to dredging activity, analyse the soil sample to prevent impacts on the receiving environment as a result of mismatch in soil characteristics; • During dredging activity, physical barriers such as silt screen/ curtains should be employed to prevent the spread of suspended sediments; • Maintain the extent of the turbidity plumes close to the dredging and disposal areas to minimise impacts on marine fauna habitat; • Visually inspect for any marine life and terrestrial organisms and stop dredging activity in 	<p>During Construction</p>	<p>Contractor</p>	<p>BEZA/PMC</p>

	<p>case of any organism in the vicinity;</p> <ul style="list-style-type: none"> • Monitoring should be done continuously during dredging to observe impacts on the marine life and in case of visible impacts, stop the dredging activity; • Dredging should be carried out during day time to minimize impacts on marine life. 			
Soil Erosion and Sedimentation control	<ul style="list-style-type: none"> • Contractor should plan the activities so that no loose earth surface is left out before the onset of monsoon. • Top soil along the road side should be stripped and kept under covered shed for plantation • After the construction activity is over, top soil will be utilized for landscaping activity. • Turfing of low embankments and plantation of grasses and shrubs should be done in slope stabilization. • Soil erosion checking measures as the formation of sediment basins, slope drains, etc, should be carried out. • Do not disturb mangroves at the site periphery • Minimize tree and vegetation destruction • Stockpiling should be done in the opposite of wind direction 	During Construction	Contractor	BEZA/PMC
Disposal of Debris and any waste generated	<ul style="list-style-type: none"> • Waste from construction camp should be segregated at site. The waste should be disposed to authorized vendors • Dustbins should be provided at the site and construction camps to prevent littering of waste • Storage area of minimum 2 days should be provided at construction camp for storage of the waste generated from labour camps • Construction debris should also be segregated at the site. This debris should be used for filling to the extent possible. • All arrangement for transportation during construction including provision, maintenance, dismantling and clearing debris, where necessary will be considered incidental. • Construction debris should be stored under covered sheds on paved surfaces to prevent leaching • Any hazardous waste generated during construction 	During Construction	Contractor	BEZA/PMC

	<p>activity shall be stored at designated place and then disposed through the TSDF using high temperature incineration or any other chemical, thermal, biological, and physical methods. Chemical methods include ion exchange, precipitation, oxidation and reduction, and neutralization.</p> <ul style="list-style-type: none"> • Utmost care shall be taken to ensure safe collection, transport and disposal of construction waste and debris. 			
Dust Generation	<ul style="list-style-type: none"> • Compaction of prepared site to re-strain the fugitive emissions. • Water should be sprayed in the cement and earth mixing sites as well as after compaction. • In high dust areas, workers should be provided and encouraged to use masks. • Regular maintenance, servicing of the vehicles and periodic emission check for equipment and machinery would be carried out in conformity with Schedule 6 – ‘Standards for Emission from Motor’ of The Environment Conservation Rules 1997 (Amended 2002); • Water will be sprayed on the haul road. • All the vehicles entering the project site will be checked for Pollution-Under-Control Certificates. • Air quality monitoring to be carried out during construction phase to check the pollutants level in the air 	During Construction	Contractor	BEZA/PMC
Procurement & Setting up of Crushers, Hot-mix plants, other Vehicles, Equipment and Machinery	<ul style="list-style-type: none"> • Specifications of crushers, hot mix plants and batching plants, other Construction Vehicles, Equipment and Machinery to be procured should comply to the DoE Standards/ norms • Adequate stack height and emission control devices such as bag house filters, cyclone separators, water scrubbers etc., should be attached • Impervious platform for storage of bituminous and other liquid hazardous chemical • Pollution control measures for Diesel Generator (DG) set i.e. stack height (calculated by $H = h + 0.2 * \sqrt{kVA}$ where h = height of building where generator set is installed and 	Pre-Construction	Contractor	BEZA/PMC

	<p>kVA is total generator capacity), acoustic enclosure etc. should be ensured</p> <ul style="list-style-type: none"> • Provision of readily available first aid kit, fire fighting equipments at the plant site at appropriate location to respond in case of accident. • Periodical monitoring of air quality and noise levels as per conditions stipulated under the statutory clearance from DoE. Whenever the emission exceeds the permissible level the plants should be stopped and necessary repairing works of faults should be done to bring down the emission levels 			
Contamination of soil	<ul style="list-style-type: none"> • Impervious platform and oil and grease trap for collection of spillage from construction equipment vehicle maintenance platform will be appropriately provided at construction camp, servicing area and liquid fuel and lubes at storage areas. • Proper management of waste from labour camps and construction site • Proper disposal of wastewater generated from labour camp and construction site 	During Construction	Contractor	BEZA/PMC
Contamination of surface & ground water	<ul style="list-style-type: none"> • Car washing / workshops near water bodies will be avoided. • Avoid excavation during monsoon season • Loosened soil will be stabilized by Contractor through landscaping and developing vegetation, wherever possible, once construction activity is completed at any site. • Sanitation facility with septic tank followed by soak pit will be developed. Common toilets will be constructed on site during construction phase and the waste water would be channelized to the septic tanks and soak pits in order to prevent waste water to enter into the water bodies. • Provision of oil & grease traps upstream of storm water drains • Surface run off due to construction activity will not be discharged in open without treatment. 	During Construction	Contractor	BEZA/PMC
Loss of water bodies/ surface / ground	<ul style="list-style-type: none"> • No excavation from the bund of the water bodies. • No earth will be excavated for development of any off-site facility • No debris disposal near any water body. 	During construction	Contractor	BEZA/PMC

	<ul style="list-style-type: none"> • Prior written permission from authorities is required for use of water for construction activity. • Construction labours to be restricted from polluting the source or misusing the source. • Labour camps will be located away from water bodies. 			
Drainage and runoff	<ul style="list-style-type: none"> • The Contractor will always clear all the cross drainage structures and natural drainage before onset of monsoon in order to keep all drainage unblocked. Earth, stones, wastes and spoils will be properly disposed off, to avoid blockage of any drainage channel. • All necessary precautions will be taken to construct temporary or permanent devices to prevent inundation 	During Construction	Contractor	BEZA/PMC
Noise from Vehicles, Plants and Equipment	<ul style="list-style-type: none"> • Construction activities would be carried out in the daytime only. • The construction equipment would be provided with adequate noise control measures and should comply with the noise standards as prescribed by DoE • Regular maintenance of vehicles and equipment would be carried out and corrective action taken in case of any deviation. • Ear muff/ear plug shall be given to the workers working around or operating plant and machinery emitting high noise levels. • DG sets if installed should be provided with acoustic enclosures • Labour working in noise prone area should be provided with ear plugs and job rotation should be practiced to prevent the prolonged exposure of any workers to high noise levels 	Throughout construction	Contractor	BEZA/PMC
Loss or damage to flora and fauna	<ul style="list-style-type: none"> • Vegetation will be removed from the construction zone before commencement of construction. All works will be carried out such that the damage or disruption to flora other than those identified for cutting is minimum. • Only ground cover/shrubs that impinge directly on the permanent works or necessary temporary works will be removed with prior approval from the Environmental Expert. 	During Construction and Operation Phase	Contractor	BEZA/PMC

	<ul style="list-style-type: none"> • Trees identified under the project will be cut only after receiving clearance from the Forest Department • Vegetation only with girth of over 30 cm measured at a height of 1.0 m above the ground will be considered as trees and shall be compensated. • Compensatory plantation should be carried out in the ratio of 1:2 minimum • Construction workers will be directed not to disrupt or damage the fauna. • Construction vehicles will run along specified access to avoid accidents to flora and fauna. • EZ development should be planned in such a way to avoid or minimize tree cutting • Twice the nos. of trees to be fell should be planted as compensatory plantation in affected areas to minimize the impact on the eco-system • No littering of waste should be allowed and waste should not be discharged in water bodies • Avoid construction activities on the periphery of the island • Do not carry out any construction activity during night time • Green buffer of 10 m all around the project site will include most of the native plant species, which will significantly improve the ecology of the area. • Periodic monitoring should be carried out as per the monitoring plan for air, water, noise and soil and ensure that no impact due to project activities. • Tree survival rate should be monitored • Non-native species should not be introduced in the Naf river • Tourist activities should be stopped after sunset. • reduction or banning of over/destructive fishing, extending alternative fishing and rehabilitation and exploitation of mangroves • Cutting of mangrove should be prohibited. Heavy fines should be levied for cutting of mangroves • No use of push nets in mangrove core protection 			
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	<ul style="list-style-type: none"> Limited use of destructive fishing gear in estuarine and near-shore area of the site The disposal of untreated waste water, oily water from boats or solid waste into the Naf river should be strictly prohibited. The development of EZ should not impact the natural characteristic of Naf river both during construction and operation phase. 			
Accidents	<ul style="list-style-type: none"> Safety officer should be appointed at site to ensure all the safety guidelines are being followed at site Cautionary guidance should be provided at site to aware people about the associated risk with the area. Entry to the fuel storage room or machinery operation room should be restricted only to authorized trainer personnel All Accidents shall be reported immediately and incident analysis, preventive measures shall be implemented. Provisions for rescue from the river should be available with the contractor 	During Construction/ operation	Contractor	BEZA/PMC
Clearing of Construction Camps & Restoration	<ul style="list-style-type: none"> Contractors shall prepare site restoration plans. The plans shall be implemented prior to demobilization. On completion of works, all temporary structures shall be cleared, all rubbish burnt, excreta or other disposal pits or trenches filled in and sealed and the site left clean and tidy. 	Post Construction	Contractor	BEZA/PMC
Occupational Health & Safety Plan	<ul style="list-style-type: none"> All construction worker should wear PPEs including safety jacket, helmet, gloves, gum boots, ear plugs, mask while working at the site Workers should be made aware about the health issues related with open defecation Training to workers should be provided for handling the construction equipment and machinery Training to the workers should be provided to handle the emergency situations like fire, floods etc. First aid facility and sufficient nos. of trained personnel should be available at all the time at construction camp Cautionary signage and notice should be displayed in local language and English at the required places like fuel 	During Construction	Contractor	BEZA/PMC

	<p>storage area so that hazards can be avoided. A security guard should be deputed in these areas and entry should be restricted</p> <ul style="list-style-type: none"> • A register of all toxic chemicals delivered to the site shall be kept and maintained up to date. The register shall include the trade name, physical properties and characteristics, chemical ingredients, health and safety hazard information, safe handling and storage procedures, and emergency and first aid procedures for the product. • A register of Materials Safety Data Sheets (MSDS) relating to all hazardous substances on board, will be maintained 			
Emergency Preoaredness	Precaution will be taken to prevent danger of the workers and the public from fire, flood, drowning, etc. All necessary steps will be taken for prompt first aid treatment of all injuries likely to be sustained during the course of work.	During Construction	Contractor	BEZA/PMC

9.2.3. Mitigation Plan for Power Supply

It is planned to build a new 33 kV dedicated power transmission line to cater the needs of industries occupying the EZ. Laying of electrical transmission may involve various environmental and social issues. Mitigation Plan has been prepared addressing all the potential issues.

Transmission line construction impacts can be minimized by the following precautions to be taken during construction of transmission line:

- Proper back filling of debris at the completed foundation locations to enable cultivation by farmers
- Efforts to reduce/minimize tree cutting
- Assessment of crop loss and proper crop loss compensation
- Ensuring safety of workers while constructing towers, identifying nearby medical facilities for emergency situations

Along with the above general mitigation methods mentioned above would help in minimising construction period impacts of power line.

9.2.4. Ecosystem Enhanced Model for Mangroves in Jaliardip Island

The island consists of clay and sand, and the only protection from being eroded by river currents are the mangrove trees that surround the island. At the southern end of the island, the mangroves are already depleted (cut by fishermen who need to access their fish ponds), thus exposing the earthen dam.

9.2.4.1 Importance of Mangrove Ecosystem

Mangrove are of great importance for a healthy coastal ecosystem. The importance of mangrove forest are:

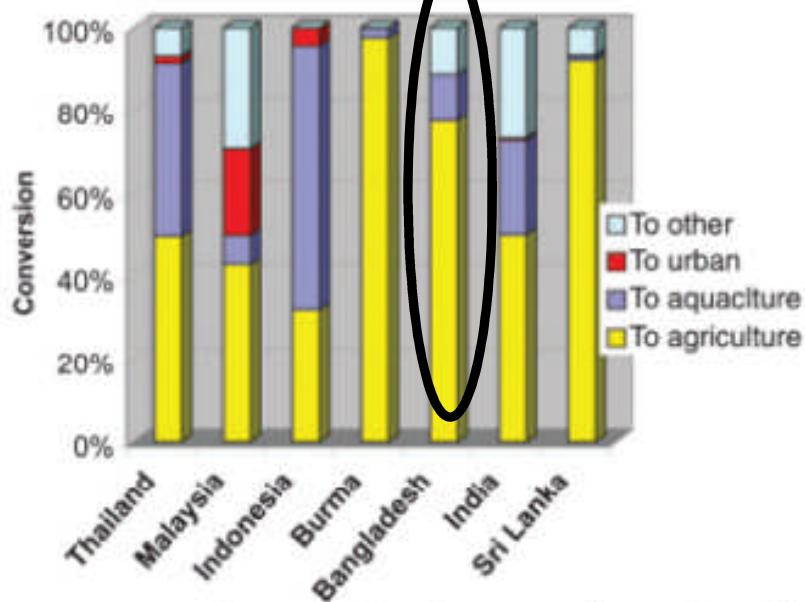
- Mangrove forests are indicators of healthy coastal ecosystems

- Mangrove helps in filtering pollutants to protect sea grasses and corals; protecting coastal ecosystem against storms and tsunamis
- Mangroves helps in carbon sequestration (Barbier and Cox 2004, Sathirathai and Barbier 2001)
- mangroves also serve as breeding grounds and nursery habitats for marine organisms, an important ecological support function for many coastal and offshore fisheries

9.2.4.2 Mangrove Degradation

It has been reported that more than 50% of mangrove ecosystems have been significantly altered or destroyed in the last century due to human development (Quarto 2013). Biswas et al. (2008) identified six major causes of mangrove degradation in Asia: conversion to shrimp/aquaculture farms; conversion to sea salt farms; conversion to other agricultural practices; development of infrastructure; development of hydrological diversions; and alteration from natural disturbances. The figure below illustrates the major causes of mangrove degradation by various Asian countries.

Figure 53: Major causes of mangrove degradation in Asia



Source: Giri et al. 2008

9.2.4.3 Ways to enhance the ecosystem of Mangrove

It is of utmost importance to protect the mangrove plants. Some of the ways to enhance the mangrove ecosystem:

- When construction works start, utmost care should be taken that the mangroves remain untouched
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- It is also recommended to reafforest the island's damaged mangrove areas. One of the best known examples in an Asian country is in Pakistan where the *Karachi Port Trust* (KPT) actively promotes mangrove restoration projects.
- A buffer shall be kept from the dense mangrove vegetation;
- Work close to the proximity of mangrove shall be strictly prohibited. If possible, the mangroves shall be fenced.
- Usage of high frequency lights shall be restricted. Lights impacts the natural biodiversity and ecology of the area which also has an indirect impact on the mangroves.
- Impacts on mangrove trees shall also be prohibited because mangroves contribute to mud flat formation which controls erosion.

9.2.4.4 *Ways to restore mangrove ecosystem*

There are 2 main approaches to restore mangrove ecosystem.

- **The Plantation Approach:** Plantation restoration has been used as the primary technique for mangrove restoration worldwide. According to Lewis III (2001), the plantation approach is inexpensive but does not usually succeed due to failure to understand the physiological tolerances of mangroves to tidal inundation. Mangrove species are often planted at the wrong elevation relative to tidal inundation. Some mangrove trees and other plants found in the landward zones of mangrove forests will die if they are they are inundated too long or exposed to air at low tide for too long.
- **EMR approach:** The EMR approach, on the other hand, can be done for similar or slightly higher costs if hand labor is used and is believed to be a more successful restoration approach with proper planning. However, Callaway and Zedler (2009) suggested that it is much easier and cheaper to preserve an ecosystem rather than restoring them.

9.2.5. *Mitigation ways of environmental impacts because of Developmental Activities*

Today, many tourists are environmentally conscious and want to stay in a place that does not negatively affect the environment, and they are ready to pay for this a higher price than for conventional tourism. The value of an eco-tourism property, however, rises and falls with its ability to protect surrounding biodiversity, wildlife and landscape. One of the first requirements in planning and building a property is that it is sustainable in design, i.e. it should be built preferably with local / traditional materials (e.g. locally made bricks or stones, sustainably processed wood) with as small an ecological footprint as possible.

Further attributes of an eco-design include:

- Employment of energy saving tactics and appliances (e.g. energy saving light bulbs, sensors or motion detectors for starting light, air condition, etc. only when the guest is in the room);
- Installation of renewable energy technology such as solar panels to meet main power needs, such as lighting and hot water;
- Natural ventilation, i.e. provision of efficient natural air circulation to minimize use of electric air condition. The flow of air inside a building can be influenced by construction of the house as well as topographical features, by the orientation of the building and by the position of surrounding buildings and other obstructions built intentionally to divert the wind in a desired direction;
- Water-saving appliances like low-flow showerheads, low-flush or dual-flush toilets, water-saving faucet taps
- Rain water harvesting systems for domestic non-potable use;
- Sewage treatment plant, this should be planned on the mainland in connection with adjacent residential areas in Jaliardip, Teknaf and Sabrang, thus providing an upvalue for the entire area. Furthermore, it would avoid running the plant at low capacity in off-season or even closing down its operation (which is very unfavorable, as a sewage treatment plant has to run non-stop once it has started);
- Avoidance of sealing of the ground by concrete or asphalt, promote greening of roof areas (unless they are used for solar panel installation); and
- Offering the guest a natural surrounding
- Having ethical employment practices and contributing to the local economy, i.e. give work opportunities to nearby villagers, train local people and employ them at fair wages, support their community

- Use local and seasonal food products at the restaurants, locally produced bed sheets, table cloths and other items. This helps demonstrate that eco-tourism is a more sustainable long term way to earn income than destroying or altering habitats for short term gains;
- Reduce and manage waste by not using things that generate excessive waste, such as disposable water bottles, or small food portions wrapped in plastic
- Recycle and reuse items wherever possible, especially glass and plastic; and
- Minimize the use of chemicals in daily operations, in particular in cleaning or pest control;
- There shall be no concrete structures in the Jaliardip Economic Zone. High density of concrete structures releases heat which will impact the localized ambient temperature and can further impact the local biodiversity and most importantly the mangrove cover.
- The economic zone shall have limited number of cottages for tourist to stay and relax. The material of construction selected by the developer shall be cognizant with the present ecological ambience of the island. It is recommended to have an ecological expert especially for this site to validate the materials selected by the developer.

9.2.6. Biological Environment/ Greenbelt Development

Development of a greenbelt/tree plantation of 30 m wide along the boundary and internal roads will be beneficial. The tree plantation will have the following objectives:

- restoration of green cover lost due to tree felling and shrub cutting during land clearance activities
- restoration/preservation of genetic diversity
- attenuation of noise pollution from EZ to surroundings
- creation of aesthetic environment

At least three rows of trees may be retained along the boundary. New trees can be planted to make up the gaps devoid of trees.

The selection of trees and plants for greenbelt/tree plantation should be those which could grow in the existing agro climatic conditions. They should be able to survive in the local soil conditions.

Based on the above considerations and also due to loss of trees on the site, the plant species should be native (especially those which are cut from the site and for road widening) in nature. The selected plant species would need minimum level of maintenance including fertilisation and other soil amelioration.

Apart from trees, the shrubs removed from the site, and other herbaceous species may also be planted in between the trees along the boundary wall. This will act as green cover, prevent soil erosion by increasing the binding capacity of the soil, and importantly act as noise barrier together with trees.

Tree plantation also need to be taken up along the roads such as approach road to the EZ, internal road reaching administration building, on the vacant land of administration building, etc. Care should be taken that mangroves adjacent to the site location should not be impacted or cut.

9.2.7. Waste Management

The importance of well-organized waste management has already been discussed before. It is, however, not an issue of the EZ alone as it requires national regulations and a well-functioning infrastructure including collection, transport, processing, recycling and final disposal of waste and garbage. At present, there is a general lack of waste management in Bangladesh and waste is dumped at many undesignated sites. This will definitely hamper the development of international tourism! Visitors coming to a country do not want to see the tourist facility alone; they also would like to get an impression of the host country.

Best Practice

The best practice w.r.t waste management could be:

- **Reduce:** Creation of as little waste as possible by not producing it, by implementing “green” procurement. Packaging alone can account for up to 40 % of a hotel’s waste stream, therefore products with little packaging or returnable packaging should be selected;
- **Reuse:** Use of items that can be reused;
- **Sort for recycling:** Having a system in place for sorting everyday waste items such as bottles, cans, cardboard and paper for recycling (e.g. by using color-coded waste bins at all rooms and areas), taking into account local disposal possibilities;
- Training of employees in waste management; and
- Information of guests on how waste is handled at the tourist area.

9.2.8. Energy Management

Provision of energy is important to the hotel industry, as it is necessary to power equipment, appliances and devices that provide the services and the level of comfort expected by the guests.

Best Practice

Energy efficiency is a fundamental requirement of sustainable tourism. This can be achieved by:

- Building design (as discussed above): Buildings should be properly sited, oriented and designed to minimize their cooling requirements and maintaining a comfortable indoor temperature without air conditioning (passive cooling);
- Selection of energy-saving equipment and appliances;
- Staff and guest participation in energy conservation: Employees should know the importance of energy conservation, and be trained and encouraged to use energy efficiently; the guests should be informed accordingly; and
- Use of fuel briquettes that are being made from an increasing variety of waste materials.

9.2.9. Water Management

Water, and especially fresh water, is one of the most critical natural resources. The tourism industry generally overuses water resources for hotels, swimming pools, golf courses and personal use of water by tourists. This can result in water shortages and degradation of water supplies, as well as generating a greater volume of waste water.

Best Practice

- The entire water supply should be designed to safe water;
- Collection and use of rainwater as a water source prior to any other source where possible;
- Reuse of treated wastewater for non-potable purposes, e.g. for irrigation;
- Installation of water saving devices wherever possible;
- Involvement of staff and communities;
- Information of guests, e.g. by explaining about unintentional wastage by a poster.

9.2.10. Community development plan

It is recommended the EZ owners to involve the local community during the project development. The EZ owner/its contractors may recruit local workforce to the extent possible during construction phase. The EZ owner would identify technically qualified unemployed youth around the project location and other

nearby areas, and employ as far as practical. The EZ owner should form a forum/ association/ trust along with its industrial units to look after community development activities of EZ. The Trust should encourage recruitment of local people during operation phase. For this, if required training shall be provided.

The Trust will organise a community advisory group involving local representatives, representatives from EZ industries and neighbouring industries; that would help them in finding ways to participate with its neighbours in addressing socio-economic concerns. With the advice of its community advisory panel, local officials, and other key individuals and groups, the Trust along with its constituent industries may sponsor appropriate programs and projects to benefit its community as a whole.

Some specific community development programs that could be considered by the Trust in coordination with other industries in the locality are suggested here:

- Conducting awareness programs in surrounding villages on health impacts due to environmental pollution (air, noise, water, solid waste, etc), and precautions to be taken to minimise health impacts.
- Conducting periodic health check-ups to the EZ (including industries) staff and in the surrounding villages to identify pollution related diseases.
- Encouragement to residents in the nearby localities for self-employment ventures, such as by assisting them in arranging micro finances to develop them as artisans/ skilled personnel.
- Periodic training programs on health and sanitary education, women and child development, and income generation schemes.
- Participation in improving the existing medical and educational facilities of the area - for this purpose, it is suggested that the Trust provide funds for facilities improvement (providing toilets, furniture, additional space creation, any other needed) to the local hospitals and schools
- Development of greenbelt/greenery or tree plantation in the nearby vacant government lands to build a green and clean environment in the surrounding areas and to reduce pollution impacts to some extent.
- Sponsoring fellowships to students in surrounding villages to encourage them to go for higher education
- Construction of a hospital in EZ area in collaboration with other industries to improve health status
- Conduct or sponsor camps to clean up river ghats, jetties and terminals in the surrounding areas.

9.2.11. Post Project Monitoring Plan

To monitor the extent of environmental impact of the proposed EZ and proposed industries, it is advised to monitor the ambient environmental quality around the project location periodically. This section describes the environmental quality monitoring detailing number and location of sampling stations, parameters to be monitored, frequency of sampling, etc. The EZ authorities has to submit all the monitoring results to DOE, Bangladesh.

Micrometeorology

The nearest meteorological station is located at Cox's Bazar, thus, it is advised to monitor the alteration of meteorological conditions in the area around EZ location, an automatic weather station for monitoring wind speed and direction, temperature, rainfall, and relative humidity will be installed within EZ premises.

Air Quality

Air quality monitoring includes ambient air quality monitoring and truck exhaust emission monitoring. The following are the details.

Two ambient air quality monitoring stations will be established at and around EZ site depending on the predominant wind directions to assess the change in ambient air quality over the time. Out of these, one sampling place will be at EZ and one will be decided based on predominant wind direction. The EZ authorities will also interact with DOE while deciding the exact monitoring locations.

The parameters to be monitored are SPM, PM₁₀, PM_{2.5}, SO₂, NO_x, CO and hydrocarbons. The frequency of sampling is once a month, with 24 hours sampling. The EZ Authority is also advised to carry out monitoring of truck exhaust emissions of SPM, SO₂, NO_x, and CO in regular intervals.

Noise Quality

It is proposed to measure noise at 10 locations day and night. Noise monitoring could be done once a month. Portable noise meters could be used for the purpose. All the air quality monitoring locations will be covered for noise monitoring.

Surface Water

Water quality should be monitored once a month at upstream and downstream locations to the EZ in Naf River.

Methods of analysis and parameters to be analysed would be according to standard methods. Parameters to be monitored should be based on Bangladesh standards for surface water quality. The main water quality parameters to be monitored are: Temperature, pH, colour, odour, DO, BOD, COD, EC, TDS, TSS, Total Coliform, Fecal Coliform, Oil and grease, ammonia, nitrates, alkalinity, sulphate, phosphate, TKN, Iron, and trace metals such as Chromium, Lead, Cadmium and Mercury.

The parameters, which could be analysed in the EZ laboratories, should be analysed there. Samples could be sent to other laboratories like DOE laboratory or any Research Laboratory for analysing remaining parameters.

Parameters such as oil and grease, TSS, COD, BOD will be measured manually as per Standard Methods, whereas pH, and temperature will be monitored with appropriate meters. The results of the monitoring will be sent to DOE periodically.

Groundwater

One groundwater sample shall be analysed in the project area. Frequency of monitoring would be monthly and parameters to be monitored are as per Bangladesh drinking water quality standards. The main parameters are as follows: pH, DO, BOD, COD, EC, TDS, TSS, Total Hardness, Calcium, Magnesium, Total Coliform, Fecal Coliform, Sulphate, Fluoride, Iron, Arsenic, and trace metals such as Chromium, Lead, Cadmium and Mercury.

Soil Quality

Soil quality to be monitored at one locations in EZ. Both physical and chemical parameters need to be monitored at each location. The parameters should be compared with the soil sample of undisturbed location. The parameters to be analysed in soil sample are as follows:

- Textural class
- Gravel (%)
- Sand (%)
- Silt (%)
- Clay (%)
- pH
- Bulk density (g/cc)
- Infiltration rate (cm/h)
- Specific gravity
- Porosity (%)
- Moisture content (%)

- Organic matter (%)
- Alkalinity (CaCO₃ mg/L)
- Sodium absorption ratio
- Conductivity (micromhos)
- Available nitrogen (%)
- Available phosphorous (mg/kg)
- Available potassium (%)
- Available boron (mg/kg)
- Available NaCl (%)
- Available Na₂CO₃ (%)
- Available iron (mg/kg)
- Available manganese (mg/kg)
- Available copper (mg/kg)
- Available zinc (mg/kg)

Flora and Fauna:

During the primary ambient environmental quality monitoring around the EZ location, flora and fauna on the site and surrounding the EZ has not been monitored to assess the flora and fauna before construction of the project. Thus, it is recommended to carry out a one-time assessment of baseline flora and fauna surrounding the project location before completion of the project. There after terrestrial and aquatic flora and fauna should be monitored to observe any alteration in their species composition and replacement. This could be done in association with local universities and research institutions which carry out such studies frequently. Such monitoring would help in taking necessary steps at the appropriate stage to prevent further deterioration of the surrounding ecology and protect the flora-fauna. The frequency of sampling could be once in a year during post monsoon season (Oct to Dec).

In addition, the Environment Management Cell should collect studies on flora-fauna conducted by local universities and research institutions in the nearby areas.

9.2.12. Project Environment Management Cell

It is recommended that the EZ Authority set up an EMC (Environmental Management Cell) to address environmental management concerns. The cell should be manned by qualified persons who will be responsible for regular environmental quality monitoring, proper functioning of ETP, implementation of community development plan, and liaison with regulatory bodies such as DOE.

The EMC will be responsible for the following:

- to implement the EHS policy of EZ
- to coordinate with EZ Trust in relevant activities
- to ensure that ETP function properly and meet effluent discharge standards
- to maintain environmental quality analysis laboratory and analyse air, noise, water and soil samples on a regular basis
- to implement community development plan,
- to coordinate and monitor EZ Trust to regularly check workers health and take appropriate steps
- to coordinate and monitor EZ Trust on safety conditions at various work environments and take necessary steps to maintain high safety standards. To deal with emergency situations.
- to liaison with regulatory bodies
- to ensure systematic and routine housekeeping of the common areas of EZ

- to maintain the proposed greenbelt along the boundary

The EMC may be headed by Manager – Environment, who should be a senior person, should have an overall knowledge of ETP, hazardous waste TSDFs, and their maintenance, environmental laws and standards, and should be able to independently manage the Cell. The EMC in-charge may be supported by Environmental scientist/ engineer and a Social Analyst. The scientist will be responsible for environmental quality analysis and should be capable of preparing reports and data sheets. He/she should have sufficient knowledge in sampling and analysis of environmental parameters. The social analyst should have knowledge of community programs and should be able to plan and implement community programs. In addition a part time occupational health specialist and a safety specialist can be appointed.

In addition the following staff at laboratory are required:

- One ETP and TSDF In-charge
- One Chemist cum laboratory incharge
- Three Plant Operators (one per shift) and three TSDF operators
- Laboratory/Field Assistants
- Sampling assistants

9.3. Mitigation Plan for EZ

The detailed plan for EZ development will be prepared in later stages. However following measures shall mandatorily form part of EMP for EZ development and operation:

- Seperate environment clearance should be taken by developer before developing economic zone from DoE
- Industries should obtain environment clearance individually from DoE prior to establishment and commencement.

Measures that should be taken by developer and individual industrial owners whicle development and operation phase is tabulated in table below

Table 40: Mitigation Measures Suggested for Developer

Impact	Mitigation Measures
Identification of Site for Disposal of construction Debris, construction labour camp and plant site	<ul style="list-style-type: none"> • Site identified should be 1.0 km away from settlement, sensitive locations, like school, hospital, religious structures, reseve forest and any other eco-sensitive zone etc. • Site identified should be approved by BEZA • Site should be located in downwind direction from settlement area • Fertile agricultural land and community land should be avoided for setting of these facilities
Air Pollution	<ul style="list-style-type: none"> • Sprinkling of water during construction phase on all unpaved roads, site and haul roads • Avoiding excess pilling of raw material and debris at site • Storage & transportation of raw material and debris in covered conditions • Cutting of only identified trees after obtaining permission of forest department • Regular cleaning of site • Guiding signage should be provided at the site for vehicles • Timings of the construction material vehicles should be fixed and should be during non-peak hours to prevent traffic congestion and traffic jams • Usage of low energy intensive building material like fly ash mic cement and bricks

	<ul style="list-style-type: none"> • Usage of low sulphur diesel for running DG sets, construction vehicles and equipments • Obtaining temporary electricity connection during construction phase and operating DG sets only during power failure • Open burning of wood or any other material should be prohibited at site and all the workers should be made aware about the same
Water Pollution & water Conservation	<ul style="list-style-type: none"> • Minimizing the run-off from the site by construction of sediment basins • Maintaining the flow of water sprinklers so as to avoid wastage of water • No debris should be thrown or disposed off in any water body like river, pond, canal etc or ground water source like functional or abandoned well • Excavation should not be carried out during monsoon • Provision of temporary storm water drainage system during construction phase to drain the storm water • Excavated pits should be provided with garland drains to prevent entrance of water inside the pit • Provision of oil & grease traps with the storm water drains draining the parking and fuel storage area • Provision of septic tanks and soak pits at the site & labour camps for disposal of sewage generated by construction labour • Waste generated by construction camps should be disposed off regularly at the identified site for debris disposal • Provision of cross drainage structures like balancing for maintaining the drainage pattern • Stone & bricks should be purchased only from licenced vendors • Keeping provision of land for development of ETP for each industry • Tank alarms should be installed so as to prevent overflow of water • Leakage detection should be carried out quarterly so as to detect any leakages in the gas pipeline
Soil Quality	<ul style="list-style-type: none"> • Top soil, if excavated from the project site should be stored in covered condition and should be used later for landscaping purpose • Storage of raw materials, debris and fuel on paved surfaces • Training the workers to handle the material so as to minimize spillage of material on soil • Provision of cross drainage structures to prevent water logging and soil erosion • Stone pitching with grass turfing should be done for the high embankment close to water body • Disposal of construction debris, municipal waste from labour camps and hazardous waste from site should be disposed off at the identified site • Keeping provision of land for development of soil waste management facility within the EZ site • No open area should be left without the vegetation to protect the soil. • Mulching of soil should be done regularly to prevent direct exposure of soil to wind and water
Noise Pollution	<ul style="list-style-type: none"> • Construction vehicles, machinery and equipment used for construction purpose should meet the standards prescribed by DoE • Upkeeping and regular maintenance of all the construction vehicles, machinery and equipment used for construction purpose • Provision of acoustic enclosures, noise mufflers, silencers etc with the DG sets and any noise generating machinery • Provision of temporary noise shield/barrier in areas where more noise will be generated
Ecology	<ul style="list-style-type: none"> • Only identified trees should be fell down after obtaining permission from forest department • Comensatory plantation should be carried out in ratio of min 1:2 under guidance of forest department • Development of 10 m (minimum) thick green buffer all along the periphery of EZ • Boundary should be constructed around the EZ site to prevent trespassing of the animals

	<ul style="list-style-type: none"> • Native plant species requiring should be considered for plantation • Timber should be purchased only from authorized vendors • No waterbody should be filled outside the EZ site • The mangroves adjacent to the site location should not be cut or impacted.
Emergency Preparedness	<ul style="list-style-type: none"> • Provision of first aid kit and first aid room and well trained first aid practioner at the site all the time • Ambulance facility should be provided at the site • Tie-ups with local hospital should be made to handly emergency case, if any • Availability of safety officers and supervisors at all the time on the site • Workers should be given training for handling construction vehicles, equipment and handling emergency situations like fire, floods, earthquake and cyclone • Cautionary signage should be provided in the areas associated with risks like storage of explosives, fuels, heavy construction material etc. Entry for only trained authorized personnel should be allowed in such areas with adequate safery measures • Emergency handling cell & room should be developed at the site and should be headed by project & safety manager • Contact no. of nearest fire-station and hospitals should be displayed within the emergency handling room

9.4. Emergency Preparedness Plan (Contingency Plan)

In order to be in a state of readiness to face adverse effects of accidents, an emergency preparedness plan is required to be prepared which includes on-site and off-site emergency plan by the individual industry and industrial estate. BEZA is committed to develop an emergency preparedness plan in consultation with district authorities and industry association.

The Emergency Preparedness Plan will have the following minimal components:

- Accidents preventions procedures/ measures
- Fire prevention planning and measures
- Fire water storage and foam system
- Accident/emergency response planning procedure
- Grievance redressal mechanism
- Emergency control centre
- Emergency information system with role & responsibility and command structure
- Recovery procedure
- Assessment of damages and rectification
- Evaluation of functioning of disaster management plan
- Accident investigation
- Clean-up and restoration

9.5. Monitoring Plan

The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. A monitoring schedule has been sketched based on the environmental components that may be affected during the construction and operation of the project and is given below. The implementation of EMF and other agreed actions of environmental management during construction and operation phase of the sub-projects, will be monitored by EMC, by a combination of regular visits to the sub-project locations and periodic reports.

Table 41: Environmental Monitoring Plan

S. No.	Aspect	Source of Impact	Monitoring Methods and Parameters	Frequency	Executing Agency	Enforcement Agency
1.0	Construction Phase					
1.1	Local Manpower Absorption	Construction Works	Contractor's report No. of people working in the project	Monthly	Contractor	BEZA & PMC
1.2	Soil Erosion	Excavation, disposal, cut & fill and land clearing activities for site levelling and internal roads, disposal	Survey & observation; Extent and degree of erosion; Structures for controlling soil erosion	Monthly	Contractor	BEZA & PMC
1.3	Greenbelt Development	-	Survival rate of species planted; Density of vegetation	Half Yearly	Contractor/ BEZA	BEZA & PMC
1.4	Air Quality	Transportation of construction materials, road construction, construction of utilities	Survey & observations; Levels of PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , CO	Monthly		BEZA & PMC
1.5	Waste Management	Restoration of disposal sites and construction areas	Status of protection measures	Quarterly	Contractors	BEZA & PMC
1.6	Noise Level	Noise levels compliance with respect to industrial standards	Ambient Equivalent continuous Sound Pressure Levels (Leq) at day and Night time at 6 to 8 locations	Daily	Contractors	BEZA & PMC
1.7	Drinking Water	Contamination	All physio-chemical & biological parameters	Monthly	Contractor	BEZA & PMC
1.8	Biodiversity	Construction works Labour camps Waterway transport	Ecological survey Surfacewater quality analysis Visual inspection	Monthly but Visual inspection should be done weekly	Contractor	BEZA & PMC
1.9	Naf river water quality/ toxicity	Construction works Labour camps Waterway transport	Laboratory test Salinity, turbidity, temperature, nutrient status	Monthly	Contractor	BEZA & PMC
1.10	Impacts on mangrove	Construction works Labour camps Waterway transport	Record total area and number of mangrove for site Record type and number of species of mangroves surrounding the site	Quarterly	Contractor	BEZA & PMC
2.0	Operation Phase					
2.1	Noise Levels	Noise levels compliance with respect to residential standards	Ambient Equivalent continuous Sound Pressure Levels (Leq) at day and	Monthly	Individual Units	BEZA

			Night time at 6 to 8 locations			
			Plant periphery and near noise generation sources	Monthly	Individual Units	BEZA
2.2	Biological Environment	Water quality/toxicity, waste disposal and littering, human interference, etc	Record total area and number of mangrove for site Record type and number of species of mangroves surrounding the site	Quarterly	BEZA	BEZA
			Analysie surface water samples from four places at the locations abutting the proposed EZ	Monthly	BEZA	BEZA
			Record presence, type and location of solid waste as and when observed	Monthly	BEZA	BEZA
			Record all species present in the project area	Monthly	BEZA	BEZA
2.3	Ambient air quality	Ambient air quality levels compliance with respect to industrial standards	Ambient air quality monitoring at individual industries – Monitor levels of PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , CO	Monthly	Individual Units	BEZA
2.4	Ground water quality	Ground water quality levels compliance with respect to industrial standards	Borewells installed at site	Monthly	Individual Units	BEZA
2.5	Naf river water quality/ toxicity	Tourism and maintainence activities	Laboratory test Salinity, turbidity, temperature, nutrient status,	Monthly	Individual Units	BEZA

9.6. Monitoring Indicators

The physical, biological and social components which are of particular significance to the proposed project are listed below:

- Air quality
- Water quality
- Noise levels
- Solid & Hazardous Waste Management
- Re-plantation success / survival rate
- Soil Erosion
- Biodiversity

These indicators will evaluated periodically based on the monitoring results, baseline conditions, predicted impacts and mitigation measures.

9.7. Institutional Arrangement

BEZA has developed Environmental Management Framework with the help of World Bank. The institutional arrangement is aligned as per this framework. BEZA will have an Environmental and social cell which will coordinate with site engineers and PMC.

Overall Project Implementation Arrangements

The overall management of the project will be carried out by BEZA which is the project implementing unit (PIU).

Institutional Set Up For Environment Management

The institutional arrangements for the implementation of various aspects of EMF and environment management of the proposed project envisaged to be implemented as part of the PSDSP comprise the following.

- Project Environment Cell (PEC) at PIU to ensure adequate integration of environment management measures in the design phase and supervise implementation of EMF and specific requirements of EMP
- Environment Management Unit (EMU) at EZ to implement EMP and other regulatory requirements during construction & operation phase of EZ .

Project Environment Management Cell (PEC) at PIU

The Project Implementation Unit (PIU) will establish a Project Environmental Cell (PEC) headed by a 'Manager – Environment' and supported by environmental engineers. The PEC will function to:

- Supervise implementation of EMF throughout project implementation period;
- Ensure integration of the EA and the EMP measures into the sub-project design and implementation plans such as contract documents, maintenance contracts, tenant lease agreements, etc;
- Supervise the implementation of the mitigation measures by the Master developers / Contractors;
- Assist the engineering staff and other PIU staff in addressing environmental issues during planning, design and implementation of the sub-projects;
- Prepare periodic progress reports on the implementation of the EMP throughout the project period.

Environment Management Unit (EMU) at Jailadweeep EZs

In order to implement various environmental management measures at EZ, the master developer / contractor / operator will set up an Environment Management Unit (EMU) for the Jailardwip EZ. The EMU will consist of environmental engineers with relevant experience on environmental issues associated with the development of tourism based EZ. The details of the EMC has been elaborated in section 9.2.7. The EMU will function all through construction and operation phase of the EZ and perform the following functions.

- Identify regulatory requirements of the sub-project and initiate necessary actions / studies to ensure compliance to the same;
- Co-ordinate with DoE and PIU and ensure securing SCC and ECC as applicable for the project(s);
- Co-ordinate with the contractors / sub-contractors and all other agencies involved in the development and operation of EZ / EPZ and ensure that all the requirements of EMP are fully complied;
- Ensure that all the common environmental infrastructure in EZ / EPZ is operated and maintained in compliance with the regulatory requirements of GoB;
- Liaise with individual enterprise/tenants and ensure that all environmental management conditions of the tenant lease agreement are fully complied;
- Prepare regular reports on environment management and submit to PIU/GoB.

9.8. Compensation Plan

The proposed project will not entail any resettlement or livelihood loss, hence the project will not involve any compensation plan.

10. Cost of EMP

The cost of EMP given here includes only that for the ETP, laboratory/analysis facilities, certain equipment for post project monitoring, and greenbelt development. The costs are approximate and need calibration at the time of detailed design and estimation stage.

Table 42: Indicative cost of EMP

S. No	Activity/ Equipment	Cost (Tk.)
1	Weather Station	65,000
2	Ear Muffs (10 Nos only for sampling personnel who may go to industries where high noise is experienced)	40,000
3	ETP construction	50,00,000
4	Solid waste bins for common areas (100 Nos)	10,000
5	Greenbelt along the boundary and plantation along the roads	20,00,000
6	High Volume Air Samplers (2 Nos)	3,00,000
7	Digital Sound Level meter	8,000
8	First time flora and fauna study	5,00,000
9	Analytical Laboratory (equipment for water quality and air quality analysis)	15,00,000
10	Laboratory and EHS department space and a small storage: total area 2000 sft	Cost will be given by feasibility team as part of building construction
11	Manpower cost: This is recurring cost. <ul style="list-style-type: none"> • Assistant Director – Environment • Environmental scientist/ engineer, • Social Analyst, • part time occupational health specialist and a safety specialist, • One ETP Incharge • One TSDF Incharge • One Chemist • Six Plant Operators (one per shift) • Laboratory/Field Assistants • Air quality sampling assistants 	42,60,000 per year
12	Fund for proposed community development activities	50,00,000

11. Conclusion and Recommendation

11.1. Conclusions

Overall the impacts from both construction and operation phase have limited adverse environmental impacts, and can be readily addressed through mitigation measures as provided in EMP. BEZA, formed under EZ Act, 2010 is overall agency for implementation of EZ projects for rapid economic development of Bangladesh. The EZ will be developed following PPP approach. BEZA will invest in land and related off-site infrastructure development so as to make zone accessible and resourceful. Thereafter economic zone development will be responsibility of private developers. The off-site facilities proposed to be developed by BEZA include development of administration building, boundary wall, electrical supply, and access road. The project falls under Red category as per ECA, 1995 and requires prior environment clearance from DoE, Bangladesh.

11.2. Recommendations

The recommendations made for the project development on the basis of EIA study are given below:

- Construction activities for the development of project should be started after obtaining environment clearance certificate from DoE, Bangladesh
- Proposed environment management plan should be implemented strictly both during operation and construction phase of the project.
- Trees cutting should be minimum and compensatory plantation should be carried out in ratio of 1:2
- Proper training of maintaining environment, health and safety should be given to Project management unit in both construction and operation phase
- Provision of garland drain, thick green belt, STP, segregated storm water shall be adhered to.
- Environmental monitoring should be conducted as proposed in environment management plan.
- Before development, separate environment impact assessment study should be carried out by individual units proposed to be developed in the EZ.
- Ecological assessment should be carried out for the proposed EZ before commencement of the project.
- While commencement of the project, care should be taken to minimize impacts on biodiversity.

A.1. Annex-Primary Monitoring Results

Surface water and ground water results

Government of The People's Republic of Bangladesh
 Department of Environment
 Chittagong Divisional Laboratory,
 Zakir Hossain Road, Khulshi, Chittagong
 www.doe.gov.bd

Analysis sheet of Surface Water and Ground Water Sample of Jaliar Dweep(EZ), Teknaf, Cox'sbazar

Sample Location	Lab code	Date	pH	EC Microhm/cm	TDS mg/l	TS mg/l	DO mg/l	BOD mg/l	COD mg/l	Arsenic mg/l	Iron mg/l	Oil & Grease mg/l	Temp °C	Note
Surface water collected from Hriila Mouja of Jaliar Dweep	2068	29/05/16	7.91	4880	2710	3860	6.20	73	240	ND	1.48	2.2	31	-
Ground Water Collected from a Deep Tube Well of Hriila Mouja	2071	29/05/16	7.99	721	312	372	3.10	2.1	16.8	ND	0.68	0.01	30.8	
Standard of Inland surface water as per ECR 1997 in Bangladesh			6.5-8.5	2250 Microhm/cm at 25°C	SNF	SNF	5 and above	Below 10	SNF	SNF	SNF	SNF	SNF	*
Standard of Drinking water as per ECR 1997 in Bangladesh			6.5-8.5	SNF	Below 1000	Below 10	6	Below 0.2	4	0.05	0.3-1	0.01	20-30	
Standard of Industrial waste water as per ECE 1997 in Bangladesh			6-9	Below 1200	Below 2100	Below 2100	4.5-8	Below 50	Below 200	Below 0.02	Below 2	Below 10	Below 40	

Note : SNF- Standard Not Fixed or Mentioned in ECR 1997, ND- Not Detectable

12/6/16

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 Sample Collector

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 Md. Munir Rahman
 Junior Chemist

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 Md. Kabirul Hossain
 Sr. Chemist

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 Md. Meabul Hossain
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Noise monitoring results

Government of The People's Republic of Bangladesh
 Department of Environment
 Chittagong Divisional Laboratory
 Zakir Hussain Road, Khulshi, Chittagong.
 www.doe.gov.bd

Sound Monitoring Result of Jaliar DwespiEZA, Teknaf, Cox'sbazar.

Sl. No	Date	Lab Code	Sampling Location	Sound Level in dB (Day Time)	Sound Level in dB (Night Time)	Remarks
01	29/05/2016	2067	Hrilia Mouja near Naval Embankment	61 dB	60.3 dB	Sea Wave Sound Exists all the time of Sampling
02	*	*	100 m North from Naval Embankment	55 dB	53.8 dB	
03	*	*	100 m South from Naval Embankment	51 dB	50.2 dB	
04	*	*	100 m East from Naval Embankment	52 dB	51 dB	

Standard as per EC/O'07 in Bangladesh		
Area	Day	Night
Silent Area	50 dB	40 dB
Residential Area	55 dB	45 dB
Mixed Area	60 dB	50 dB
Commercial Area	70 dB	60 dB
Industrial Area	75 dB	70 dB

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Ambient air quality monitoring results

Government of The People's Republic of Bangladesh
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Analysis Sheet of Ambient Air Quality Monitoring Sheet of Jaliar Dweep (I, Z), Teknaf, Cox's Bazar

Lab Code	Date	Sampling Location	SPM µg/m ³	PM _{2.5} µg/m ³	PM ₁₀ µg/m ³	NOx µg/m ³	SOx µg/m ³	Remarks
2065	20/05/2016	Hilla Mouja near Neval Embankment	86.32	16.5	46.2	8.2	3.1	
2066	"	100m North from Neval Embankment	78.12	18.8	44.6	7.6	3.0	
2067	"	100 m South from Neval Embankment	84.50	15.2	42.6	"	"	
2068	"	100 m East from Neval Embankment	82.30	13.5	45.8	"	"	
Standard Limit as per ECR 1997			Below 200 in Avg time 8 Hours	Below 65 in Avg time 24 Hours	Below 150 in Avg time 24 Hours	Below 100 in Avg time Annual	Below 80 in Avg time Annual	

Note:- 1. SPM – Suspended Particulate Matter. 2. NOx – Oxides of Nitrogen. 3. SOx – Oxides of Sulphur.

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A.2. Annex II– Approved TOR (1/4)

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, E-16 Agargaon
Dhaka-1207
www.doe.gov.bd

Memo No: DoE/Clearance/5605/2016/ 227

Date: 13/06/2016

Subject: Approval of Terms of Reference (TOR) for EIA of Jaliar Dweep Economic Zone at Teknaf under Cox's Bazar District.

Ref: Your Application dated 22/05/2016.

With reference to your application dated 22.05.2016 for the subject mentioned above, the Department of Environment hereby gives approval of the Terms of Reference (ToR) for Environmental Impact Assessment (EIA) Study of the proposed Jaliar Dweep Economic Zone at Teknaf under Cox's Bazar District subject to fulfilling the following terms and conditions:

- I. The project authority shall conduct a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of the said project in accordance with this ToR and following additional suggestions.
- II. The EIA report should be prepared in accordance with following indicative outlines :
 1. Executive summary
 2. Introduction: (Background, brief description, rationale of the project, scope of study, methodology, limitation, EIA team, references)
 3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)
 4. Project Description
 - i. Introduction
 - ii. Project Objective
 - iii. Project Options
 - iv. Interventions under Selected Options
 - v. Project activities: A list of the main project activities to be undertaken during site clearing, construction as well as operation
 - vi. Project schedule: The phase and timing for development of the project
 - vii. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project
 - viii. Map and survey information
Location map, cadastral map showing land plots (project and adjacent area), geological map showing geological units, fault zone, and other natural features.
 - ix. Project Plan, Design, Standard, Specification, Quantification, etc.
 5. Environmental and Social Baseline
 - 5.1 Meteorology
 - 5.1.1 Temperature
 - 5.1.2 Humidity
 - 5.1.3 Rainfall
 - 5.1.4 Evaporation



1/4

Approved TOR (2/4)

- 5.1.5 Wind Speed
- 5.1.6 Sun Shine Hours
- 5.2 Water Resources
 - 5.2.1 Surface Water System
 - 5.2.2 Tropical Cyclones and Tidal Flooding
 - 5.2.3 Salinity
 - 5.2.4 Drainage Congestion and Water Logging
 - 5.2.5 Erosion and Sedimentation
 - 5.2.6 River Morphology
 - 5.2.7 Navigation
 - 5.2.8 Ground Water System
- 5.3 Land Resources
 - 5.3.1 Agroecological Regions
 - 5.3.2 Land Types
 - 5.3.3 Soil Texture
 - 5.3.4 Land Use
- 5.4 Agriculture Resources
 - 5.4.1 Farming Practice
 - 5.4.2 Cropping Pattern and Intensity
 - 5.4.3 Cropped Area
 - 5.4.4 Crop Production
 - 5.4.5 Crop Damage
 - 5.4.6 Main Constraints of Crop Production
- 5.5 Livestock and Poultry
 - 5.5.1 Feed and Fodder Shortage
 - 5.5.2 Livestock/Poultry Diseases
- 5.6 Fisheries
 - 5.6.1 Introduction
 - 5.6.2 Problem and Issues
 - 5.6.3 Habitat Description
 - 5.6.4 Fish Production and Effort
 - 5.6.5 Fish Migration
 - 5.6.6 Fish Biodiversity
 - 5.6.7 Fisheries Management
- 5.7 Ecological Resources
 - 5.7.1 Bio-ecological Zone
 - 5.7.2 Common Flora and Fauna
 - 5.7.3 Ecosystem Services and Function
- 5.8 Socio Economic Condition
 - 5.8.1 Socio Economic Condition
 - 5.8.2 Quality of Life Indicators
 - 5.8.3 Income and Poverty
 - 5.8.4 Gender and Women
 - 5.8.5 Common Property Resources
 - 5.8.6 Conflict of Interest and Law and Order Situation
 - 5.8.7 Historical, Cultural and Archaeological Sites
- 5.9 Ecological Resources
 - 5.9.1 Bio-ecological Zone
 - 5.9.2 Common Flora and Fauna
 - 5.9.3 Ecosystem Services and Function
- 6. Identification and Analysis of Key Environmental Issues (Analysis shall be presented with Scenarios, Maps, Graphics, etc. for the Case of Anticipated Impacts on Baseline)
 - 6.1 Environmental Sensitivity Investigation
 - 6.2 Environmental Asset
 - 6.3 Environmental Hot Spots




Approved TOR (3/4)

- 6.4 Likely Beneficial Impacts
 - 6.5 Community Recommendations
 - 6.6 Alternate Analysis
 - 7. Environmental and Social Impacts
 - 7.1 Introduction
 - 7.2 Impact on Water Resources
 - 7.2.1 Pre-Construction Phase
 - 7.2.2 Construction Phase
 - 7.2.3 Post-Construction Phase
 - 7.3 Impact on Land Resources
 - 7.3.1 Pre-Construction Phase
 - 7.3.2 Construction Phase
 - 7.3.3 Post-Construction Phase
 - 7.4 Impact on Agriculture Resources
 - 7.4.1 Pre-Construction Phase
 - 7.4.2 Construction Phase
 - 7.4.3 Post-Construction Phase
 - 7.5 Impact on Fisheries
 - 7.5.1 Pre-Construction Phase
 - 7.5.2 Construction Phase
 - 7.5.3 Post-Construction Phase
 - 7.6 Impact on Eco System
 - 7.6.1 Pre-Construction Phase
 - 7.6.2 Construction Phase
 - 7.6.3 Post-Construction Phase
 - 7.7 Socio Economic Impact
 - 7.7.1 Pre-Construction Phase
 - 7.7.2 Construction Phase
 - 7.7.3 Post-Construction Phase
 - 8. Public Consultation and Disclosure
 - 8.1 Introduction
 - 8.2 Objectives of Public Consultation and Disclosure Meeting
 - 8.3 Approach and Methodology of Public Consultation and Disclosure Meeting
 - 8.4 Public Consultation Meetings (PCMs)
 - 8.5 Public Disclosure Meetings (PDMs)
 - 9. Environmental Management Plan and Monitoring Indicators
 - 9.1 Introduction
 - 9.2 Mitigation Plan
 - 9.3 Enhancement Plan
 - 9.4 Contingency Plan
 - 9.5 Compensation Plan
 - 9.6 Monitoring Plan
 - 9.7 Monitoring Indicators
 - 10. Cost Estimation for Environmental Mitigation Measures and Monitoring
 - 11. Conclusions and Recommendations
- III. Without obtaining approval of EIA report by the Department of Environment, the project authority shall not be allowed to conduct earth filling or any kind of physical intervention in the proposed project site and also not be able to start the physical activity of the project.
- IV. This approval of the Terms of Reference (TOR) would not mean any acceptance or site clearance of the project.



Approved TOR (4/4)

- V. The proposed EIA study would not establish any claim, right in favour of the proponent for getting site clearance or environmental clearance.
- VI. Without obtaining Environmental Clearance, the project authority shall not be able to start the operation of the project.
- VII. The project authority shall submit the EIA report along with a filled-in application for Environmental Clearance in prescribed form, the applicable fee in a treasury chalan, the No Objection Certificates (NOCs) from the local authority/ies, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public), NOC from concerned authority for cutting/razing/dressing of hill or hilly land (if it is required) and NOC from other relevant agencies for operational activity etc. to the Cox's Bazar District Office of DoE with a copy to the Chittagong Regional Office of DOE in Chittagong and the Head Office of DOE in Dhaka.


13.06.2016

(Syed Nazmul Ahsan)
Director (Environment Clearance, e.c)
Phone # 02-8181673

Project Director

Jaliar Dweep Economic Zone
Support to Capacity Building of Bangladesh Economic Zones Authority Project
Bangladesh Economic Zones Authority (BEZA)
BDBL Bhaban, Level # 15
12, Kawran Bazar, Dhaka-1215.

Copy Forwarded to:

- 1) PS to the Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
- 2) Director, Department of Environment, Chittagong Regional Office, Chittagong.
- 3) Deputy Director/Officer in-charge, Department of Environment, Cox's Bazar District Office, Cox's Bazar.
- 4) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

A.3. Land Transfer Documents

বাংলাদেশ ফরম নং-৫৪৬২ (সংশোধিত)

খতিয়ান নং-১/২

জেলা-কক্সবাজার উপজেলা-টেকনাফ মৌজা-টেকনাফ জে, এল. নং-০৯ রেং সাই নং.....

মালিক অধিগ প্রজা বা ইজারাদারের নাম ও ঠিকানা	অংশ	রাজস্ব	দাগ নং	জমির শ্রেণী		দাগের মোট জমির পরিমাণ		দাগের মধ্যে অত্র খতিয়ানের অংশ	অংশ অনুযায়ী জমির পরিমাণ		দখল বিবরণ ও অন্যান্য বিশেষ মন্তব্য
				কৃষি (এক)	অকৃষি (এক)	একর (ক)	শতাংশ (খ)		একর (ক)	শতাংশ (খ)	
নির্বাহী চেয়ারম্যান বাংলাদেশ অর্থনৈতিক অঞ্চল কর্তৃপক্ষ (বেঙ্গা) প্রধানমন্ত্রীর কার্যালয় বিডিবিএল ভবন, লেভেল-১এ, ১২ কারওয়ান বাজার, ঢাকা।	১		২	বেড়ীবাধ		০৪	৪০	সম্পূর্ণ	০৪	৪০	নিয়ারা খং নং ১ হতে আগত
			৩	পুকুর পাড়		০৩	২০	সম্পূর্ণ	০৩	২০	নিয়ারা খং নং ১ হতে আগত
			৪	পুকুর		০৩	৮৭	সম্পূর্ণ	০৩	৮৭	নিয়ারা খং নং ১ হতে আগত
			৫	পুকুর		০১	৭৩	সম্পূর্ণ	০১	৭৩	নিয়ারা খং নং ১ হতে আগত
			৬	পুকুর		১০	৫০	সম্পূর্ণ	১০	৫০	নিয়ারা খং নং ১ হতে আগত
			৭	পুকুর		১২	৭৭	সম্পূর্ণ	১২	৭৭	নিয়ারা খং নং ১ হতে আগত
			৮	পুকুর		১১	৮৭	সম্পূর্ণ	১১	৮৭	নিয়ারা খং নং ১ হতে আগত
			৯	পুকুর		০৬	৪১	সম্পূর্ণ	০৬	৪১	নিয়ারা খং নং ১ হতে আগত
			১০	পুকুর		০৭	৮৭	সম্পূর্ণ	০৭	৮৭	নিয়ারা খং নং ১ হতে আগত
			১১	পুকুর		০৭	৩৪	সম্পূর্ণ	০৭	৩৪	নিয়ারা খং নং ১ হতে আগত
			১২	পুকুর		০৩	৭২	সম্পূর্ণ	০৩	৭২	নিয়ারা খং নং ১ হতে আগত
			১৩	পুকুর		০৭	২৮	সম্পূর্ণ	০৭	২৮	নিয়ারা খং নং ১ হতে আগত
			১৪	পুকুর		০৭	৯৮	সম্পূর্ণ	০৭	৯৮	নিয়ারা খং নং ১ হতে আগত
			১৫	খামারবাড়ী		০৩	১৪	সম্পূর্ণ	০৩	১৪	নিয়ারা খং নং ১ হতে আগত
			১৬	পুকুর		০৭	২৩	সম্পূর্ণ	০৭	২৩	নিয়ারা খং নং ১ হতে আগত
১৭	পুকুর		১৭	৭২	সম্পূর্ণ	১৭	৭২	নিয়ারা খং নং ১ হতে আগত			
১৮	পুকুর		১৮	১৩	সম্পূর্ণ	০২	১৩	নিয়ারা খং নং ১ হতে আগত			
১৯	পুকুর		১৯	৩৬	সম্পূর্ণ	০৬	৩৬	নিয়ারা খং নং ১ হতে আগত			
			১৮(অটোর) দাগ মাত্র।								

উপজেলা জমি অফিস, টেকনাফ এর ০১/২০১৫-১৬ নং দীর্ঘমেয়াদী বন্দোবস্ত মামলা, জমি মন্ত্রণালয়ের ১৯ এপ্রিল ২০১৬ তারিখের ৩১.০০.০০০০.০৪২.৫৬.০১২.১৬-১৮১ নং স্বাক্ষর, জেলা প্রশাসকের কার্যালয়, কক্সবাজার এর ২১.০৬.২০১৬খ্রি: তারিখের ০৫.২০.২২০০.১২৮.১২.০২৪.২০১৫-৭৪০ নং স্বাক্ষর এবং নামজারী ও জমাভাগ মামলা নং-২৮০৯(IX-1)/২০১৫-১৬এর-১৮.০৭.২০১৬খ্রি: তারিখের আদেশ মতে অত্র খতিয়ান সূজন করা হলো।

২১৫ ৪২

মেট =

২৯/৯/২০১৬

ধারা মতে নোট বা পরিবর্তন।

A.4. VES survey report from DPHE

4.1 Field Investigation

Field investigation that includes geo-electric resistivity sounding was carried out in the study in the month of December, 2012.

4.2 Geo-electric Resistivity Survey

Vertical Electrical Resistivity Soundings (VES) were carried out in the study area with an objective to follow the subsurface lithology variation, determine aquifer geometry, and possible thickness and extension of the aquifer and aquitard.

4.2.1 Field Procedure of Vertical Electrical Soundings (VES)

4 VES of Schlumberger Configuration with maximum spread of 800 m was executed at different locations of the study area (Fig 1). The site should have enough open space straight in both sides from the center of the spreading. So it is not always possible to get a suitable site for VES in targeted position. It is very difficult to locate VES uniformly due to lack of suitable site to carry out the survey. It is also tried to locate few VES nearby the existing bore holes location so that VES data can be correlated with the existing borehole data. After selecting the site the center of the spread and the direction of the array were marked and are presented in table 3,

Table 3: Location Information of VES carried out of the study area

VES #	Coordinate	Location	Array Direction	Date
VES 01	N 20.9708	Rohinga Camp (extended)	N-S	02.12.12
	E 92.2458			
VES 02	N 20.85843	Purba Gudarbil, Bitorshorof Dakhil madrasa, Teknaf Sadar	E-W	03.12.12
	E 92.29170			
VES 03	N 20.95383	Nayapara, Teknaf Sadar	N-S	03.12.12
	E 92.25686			
VES 04	N 21.04176	Nayapara, Whykong Union	N-S	03.12.12
	E 92.24264			



Figure 5: Sounding data acquisition in the study area

The resistivity measuring equipment “Resistivity Meter” for the survey is kept at the center. The layout is done along a straight line from the center. The current electrode 1 m, 2 m, 4 m, 6m, 8m,10m, 12m, 15m, 20m, 25m, 30m, 40m, 50m, 60m, 80m, 100m, 120m, 150m, 200m, 250m, 300m, 400m spacing from the centre on each side is used in the field. The potential electrode spacing is selected depending on the measurement of potential difference and the potential electrode spacing was selected 0.5m, 1m, 1.5m, 2m, 5m, 10m and 20m in each side of the centre point. The execution of the field work is shown in figure 9.

Table 4: Interpreted parameters of Resistivity Sounding Survey

Teknaf Resistivity Survey Results				
VES No. 01				
Layer No.	Layer Resistivity	Thickness	Depth	Remarks
1	13.905	1.4828	1.4828	
2	8.5189	61.158	62.641	
3	32.151			
VES No. 02				
1	27.356	0.869	0.869	
2	5.035	4.232	5.101	
3	0.83176	22.888	27.989	
4	171.4			
VES No. 03				
1	35.274	0.34029	0.340	
2	5.679	1.375	1.715	
3	15.937	25.642	27.357	
4	31.739	67.908	95.265	
5	9.6416			
VES No. 04				
1	10.904	1.2436	1.243	
2	0.87741	17.683	18.926	
3	33.574	54.546	73.473	
4	5.3867	84.667	158.14	
5	55.248			

Vertical electrical sounding 01 was carried out beside a brick field along north south direction at the north-west corner of the lada Khal Rohingya Camp. The maximum spreading for the array on the availability of the space was taken 400m ($AB/2 = 200m$). Plotting of data on a double log sheet produced a smooth curve indicating good quality data. Interpretation of VES 01 shows a 4 layer geoelectric model (Figure 6, Table 4). The top layer composing of surface soil shows resistivity $13.9 \Omega m$ of about 1.5m thickness. The 2nd and 3rd layers show more or less similar resistivity varying from 6.31 to $8.51 \Omega m$. The lithology of these two

layers is similar and is composed of alluvium of fine sand silt and clay with a thickness of about 70m. In the lower part (3rd layer) the proportion of sand and silt may be higher. The bottom layer shows resistivity around 32 Ωm reflecting the compacted current rocks of Tertiary age. The middle portion of the sequence may act as an aquifer of low permeability with limited abstraction capacity. Shallow tube wells and dug wells may be the best option for abstraction of water from this aquifer.

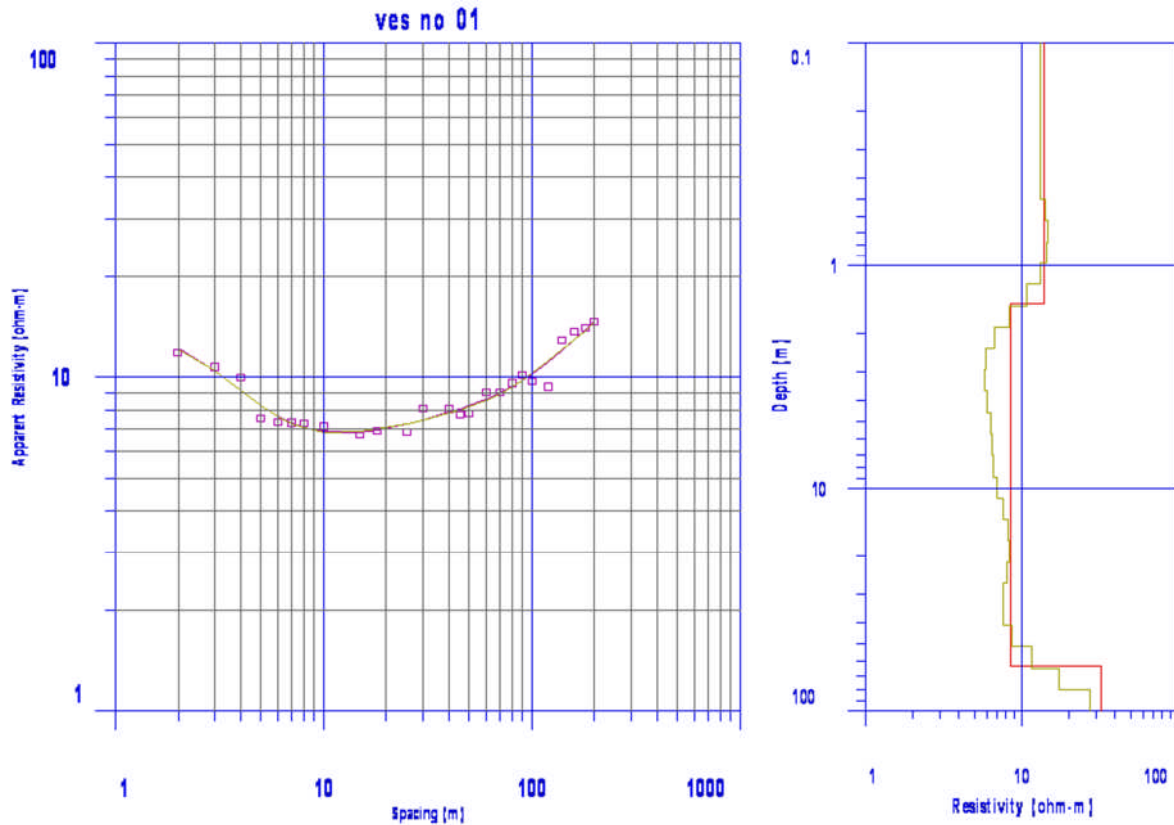


Figure 6: Interpretation of sounding Curve VES 01; Field curve with the matched theoretical (left) and the subsurface layered model (right)

VES 02 was executed at Purba Gudarbil, Bitorshorof Dakhil Madrasa area in Teknaf Sadar. The area is relatively depressed and the sounding centre is in the paddy field. Maximum array was 400m (AB/2 = 200m) in E-W direction. Interpretation of the sounding curve produced a 4 layer geo-electric model (Figure 7, Table 4). Top soil shows resistivity of 27 Ωm. The top soil is dry and clay-silty clay in composition and the thickness is around 1m. The following layer shows resistivity around 5 Ωm and the total thickness of the layer is about 3.5m. This layer is composed of clay-silty clay materials. The following layer shows very low resistivity around 1 Ωm reflecting that these layers may be composed of clayey sediments saturated with brackish/saline water. Thickness of the layer is about 23m. The deepest layer of the investigated sequence shows resistivity around more than 100 Ωm indicating that the layer is tertiary bed rock.

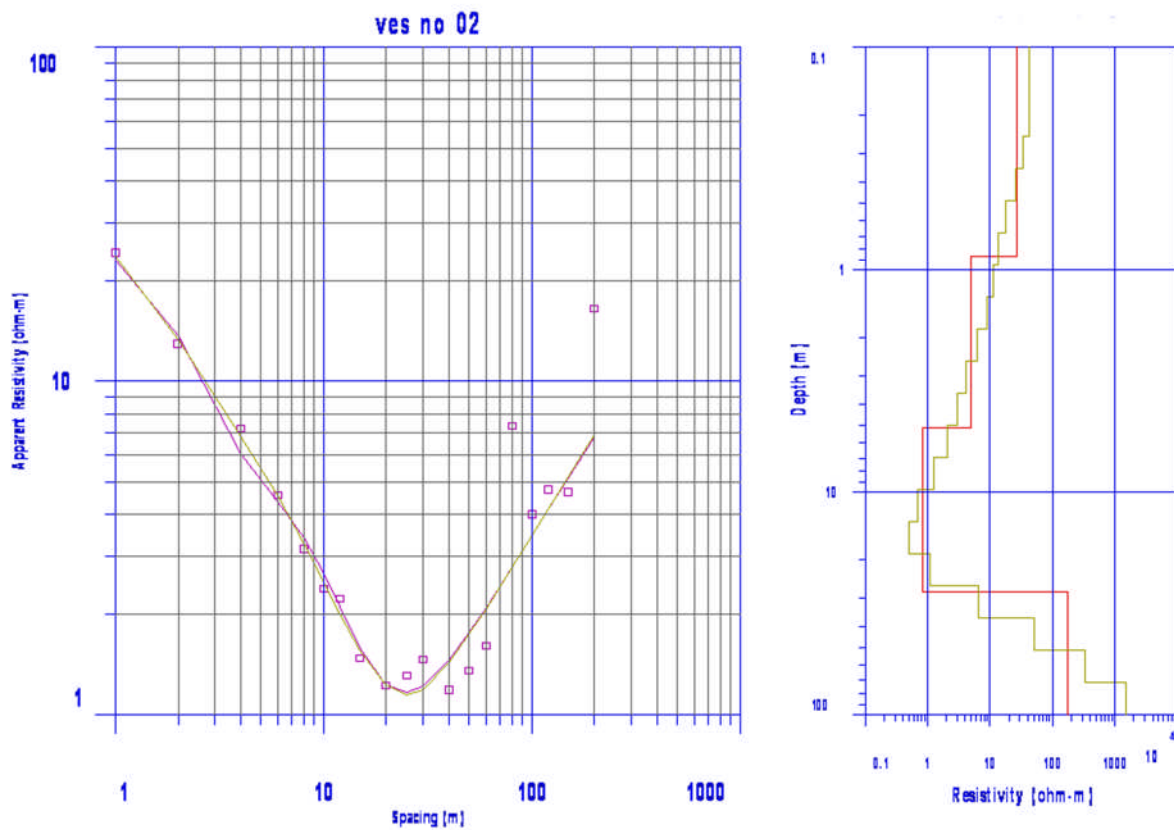


Figure 7: Interpretation of sounding Curve VES 02; Field curve with the matched Theoretical (left) and the subsurface layered model (right)

Interpretation of sounding curve VES 3 at Nayapara, Teknaf Sadar, shows a 5 layer HAK type model (Figure 8, Table 4). The top dry soil shows resistivity around 35 Ω m and is clay-silty clay in composition. The 2nd layer shows resistivity around 6 Ω m. The layer is a saturated one with clayey composition and the thickness is about 1.5m. The third layer shows resistivity around 16 Ω m with a thickness of 26m. It may be composed of silty fine sand to medium sand and the containing water may be fresh. The third layer shows resistivity around 32 Ω m with a thickness of around 68m. Resistivity value suggests that the layer may be composed of fine to medium sand saturated with fresh water. The following layer shows resistivity around 10 Ω m suggesting silty to fine sand composition and the water quality may be brackish.

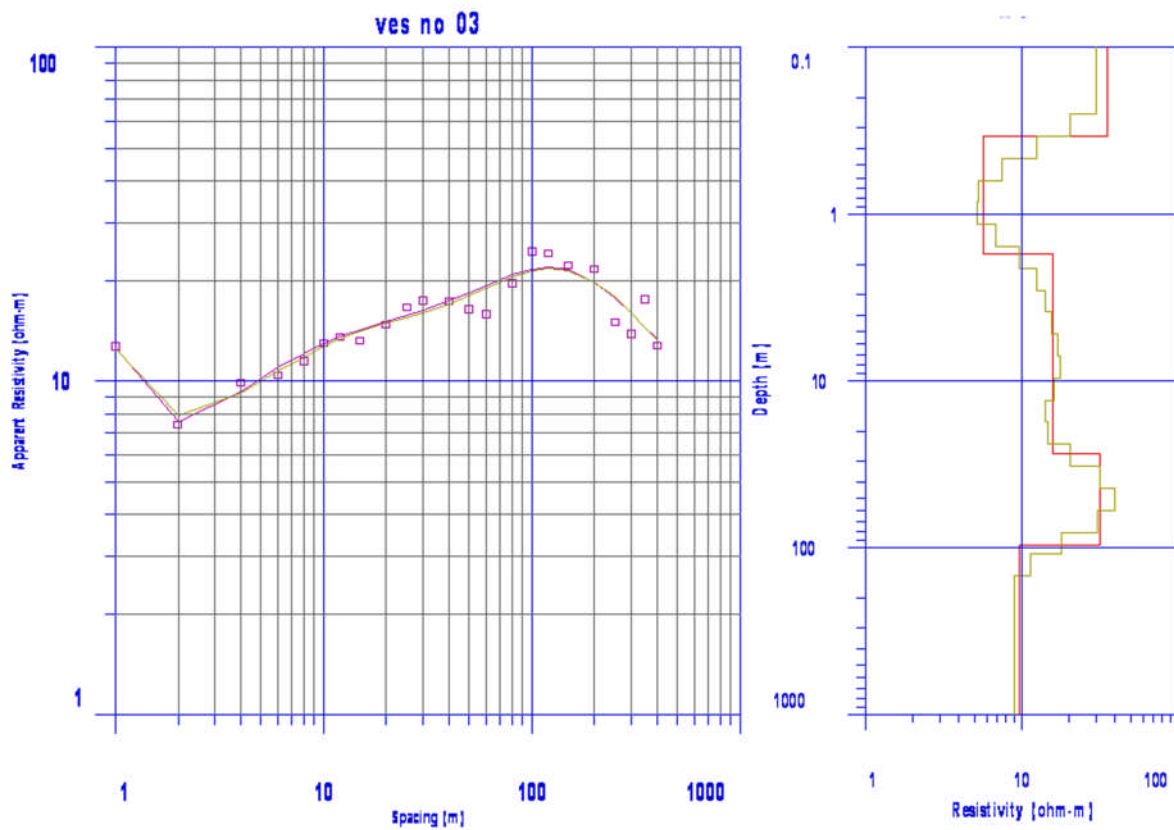


Figure 8: Interpretation of sounding Curve VES 03; Field curve with the matched Theoretical (left) and the subsurface layered model (right)

Interpretation of VES 4 at Nayapara, Whykong Union shows a 5 layer HKH type model (Figure 9, Table 4). The top layer shows resistivity around 11 Ωm with thickness of 1m. The soil is clay-silty sand in composition and moisture saturated. The 2nd layer shows resistivity around 1 Ωm with a thickness of 18m. It is clay to silty clay in composition and is saturated with saline/brackish water. Resistivity of the 3rd layer is around 34 Ωm indicating its sandy composition containing fresh water. The thickness is adequate and is about 55m. The 4th layer shows resistivity around 6 Ωm with a thickness of around 85m. The layer is a saturated one with clay to silty clay composition. The 5th layer of the investigated sequence shows resistivity around 55 Ωm and may be the compacted Tertiary rock.

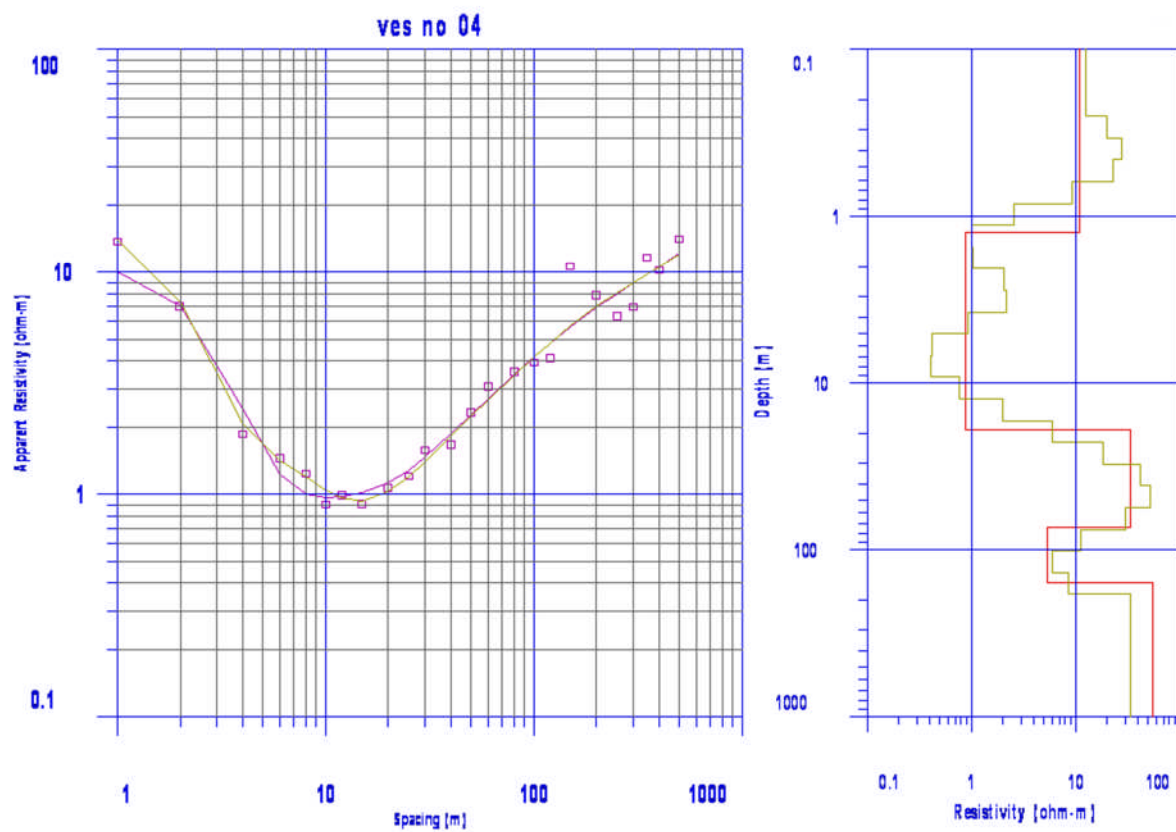


Figure 9: Interpretation of sounding Curve VES 04; Field curve with the matched Theoretical (left) and the subsurface layered model (right)