ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

For

YWAMA COMBINED CYCLE GAS TURBINE (CCGT) POWER PLANT UPGRADE

UPDATED FINAL REPORT

Project Proponent

ELECTRIC POWER GENERATION ENTERPRISE

MINISTRY OF ELECTRICITY AND ENERGY

NAYPYITAW, MYANMAR

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AAQ	:	Ambient Air Quality
ADB	:	Asian Development Bank
AERMOD	:	Atmospheric dispersion modeling software
AIS	:	Air Insulated Sub-Station
AVG.	:	Average
BAT	:	Best Available Technique
BID	:	Background Information Document
BOD	:	Biochemical Oxygen Demand
BOP	:	Balance of Plant
C	:	Construction
CBO	:	Community Based Organization
CCGT	:	Combined Cycle Gas Turbine
CEDAW	:	Convention on Eliminations of All forms of Discrimination Against Women
CEMS	:	Continuous Emission Monitoring System
CITES	:	Convention on the International Trade of Endangered Species of Wild Fauna & Flora
COD	:	Commercial Operation Date
COD	:	Chemical Oxygen Demand
CSO	:	Civil Society Organization
CT	:	Cooling Tower
D	:	Decommissioning
DFR	:	Digital Fault Recorder System
DM	:	Demineralization
DO	:	Dissolved Oxygen
E&S	:	Environmental and Social
EC	:	Electrical Conductivity
ECC	:	Environment Conservation Committee/Environment Compliance Certification
ECD	:	Environment Conservation Department
ECR	:	Environment Conservation Rules
EGAT	:	Electricity Generating Authority of Thailand
EHS	:	Environment Health and Safety
EIA	:	Environment Impact Assessment
EM	:	Emergency Manager
EMP	:	Environment Management Plan
EPC	:	Engineering, Procurement and Construction
EPGE	:	Electric Power Generation Enterprise
ERC	:	Emergency Response Cell
ERP	:	Emergency Response Plan
ESE	:	Electricity Supply Enterprise
ESIA	:	Environment and Social Impact Assessment
ESMP	:	Environment and Social Management Plan
FESR	:	Framework for Economic and Social Reform
FGD	:	Focus Group Discussion
FO	:	Fire Officer
FPS	:	Fine Particulate Matter
FS	:	Feasibility Study
GBV	:	Gender Based Violence

GCPL	:	Greencindia Consulting Private Limited
GDP	:	Gross Domestic Product
GE	:	General Electronic
GIS	:	Gas Insulated Substation
GLC	:	Ground Level Concentration
GRC	:	Grievance Redressal Cell
GRM	:	Grievance Redressal Mechanism
GRP	:	Glass Reinforced Pipes
GT	:	Gas Turbine
GTG	:	Gas Turbine Generator
Ha	:	hectare
HAZOP	:	Hazard and operability study (HAZOP)
HDPE	:	High Density Polyethylene
HO	:	Head Office
HP	:	High Pressure
HRSG	:	Heat Recovery Steam Generators
HV	:	High Voltage
IC	:	Inorganic Carbon
ICESCR	:	International Covenant on Economic, Social and Cultural Rights
IFC	:	International Finance Corporation
IEE	:	Initial Environment Examination
INDC	:	Intended Nationality Determined Contribution
IPPC	:	International Plant Protection Convention
IP	:	Intermediate Pressure
IPP	:	Independent Power Producer
ISCST3	:	Industrial Source Complex Short Term Version 3
LCP	:	Large Combustion Plant
LNG	:	Liquefied Natural Gas
LOC	:	Level of Concern
LPCD	:	Litre per Capita per Day
LP	:	Low Pressure
LPM	:	Litre Per Minutes
LSB	:	Last Stage Blade
LTSA	:	Long Term Service Agreement
KLD	:	Kilo Litre per Day
MEPP	:	Myanmar Electric Power Project
MESC	:	Mandalay Electricity Supply Corporation
MHI	:	Mitsubishi Heavy Industries
MHPS	:	Mitsubishi Hitachi Power System
MOE	:	Ministry of Energy
MOEE	:	Ministry of Electricity and Energy
MOEP	:	Ministry of Electric Power
MOGE	:	Myanmar Oil and Gas Enterprise
MONREC	:	Ministry of Natural Resources and Environmental Conservation
MPE	:	Myanmar Petrochemical Enterprise
MSCFD	:	Million Standard Cubic Feet Per day
MSL	:	Mean Sea Level
NAPAP	:	National Acid Precipitation Assessment Program
NCDP	:	National Comprehensive Development Plan
NCEA	:	National Commission for Environment Affairs

NDIR	:	Non-dispersive Infra Red Spectroscopy
NEP	:	National Environment Policy
NEQG	:	National Environment Quality Guidelines
NFPA	:	National Five Protection Association
NGO	:	Non-Government Organization
NNE	:	North North East
NNW	:	North North West
NSDS	:	National Sustainable Development Strategy
NTP	:	Notice to Proceed
NW	:	North West
O&M	:	Operation & Management
OHS	:	Occupational Health and Safety
OM	:	Organic Matter
OP	:	Operation
OPEX	:	Operating Expenses
OT	:	Once Through
PAP	:	Project Affected Person
PC	:	Pre-Construction
PM	:	Particulate Matter
PRA	:	Participatory Rural Appraisal
PTSCD	:	Power Transmission and System Control Department
RCC	:	Reinforced Cement Concrete
RDS	:	Respirable Dust Sampler
ROUM	:	Republic of the Union of Myanmar
S	:	South
SCPP	:	Simple Cycle Power Plant
SE	:	South East
SEA	:	Stakeholder Engagement Activities
SLM	:	Sound Level Meter
SPL	:	Sound Pressure Level
SSE	:	South South East
SSW	:	South South West
STG	:	Steam Turbine Generator
TCM	:	Tetra Chloro Mercurate
TDS	:	Total Dissolved Solid
TOC	:	Total Amount of Organic
TOR	:	Terms of Reference
TSS	:	Total Suspended Solid
UNCED	:	United Nations Conference on Environment and Development
UPS	:	Uninterruptible Power Supply/Emergency Power System
USD	:	United States Dollar
USEPA	:	United States Environment Protection Agency
WBG	:	World Bank Group's
WTP	:	Water Treatment Plant
YESB	:	Yangon City Electricity Supply Board
YESC	:	Yangon Electricity Supply Corporation

LIST OF UNITS

Sl. No.	Unit	Full Form	Particulars
1.	MW	Mega Watt	Capacity
2.	GWh	Giga Watt Hour	Energy
3.	kWh	Kilo Watt Hour	Energy
4.	kV	Kilo Volt	Voltage
5.	Ha	Hector	Area
6.	MJ/s	Mega Joule per second	Power
7.	HP	Horse Power	Engine Power
8.	kW	Kilo Watt	Capacity
9.	V	Volt	Voltage
10.	Hz	Hertz	Frequency
11.	m^3/day	Cubic meter per day	Flow rate
12.	m^3/hr	Cubic meter per Hour	Flow Rate
13.	mg/l	Milgram per Litre	Concentration
14.	Tons	Tons	Emission
15.	µ	Micron	Diameter
16.	ppm	Parts per Million	Concentration
17.	gph	Gallons per Hour	Quantity of water
18.	mph	Meter per Second/ Miles per second	Wind Speed
19.	m^3/min	Cubic meter per minute	Flow Rate
20.	lpm	Litres per Minute	Flow rate
21.	µg/m^3	Micro Gram per Cubic meter	Concentration
22.	mg/m^3	Milli Gram per cubic meter	Concentration
23.	dB(A)	Decibel (A-Weighted)	Sound Pressure Levels
24.	JTU	Jackson Candle Turbidity Unit	Turbidity Measurement
25.	NTU	Nephelometric Turbidity Unit	Turbidity measurement
26.	Hazen	Hazen	Colour measurement
27.	µS/cm	Micro Simons per Centimetre	Conductivity
28.	MPN	Most Probable Number	Total Coliform Concentration
29.	Inch/hours	Inch per Hour	Infiltration rate
30.	gm/cc	Gram per Cubic centimeter	Bulk density
31.	mg/kg	Milli gram per kilo gram	Concentration (Soil Parameter)
32.	kg/ Ha	Kilo Gram per Hector	Concentration (Soil Parameter)
33.	µmhos/cm	Micro mho per Centimetre	Electrical Conductivity
34.	mmhos /cm	Milli Mho per Centimetre	Electrical Conductivity
35.	mS/cm	Milli Simons per centimetre	Electrical Conductivity
36.	GW	Giga Watt	Capacity
37.	mg/m^3	Milli Gram per cubic meter	Concentration
38.	g/bhp.h	Grams per Brake Horsepower Hour	Emission rate Factor
39.	g/s	Gram per Second	Emission Rate
40.	g/s/m^2	Gram per second per square meter	Emission Rate per Area
41.	eq/kWh	Equivalent per kilo watt hour	Electricity Generation
42.	lpcd	Litre per capita per day	Water Consumption
43.	KLD	Kilo Litre per day	Water Consumption

Sl. No.	Unit	Full Form	Particulars
44.	g/mol	Gram per Mole	Molecular Weight
45.	Kg/s	Kilo gram per second	Burn Rate
46.	Pa	Pascal	Pipe Pressure
47.	mg/Nm^3	Milli Gram per Normal Metre cube	Concentration

EXECUTIVE SUMMARY

UPDATED FINAL ESIA REPORT

Project Proponent: Electric Power Generation Enterprise

MINISTRY OF ELECTRICITY AND ENERGY, NAYPYITAW

1 EXECUTIVE SUMMARY

This Environmental and Social Impact Assessment report presents an assessment of the potential environmental and social impacts associated with the proposed Combined Cycle Gas Turbine power plant and project facilities proposed to be installed in the existing power plant at Ywama, Yangon Region, Myanmar. This report has been prepared for Ministry of Electricity and Energy (MOEE), Myanmar by Greencindia Consulting Private Limited, India.

1.1 THE PROJECT

The project involves dismantling of two existing Simple Cycle Power Plant and relocating one existing gas turbine with stream turbo generators units and its auxiliary systems and making space to install a high efficiency Combined Cycle Gas Turbine Power unit.

Presently there are three types of power generation units and one Gas-Engine IPP plant in the site with a total generating capacity of 350.9MW. The details are as follows:

- 52 MW Independent Power Producer (IPP);
- 2x120 MW Mitsubishi M701D;
- 23.4MW Hitachi H25CCGT(to be de-commissioned); and
- 2x18.45MW John Brown Simple Cycle Power Plant (SCPP) (to be de-commissioned).

The single unit of the Hitachi CCGT and 2 units of the John Brown SCPP will be de-commissioned and replaced by a new Combined Cycle Gas Turbine Plant of capacity in range of 250 to 300MW.

1.2 NEED OF THE PROJECT

Myanmar grid suffers frequent load shedding for several reasons such as:

- Most of the thermal power plants are old and have low efficiency;
- Lack of water for hydropower plants during dry season leading to seasonal power supply from hydropower projects;
- Transmission constraints to distribute the power generated by the hydropower plants located in the north of the country to the main consumption center in Yangon region.

Without implementation of new power projects and considering the power demand increase, the current problems will grow. To remedy to the above issues, the following actions have been planned.

- Reinforce the transmission system with a new 500 kV line connecting North and South of Myanmar (expected COD in 2022) in order to improve the hydropower use across the country;
- Develop the country's hydropower and renewable energy potential;
- Increase the natural gas supply capacity via new LNG plants and

- Install new efficient gas fired power plants

Keeping in mind the availability of natural gas in Myanmar and gas line to the Ywama plant from Yadana off-shore gas fields, installation of a 250-300MW CCGT at the Ywama plant is needed for both reducing the gap between power supply and demand as well as for economic development of the country.

In addition to the above, the plant will generate 2.5 times electricity output from the same amount of gas, reducing GHG emissions per unit of output. Given that the plant will increase generation, the absolute emissions would marginally increase for the plant if compared to a business-as-usual scenario, in which the obsolete turbines would keep on working for about 5 more years (until the end of their operational life in 2023) and then electricity would be generated at an average efficiency of existing gas-fired power plants. According to the least-cost plan that was undertaken for the purpose of the project, the need for other fossil fuels such as HFO, coal and LNG would increase to supply demand without the efficiency and capacity upgrade of the proposed project. This way, the project is expected to reduce carbon emissions by 12.3 million tons of CO_2 equivalent.

1.3 OBJECTIVES OF THE ESIA STUDY

The specific objectives of this ESIA are as follows:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be potentially impacted by the Project;
- Identify the aspects of the Project that could potentially result in significant environmental and social impacts on resources/ receptors;
- Document how stakeholders have been engaged during the ESIA Process, and how stakeholder feedback has been considered in the ESIA;
- Identify the aspects of the Project that need to be managed, and recommend appropriate and justified mitigation and enhancement measures;
- Determine the significance of residual impacts, considering the implementation of mitigation measures;
- Generate plans for the management and monitoring of impacts, including plans for ongoing stakeholder engagement; and
- To meet international environmental and social requirements.

1.4 LOCATION OF THE PROJECT

The site for the Project is situated at Insein township in suburbs of Yangon city. It is located adjacent to the Hlaing River, which is a wide tidal channel. The proposed project will be located within the existing footprint of the plant. The Yangon International Airport is about 4.2km (aerial distance) while the Myanmar Industrial Port is 16.2km away from the Ywama Power Plant. The total area of the Ywama power plant is 8.9 ha (22.54 acres). After dismantling of three of the generating units, the area for the new CCGT will be about 2.4ha (6.0 acres). The site is plain and the contours vary between 3.7 to 3.8 m above mean sea-level.

The power plant site is located in an area having mixed land-use of industrial, commercial and residential facilities. On the northern side of the project site there is a steel mill located adjacent to the site followed by the Shwe Pyi Thar Industrial Zone (Zone-4). On the Eastern side of the Ywama Power Plant are residential colonies of EPGE, Municipal Corporation and Steel Mill. The sub-quarters 5 & 6 of Ywama Township is located in the southern side of the plant. The Western boundary of the plant is adjacent to the Hlaing River, which is about 510m wide near the plant.

1.5 PROPOSED PLANT CONFIGURATION

It has been decided with EPGE that the configuration of the combined cycle can be either the 1-1-1 configuration or the 2-2-1 configuration. Only a range of power capacity (e.g. between 250MW and 300MW) have been determined. The CCGT will be either in the:

- 80-120 MW ISO size per Gas Turbine (“GT”), which would be configured as a 2-2-1 [2 GT, 2 Heat Recovery Steam Generator(“HRSG’s”) and 1 Common Steam Turbine (“ST”)]plant;
- or in the 180–190 MW ISO size, which would be configured as a 1-1-1 (1 GT, 1 HRSG’s and 1 ST)plant.

For both configurations, by-pass stack between each GT and HRSG will be provided.

The diffuser between the GT exit and HRSG inlet is noisy equipment. In order to reduce the noise level of the gas turbine, it is recommended to insulate it properly (acoustically and thermally) and install it.

1.5.1 Electrical System

The electrical power system of the plant can mainly be classified according to voltage level as follows:

- 230kV Transmission System
- 11kV GTG and STG Power Generation System
- 6.6kV Power Distribution System
- 400/230VAC Power Distribution System
- 400VAC EmergencyPower Supply
- 220VDC Power Distribution Supply
- 230VAC UPS Power Distribution Supply

1.5.2 Power Evacuation

The power generation in the new CCGT plant will be at about 11kV voltage level. The 11kV power generated will be stepped–up to 230kV voltage level using generator step-up transformers. The 230kV power from the new CCGT plant will be transmitted to the new 230KV GIS by underground cables and the new 230kV GIS is connected to the existing 230kV AIS by underground cables, then the 230kV power will be evacuated to 230kV grid thought the existing230kV transmission lines.

1.5.3 Fuel Supply

The natural gas for the proposed plant will be provided from the Yadana off-shore gas fields. Its quality of the gas is poor containing about 70% methane and 25% nitrogen. The requirement for the proposed plant has been estimated to be about 80 MSCFD. The natural gas will be supplied through existing pipelines from the country's offshore fields to the plant.

1.5.4 Plant Water System

Presently, service water is sourced from wells installed in the plant. After plant upgrading, make-up water for cooling purposes and service water will be extracted from the Hlaing River. The River bank is located at about 20 meters from the site boundary. That water will be used as make-up for the cooling tower and service water. All effluents after treatment to meet World Bank norms will also be discharged to the river.

A mechanical wet draft evaporative cooling tower has been selected for this plant. The de-concentration purge or tower blow down is discharged to the river using thermal diffuser in order to comply with the World Bank criteria. The temperature of discharged water will be within 3^0C above river water temperature. The cells of the cooling towers must be designed assuming salty water.

The towers would be equipped with a system to abate the white panache created by the evaporation of the water. Such system may be necessary due to the vicinity of the existing habitations. The River bank is located at about 20 meters from the site boundary.

It has been calculated that about 700m^3/hr make up water will be required for the cooling towers, considering the saline nature of the river water. A floating deck method for water abstraction from the river would be required. In this system, pumps are installed on a floating deck located at a sufficient distance for the river bank to have enough depth for pumping. However, for this plant, it has to be ensured that there is no interference with the fluvial traffic.

The sources of effluent from the power plant are as follows:

- Effluents coming from the water steam cycle (the purge of boiler drums, the various losses of the circuit, especially at start-up);
- Oily effluents resulting from various losses from oil tanks;
- Sanitary effluents from toilets;
- Rainwater considered as oily water during the first minutes of rainfall;
- The effluents of the demineralization unit; and
- The blow-down from the cooling towers

1.5.5 Time Frame

The execution of the project by the EPC Contractor starts at contract signing to end at the Commercial Date of Operation. The duration is estimated at 32 to 36 months. This is a best estimate considering the site complexity (small site, limited access, distant temporary areas and monsoon period).

1.5.6 Project Cost

Capital Cost

The total investment cost for the plant option assuming the largest power output of around 300Mw (net at site) is of around US$ 300 million, including contractor (EPC), owner, cost and contingencies. The estimated cost of demolition work of around 600,000USD is included in the total investment cost estimate. The demolition cost of the existing power plants was based on the number of buildings/ structures, size of buildings/structures, types of buildings/structures, foundations, site clearing and preparation, etc.

Operation Cost

The OPEX cost (fuel excluded) includes LTSA, fixed and variable costs. Based on similar projects, they are estimated between 4.5 to 6 USD/MWh, depending on the equipment and thermal conversion efficiency.

1.6 ENVIRONMENT AND BIO-PHYSICAL BASELINE CONDITIONS

This ESIA report incorporates the baseline data generated during November 2018.

The main feature of the area includes Hliang River on the western side of the plant. On the eastern side of the plant there are residential buildings/colonies of EPGE, Municipality and adjoining steel mill. The residential areas of Ywama Sub-quarters 5 and 6 continue on the southern side. The Ywama Monastery is also located in the south-eastern direction at distance of 500m.

1.6.1 Area Drainage

The natural slope of the area is towards the southern side. As mentioned, the River Hlaing flows adjacent to the plant site on the western side. it is found that there are many drainages joining the River near the plant. As the whole area around the plant comprises of settlements, there are artificial drains with domestic sewage flowing to the river.

1.6.2 Hazard Related to Natural Disaster

It has been estimated that about 50 percent of the total number of disasters in Myanmar was related to floods followed by storm (23 percent), earthquake (15 percent), and mass movement-wet (12 percent), whereas 73 percent of the total affected people by disasters were due to storm followed by floods in 1980-2011[1]. Similarly, storm is a major cause of disaster-related death and biggest estimated damage cost (86 percent). Earthquake (11 percent) and flood (3 percent) are next on the estimated damage cost. This pattern of disasters is due to Cyclone Nargis in 2008 which affected 2,400,000 people, left 138,000 fatalities and estimated damage cost for infrastructure of USD 4,000,000 to Myanmar.

1.6.3 Ambient Air Quality

Monitoring for PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO was done in 4 locations for determining the ambient air quality in the area. The monitoring was done in industrial and residential areas.

Station Code	Location	Direction	Distance	µg/m³				mg/m³
				PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO
AAQ1	Project Site	-	-	89.6	35.3	15.4	19.7	1.10
AAQ2	Adjacent residential area	NE	100m	84.7	31.4	13.2	17.6	0.77
AAQ3	Insein Township	S	2.1km	90.1	30.7	15.7	19.7	0.97
AAQ4	Shwe Lin Ban Industrial Zone	SW	1.2km	95.2	34.2	16.8	25.4	1.39

Particulate Matter (PM10 and PM2.5): It was found that due to industrial activities and large volume traffic in the area, PM10 values were on the higher side and ranged between 95.2µg/m³ and 84.7µg/m³. The PM2.5 value of the monitored locations varied between 35.3µg/m³ and 30.7µg/m³.

Gaseous Pollutants: The 98 percentile values of Sulphur Dioxide (SO_2) were found to be well within the WHO limit and varied between 16.8µg/m³ to 13.2µg/m³. Nitrogen Dioxide was monitored between 25.4µg/m³ and 17.6µg/m³ in spite of vehicle movements and an operational Gas Power Plant. The CO value was found to be within the range of 1.39mg/m³ and 0.77mg/m³. Overall it can be concluded that the air-shed in which the plant is located is polluted with SO_2, NO_2, and CO levels above or very close to the WHO limits. It is also contaminated with PM_{10} and PM_{20}.

1.6.4 Noise Level

The impact of noise is one of the major concerns related to the project. Thus noise monitoring for 24 hours was done in four locations with the distances measured from the center of the existing power plant.

Location	Distance	Direction	Day (in dBA)			Night (in dBA)		
			L_{Max}	L_{Min}	L_{eq}	L_{Max}	L_{Min}	L_{eq}
Project Site	-	-	98.4	91.1	96.0	93.3	88.2	90.5
Residential area in North	100m	NE	79.0	72.7	76.5	68.2	60.2	65.4
Insein	1.1km	S	55.8	50.9	53.4	49.8	40.1	43.5
West Bank of Hlaing River	1.0km	SW	58.5	51.9	55.4	52.3	47.4	50.0

[1] Natural Disaster Risk Assessment and Area Business Continuity Plan Formulation for Industrial Agglomerated Areas in the ASEAN Region

The maximum noise level was found inside the plant at 96.0dB(A) while at the nearest residential area, which is located about 100m from the center of the existing power plant, it was calculated to be 76.5dB(A). There was a slight variation between the day and night level, although it was not significant. This was due to the continuous noise emitting from the existing plant. The noise level at both these locations were much higher than the national ambient noise standards of 55dB(A) during day and 45dB(A) during night. The noise level inside the plant was higher than the 70dB(A) prescribed for industrial areas. The noise level in the other residential areas about 1km from the plant was found to have normal noise level below the prescribed standards. The night time noise levels (Leq) ranged between 65.4dB(A) to 90.5dB(A) near the plant.

Those levels exceed the prescribed WBG Environmental Health Safety Guidelines' limit of 55 dB(A) during day time and 45 dB(A) during night time for residential areas. This problem especially affects the 80 apartments (buildings E6-E10) located closest to the power plant. Company employees and their families live there, and they are also affected by vibrations, especially caused by sporadic emergency shutdowns.

1.6.5 Traffic Volume

The main road near to the Plant is the Bayint Naung Road, which is a 4 lane arterial road joining the port area to the northern districts of Yangon. The 24-hour vehicle traffic survey was conducted for a day. Manual direct observation and recording using tally counters were conducted to count the number of vehicles moving in each direction. The classified traffic volume count shows that there is heavy traffic in T1 as compared to the other two locations. It was found that there is more volume of heavy goods vehicles near the plant site than the down-town area. Overall it can be concluded that the road has enough capacity for movement of over-sized vehicles required for transportation of plant machineries.

Classified Traffic Volume Count in Study Area

Code	Location	Direction	Car	Van	Two- axle Heavy	Multi- Axle Truck	2- wheeler
T1	Strand Rd, Near Port, Opposite to AYA bank	Towards Port	11,880	2,750	5,904	321	0
		Towards Plant	12,996	864	6,744	416	0
Total			**24,876**	**3,61**	**12,648**	**737**	**0**
T2	BayintNaung Rd, Near BayintNaung	Towards Port	6,490	672	2,644	576	0
		Towards Plant	7,408	1,632	3,744	1,296	0
Total			**13,898**	**2,30**	**6,388**	**1,872**	**0**
T3	BayintNaungRd, Near YwamaPower	Towards Port	2,160	1,008	2,712	1,536	1225
		Towards Plant	3,708	1,435	2,376	1,823	812
Total			**5,868**	**2,443**	**5,088**	**3,359**	**2,037**

1.6.6 Water Quality

The analysis results for surface water indicate that pH is found to be 6.5 to 6.8, which is well within the specified standard 6.5-8.5. The TDS was observed at 986 to 1012mg/l. It is found that water quality of Hlaing River deteriorates and doesn't meet requirements for conserving of living environment due to the pollution from the tributary streams which received waste-water from adjacent industrial zones and new satellite town. Dissolved oxygen was observed to be 5.7 to 7.4mg/l. The chlorides and sulphates were found to be 402 to 436mg/l and 22 to 31mg/l respectively. The river water was observed to be brackish in nature.

The physic-chemical analysis of the ground water was taken from three sources near to the plant shows that the water quality is suitable for drinking after proper disinfection. Parameters such as, alkalinity, chloride and fluoride was within the permissible limits. No heavy metals were found in any of the samples.

1.6.7 Soil Quality

Soil quality was assessed at three locations, at the place of the new plant (S1), at the lay down area 0.23km from the center of the power plant (S2), and at the opposite side of river to Project area which is 0,8km from the center of the power plant. The soil quality as analyzed from the collected samples is given in the table below.

Sl. No.	Parameters, Units	S1	S2	S3	Vietnam	Thailand
1	Organic Carbon, %	1.52	0.98	1.03	-	-
2	Organic matter, %	2.62	1.68	1.74	-	-
3	Cadmium, mg/ Kg	<0.2	<0.2	<0.2	2	37
4	Total chromium, mg/ Kg	<0.2	<0.2	<0.2	200	-
5	Lead, mg/ Kg	10.7	11.4	12.7	70	400
6	Manganese, mg/ Kg	106	51	62	-	1800
7	Mercury, mg/ Kg	<0.1	<0.1	<0.1	-	23
8	Nitrogen as N, Kg/ ha	204	194	198	-	-
9	Phosphorous, Kg/ ha	13.1	12.4	13.8	-	-
10	Potassium as K, Kg/ ha	156	156	172	-	-

The soil type in the area was found to be sandy-clay. The fertility of the soil is quite good and would sustain healthy growth of vegetations. Based on the assessment, the soil is not contaminated with heavy metals, although more detailed measurements will be undertaken prior to upgrading the plant. There does not seem to be historical pollution in the project area.

1.6.8 Ecological Environment

As the study area is urbanized, natural habitats for vegetation is very less and trees present are mostly planned plantations. A survey was conducted to study the types of vegetations present in the area. Majority of the affected trees are mango (*Mangifera indica*). The other dominant species include vandar (*Terminalia catappa*) and Jackfruit (*Artocarpusheterophyllus*). There were also clumps of banana trees in the whole area.

1.6.9 Social Environment

As the proposed plant will be developed in place of the existing plants, no additional land is required for the project. The nearest habitations are residential buildings of industries and Ywama West Sub-quarters 5 & 6. The number of households in the locality is 6,752 with a total population of 30,704. The sex ratio is 106.2, which includes 14,889 males and 15,815 females.

There is a dominance of Bamah with 88% of the total population. This is followed by Kayin (8%) and Rakhine (1.2%). Other ethnic groups are in the area includes Kachin, Kayah and Chin. As the area under study is an urban area, there is a mixed urban population that does not have collective or ancestral attachment to this area.

1.7 ENVIRONMENTAL AND SOCIAL IMPACT AND MITIGATION MEASURES

This section analyses the potential environmental and social impacts due to the project. The project activities will occur in 4 distinct stages of the project life cycle:

- Dismantling of existing plant (Pre-construction Phase);
- Construction of the Plant (Construction Phase);
- Operation and maintenance of the Plant (Operation Phase); and Decommissioning Phase.

In this section, the major impacts identified are discussed

1.7.1 Impact on Air Quality

Pre-Construction: The dismantling process consists of mechanical, hydraulic and electrical unbolting, cutting or disconnecting and lead to use of fuel driven heavy equipment. Gaseous emission is expected from these activities from the machines, generators and heavy vehicles used for transporting the dismantled machineries and scraps. Also, as the initial storage before packaging or disposal will be done in the lay-down area identified close to residential areas, there is a risk of fugitive emissions.

Construction: Materials handling, truck movements within the work sites, wind erosion of the open uncovered areas are the potential sources of fugitive dust emissions. Construction dust arising from the dust generating activities and air emissions from construction vehicles and non-road machinery within the construction site boundary are the key concerns during construction of the Project. Care is to be taken to ensure that the fugitive emission do not cause too much inconvenience to the adjacent residential areas. The decision to whether transport heavy machineries from Yangon Port to the Project site by trucks and trailers or by the river is yet to be decided. This may also cause gaseous emissions, mainly NO_2 and CO, near the lay-down area. The duration of the construction activity will be medium term and impact localized and reversible, the significance of impact will be minor.

Mitigation: The main mitigation measures will be as follows:

- Screens of minimum 5m height will be erected along the boundary of the Project site to suppress wind-blown dust.

- The access roads within works areas will be watered and maintained wet all the time
- Minimizing the size of exposed areas and material stockpiles and the periods of their existence;
- Temporary stockpiles of dusty materials will be either covered entirely by impervious sheets or sprayed with water to maintain the entire surface wet all the time;
- Covering the construction materials transported by trucks or vehicles;
- Cleaning wheels and the lower body parts of trucks at all exits of the construction site;
- Cleaning the entire construction work sites at least once per week;
- Controlling the height of unloading the fill materials during filling as far as possible. Where possible, this should be well below the 5m height of the hoardings along the project site boundary;
- Prohibiting the burning of waste or vegetation on site;
- Compacting the reclaimed land immediately to avoid fugitive dust emissions;
- Maintaining and checking the construction equipment regularly;
- Switching off engines when idling; and
- Using ultra-low sulphur diesel for trucks and diesel-fuelled construction equipment if available.

Operation: The main air pollutant of concern for a gas-fired combined cycle power plant is nitrogen dioxide (NO_2) whilst emissions of sulphur dioxide (SO_2) and particulate matters (PM_{10} and $PM_{2.5}$) are likely to be minimal provided that the combustion process is optimized and efficient. From the baseline, it was found that the present value of $NO_2$with 3 operational units of Ywama power plant and the IPP plant functional was around 25.4µg/m^3, which is within the prescribed standard of World Bank and Myanmar.

The highest predicted GLCs of NO_2, for the proposed project (4 functional units and Gas Engine Plant) during normal combined cycle operation was found to be about 29.0µg/m^3, which is about 3.6 µg/m^3 above the present scenario. It was found that due to stable and low wind speed, there will be no impact on the receptors near to the plant. The concentration will be towards the river and industrial area, which are also a source of pollution. Also, as mentioned before, there are no ecological sensitive areas near to the project site. Thus, it can be concluded that an incremental GLC of 3.6µg/m^3 is not severe and the significance of impact will be minor.

Mitigation: The main mitigation measures will be as follows:

- Ascertain that the emission limit for NO_2 is limited to 50mg/Nm^3 as the study area has been found to be falling in non-degraded air-shed;
- Installation of dry low NOx burners;
- Plantation of large canopy trees in the eastern and southern side of the plant. As

there is no space inside the plant boundary, plantation should be made on the outside, as the land belongs to EPGE only.

Impact during De-Commissioning Phase

The impact during de-commissioning of the proposed plant will be same as the pre-construction stage as the activities will involve dismantling of the plant. Thus, the significance of impact on air quality will be minor.

Mitigation: The mitigation measures will be same as the pre-construction stage.

1.7.2 Impact on Surface Water

During the construction and operation phases, different activities have the potential to generate waste-water, accidental spills, sedimentation and increased water consumption, which could lead to impacts on the hydrology and quality of surrounding fresh water-bodies. In the Project Study Area, the Hlaing River is identified as the most prominent potential receiving body.

Pre-construction and Construction: The waste water is expected to be generated from sanitary wastes (of domestic sewage), run-off from stock-piles, washing of machineries and oil and grease from the construction site. As the duration of impact will be short-term and the impact localized, the impact significance will be minor as the impact will be detectable but with no significance to human health.

Mitigation: The main mitigation measures will be as follows:

- Install oil/water separators to treat surface run-off from bunded areas prior to discharge to the storm-water system;
- Implement adequate sanitary facilities, (one toilet for every 25 workers up to the first 100, and one for every 50 thereafter) will be provided for the construction workforce;
- Septic tanks will be provided to treat sanitary discharge;
- Exposed soil surfaces should be protected by paving or fill material as soon as possible to reduce the potential of soil erosion and subsequent sedimentation;
- Open stockpiles of construction materials or construction wastes on-site should be covered with tarpaulin or similar fabric during rainstorms;
- Provision of sedimentation tanks;
- Garland drains around all open stockpiles of construction materials.

Operation: It is not foreseen that the waste waters from different streams will have any chemical or any other materials having adverse effect on the environment. All water from the process will be discharged to Hlaing River after necessary curing such as neutralization, settlement tank, septic tanks, etc. The brine from RO will be directly discharged to Hlaing River. However it has been ascertained that due to the saline nature of the river water, there will be negligible increase in the river salinity. The other aspect which may have an impact on the river water is that the discharge of cooling tower blow-down directly into the river will increase the ambient water temperature of river water.

However, as per the design, it will be ensured that the incremental temperature of the discharge water will not exceed 3°C.

As the temperature variation due to impact of the project will remain within the natural variation of the river water quality, the significance of impact on surface water will be negligible.

Mitigation: The main mitigation measures will be as follows:

Sl. No.	Effluent Stream	Treatment/Disposal Method
1	Water from Cycle	pH neutralized and discharged to Hliang River
2	Oily Effluents	Passed through oil filters and collected oil will be stored in containers and disposed for external treatment
3	Sanitary Effluents	Septic tanks and soak pits.
4	Cooling Tower Blow-down	Discharged to Hliang River without treatment
5	Effluents from DM unit	Brine from RO process will be discharged to Hliang River through diffuser Water from RO membrane cleaning will be neutralized and discharged to Hliang River

1.7.3 Impact of Solid Waste

Pre-construction: Dismantling of the plants will lead to generation of solid wastes from power plant equipment, structures, transmission equipment and materials from civil structure. It has been estimated that about 5400 tons of C&D waste will be generated over period of 6 months. Industrial wastes like lubricating oils, hydraulic fluids, dielectric fluids, coolants, solvents and cleaning agents are managed just as maintenance wastes are treated during operation. Municipal solid waste will be generated from the workers. It is estimated that about 60kg of MSW will be generated per day. Thus the significance of impact will be moderate.

Mitigation: The main mitigation measures will be as follows:

- Proper segregation of hazardous and non-hazardous waste and provide appropriate containers for the type of waste type
- Ensure that storage areas have impermeable floors and containment, of capacity to accommodate 110% of the volume of the largest waste container
- Provide training to all staff for waste disposal in designated areas
- Store wastes in closed containers away from direct sunlight, wind and rain

Construction: During the construction phase the solid waste generated will be mainly C&D wastes and municipal solid waste from labours and materials such as woods, polythene, plastics and cartons from casings of machineries. The C&D wastes estimated to be generated is about 675 tons. Most of the materials can be either recycled and sold or used for land-filling. As there will be no labour camps, the generation of MSW (paper, plastic and food waste) will be 60 kg per day which is also negligible.

Operation: During the operation phase, the waste streams will be generally municipal solid wastes from labours or a range of wastes such as waste papers from office, scraps of steel or plastic during maintenance activities. While most of them will be non-hazardous there will be some such as paints, engine oils, spent solvents, lubricating oils, batteries, which may be hazardous. However, generation of hazardous solid wastes will be very less and occurrence far in between. Thus the impact will be minor.

Mitigation:

- Proper siting of waste disposal facilities with signs
- Proper segregation of hazardous and non-hazardous waste and provide appropriate containers for the waste type
- Training to all personnel for proper use of disposal facilities
- Waste management plan to be developed keeping in mind the probable waste streams
- Appointment of a waste contractor who will take care of all waste disposal (except hazardous waste unless he is eligible)

1.7.4 Hazardous Waste

Pre-Construction: The hazardous waste generated during this stage will include used oils, PCB, and asbestos, which has adverse impact on human health. In case of breakage of asbestos and the fibres mixing in the air, the significance of impact will be major. Capacity of the country for management of hazardous materials is low; there are limited facilities for the treatment and disposal of waste as well as lack of awareness for their adequate handling and storage.

Mitigation Measures:

- For hazardous waste from the power plant, including PCBs, asbestos, and others, the EPC contractor will be required to develop and implement a detailed hazardous waste management plan and OHS management plan both during the pre-construction and construction phase. This requirement will be included in the bidding and contractual document.
- Only authorized personnel, with adequate information and training, should be allowed to handle hazardous waste
- Before handling the asbestos, it should be sprayed with water so that it does not crumble.
- Workers handling asbestos should be provided with proper PPEs
- Shower room to be provided for the workers so that they can immediately shower after handling asbestos
- The pipes containing asbestos should be immediately packed and sealed. The asbestos should be packed in plastic sheets of at least 500 gauge.
- Since the country capacity in management of hazardous waste is being developed in the country, EPGE, with support from the contractor, will be responsible for OHS risk assessment and the implementation of the OHS management plan that will

consider all hazardous materials during demolition, including used oils, PCBs and asbestos.

1.7.5 Impact on Noise Levels

The impact of noise and vibrations from the plant on the nearby residential area is a major cause of concern, especially for the 80 apartments (buildings E6-E10) located closest to the power plant. At present the baseline noise level recorded about 75dB(A), and thus, exceed the prescribed WBG EHS Guidelines' limit of 55 dB(A) during day time and 45 dB(A) during night time for residential areas. Company employees and their families live there, and they are also affected by vibrations, especially caused by sporadic emergency shutdowns. There are also settlements on the southern side of the plant which may be affected by the noise emitting from the plant.

Pre-construction and Construction: A noise modelling was done to understand the extent to which the impact of incremental noise will remain outside the plant boundary. It was found that at 200 m the noise level reaches the day-time standard of 55dB(A), while the night-time standard is reached of 45dB(A) is reached at 600m. It can be also noted that the noise level at the residential building on the eastern boundary of the plant is much higher than the standard. Further it can be observed that at the densely populated Ywama West Quarters the night time standards are not met. Thus, there has to be reduction of construction activities using heavy machineries at night.

Mitigation:

- Well-maintained equipment to be operated on-site;
- Regular maintenance of equipment such as lubricating moving parts, tightening loose parts and replacing worn out components;
- Shut down or throttled down between work periods for machines and construction plant items (e.g. trucks) that may be in intermittent use;
- Orientate equipment known to emit noise strongly in one direction so that the noise is directed away from receptors as far as practicable;
- Install noise barrier at site boundary. The barrier material shall have a mass per unit of surface area in excess of about 7 kg/m^2 and no gaps at the joints.;
- Locate noisy plant as far away from receptors as practicable.

Operation: Noise level modeling was done to ascertain the predicted noise level after expansion of the plant. Noise modeling output shows the calculated pristine condition noise level at project site is 66.7 dB(A) while in present condition observed and calculated values for proposed plant are 96.0 dB(A) and 95.9 dB(A) respectively inside the plant. The value of noise at the residential colonies is much higher than the prescribed standard.

Mitigation:

- Install silencers, mufflers or acoustic enclosures to reduce sound power level of noisy equipment at all times. The main plant machineries will be inside acoustic enclosures and the turbines will be located inside buildings. Although the capital cost increases, due to predicted high impact of noise on nearby residential areas, it has been planned to design indoor turbines;

- Install acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located close to the source or to the receptor location to be effective. The height of the wall in front of the nearby living apartments will be increased by another 5 meters (presently it is 5 m) and acoustic barriers will be installed on top of it during pre-construction phase. Before its construction, the design of upgraded wall/acoustic barriers will be previously consulted with the families living in the 80 apartments (buildings E6-E10) located closest to the power plant, in order to make sure that it doesn't block the sunlight entering through their windows;
- In case the above-listed noise mitigation measures are not enough to reach the prescribed WBG EHS Guidelines' limit, additional noise control and insulation measures should be adopted to protect the surrounding apartments from the impacts of noise and vibration (acoustic insulation of windows and doors, etc).
- At the project implementation stage, the EPC contractor will be responsible for undertaking additional noise studies and implement adequate mitigation measures to ensure that noise levels for the residential area will be within the WBG ESH Guidelines. Such requirements will be included in the EPC bidding package/contract. In case those noise thresholds cannot be met by implementing cost-effective measures, EPGE will relocate staff living in the areas affected by noise.

1.7.6 Impact on Soil and Ground Water

There are different activities which have the potential to generate waste water, accidental spills, which could lead to contamination of soil and ground water through leaching. In addition, ground water use by the project may impact the users in surrounding communities.

Pre-construction and Construction: The impact on soil during construction activities is due to spillage, run-off from stock piles and improper storage of materials. The leaching causes impact on the quality of groundwater. The other risk may be depletion of ground water due to withdrawal for domestic and industrial use. Though the impact on soil will be negligible, spillage of oil can lead to contamination of soil, if not controlled.

Operation: Ground water will be used only for drinking purpose. Also, the plant area will be paved, thus reducing the risk of leaching of oils. Exposed soil in the plant area will be non-existent. Overall there will be negligible impact of the plant activities on soil as well as groundwater. In case of soil contamination, bio-remediation measures will be adopted which is cost-effective and viable.

Mitigation:

- All oil storage (especially spent oil) to be done on impervious surfaces.
- Special space with concrete surface will be demarcated in lay-down area for storing

drums of spent oil.

- Oil and grease traps will be put in all drains so as to avoid draining of oil and grease
- All staff will be trained to understand the importance of proper handling of oil.

1.7.7 Traffic Safety Risks

Transportation by road will lead to increased risk of accidents as the route passes through heavily congested areas. In addition to that, there will be other inconveniences to the local residents such as increase in noise, traffic jams and disturbances during the nighttime.

Mitigation:

- Ensure that the local communities affected by the project works are properly notified of the timing and scope of the planned works and disturbances are minimized.
- Limiting working hours to daylight, special precautions when the work is carried out near children's institutions or traffic management including, if required, the establishment of alternative temporary traffic routes.
- Keep the unpaved working areas and stockpiles moist all the time by water sprinkling. In unpaved roads water sprinkling at least two times everyday.
- Specifying transport networks and locating stockpiles as far away from the site boundary which is close to the residential buildings, as practicable to minimize the impact of air pollutants and dust
- Maintaining and checking the construction equipment & vehicles regularly to avoid gaseous emission above the stipulated norms.
- Transportation of construction material in covered trucks.

1.7.8 Labor Influx, skill training and prevention of Gender Based Violence

During construction works, labor influx is expected to be moderate. It is estimated that about 300 workers will be recruited during the dismantling of the old plant at pre-construction stage. This will increase to about 800 during the construction phase. Workers will be sourced from Yangon city (with an estimated population of over 7 million people) and commute on a daily basis. To reduce labor influx and boost local benefits of the project, a training program will be in place for EPGE together with the EPC contractor to provide skill training to eligible local people so that they become skilled workers that can be employed in the plant, at least, for the pre-construction and construction phases.

Mitigation:

- Provisions to promote local recruitment of workforce, including a training program to provide skill training to eligible local people,
- Prepare and implement a GBV Plan, including the following minimum contents: (a) Assign a GBV Focal Point, (b) Map of GBV prevention and response actors, (c) GBV sensitive, effective grievance redress mechanism, (d) Codes of Conduct, (e) Training for workers and local community on Sexual Exploitation and Abuse and

Sexual Harassment.

1.7.9 Disturbances during construction works

During construction works, provisions will be in place to ensure that the local communities affected by the project works are properly notified of the timing and scope of the planned works and disturbances are minimized. Such minimization of disturbances may include limiting working hours to daylight, special precautions when the work is carried out near children's institutions or traffic management including, if required, the establishment of alternative temporary traffic routes.

Special attention will be paid to the 650meters long access road to the plant is an area with risk of accidents, as it is narrow and has just enough width to allow maneuver of the vehicles. Therefore, proper mitigation measures will have to be adopted by the EPC contractor to reduce the risk of any incidents on this road.

1.8 CUMULATIVE IMPACT ASSESSMENT

It has been proposed that EPGE has planned the rehabilitation and upgrade of the 66kV and 33kV substations from AIS to GIS, and new 230kV GIS sub-stations. The constructions of both these activities are planned in the same period. Thus, a cumulative impact assessment is required to comprehend impact during construction.

Air Quality: The combined modeling for air quality of the two construction sites was conducted. The modeling result showed an incremental GLC of about 130µg/m^3 at a distance of 100m in the South South-East direction. The increase of GLC due to the JICA project will be about 21µg/m^3 which is negligible. Also, the impact will be short-term and reversible. Also, proper mitigation measures will be taken to ensure that the fugitive emissions are minimized. Thus the significance of impact will be minor on the neighboring receptors.

Noise Level: Simultaneous construction activities at two sites will lead to increase in the ambient noise level of the area. A combined modeling was done to ascertain the impact of noise on the host environment due to simultaneous construction at both Plant and Sub-station site. While modeling, it was assumed that machines at both the sites will be operational at the same time. It can be seen that the increase in noise level due to simultaneous construction activities in two sites is almost negligible and is around 1 dB(A) at any given distance. The noise-level at the residential buildings in the eastern side will experience a noise level of 72.1 dB(A) while the Ywama Quarters will receive about 49.3dB(A).

Solid Waste: As there will be removal of transformers containing polychlorinated biphenyl (PCB), there is a risk of leakage or spillage from the transformers while decommissioning and dismantling. PCBs can be transported long distances and they bind strongly to soil and sediment so they tend to be persistent in the environment. They have been found in air, water, soil, and sediments throughout the world.

Although PCB is not a direct impact of the power project, PCB can indirectly impact the project due to the proximity to the sub-station. Although EPGE cannot do any direct intervention for proper handling and management of PCBs, the construction workers and other employees can be made aware of the health impact of PCBs and risk mitigation measures in case of leakage/ spillage from the adjacent sub-station area.

1.9 RISK ASSESSMENT

Risk assessment is applied to a substance, proceeds in four major steps:

- Hazard identification: determining what kinds of adverse health effects a substance, product or activity can cause
- Dose-response assessment: predicting the degree of adverse effects at a given exposure level
- Exposure assessment: estimating the amount of exposure, and
- Risk characterization: combining the foregoing into a numerical range of predicted deaths or injuries associated with actual exposure event

In a gas-fired power plant, the main risk is of fire in the plant due to rupture of gas pipeline. Thus, the risk quantification has been done for a scenario where there is complete rupture and the end of the pipe at the plant end is completely open. It has been interpreted that the worst-case scenario will be thermal radiations from jet fire and the travel distance will be up to 71m. Therefore, it requires immediate evacuation of population up to 100m and provides immediate medical facilities for injured person. The receptors within this range are the residential quarters of EPGE which is located about 60m from the plant.

The worst-case scenario graph has been plotted which shows that if the wind is from west to east, i.e. towards the residential buildings, then the lethal impact will be till 35 m. Residents of the building will also feel the pain within 60 seconds and thus will have to be evacuated immediately.

During implementation, the EPC contractor will undertake a hazard and operability study (HAZOP) to identify and evaluate problems that may represent risks to personnel or equipment. Among others, the study would focus on assessing explosion risks and their impact on the nearby residential areas. The HAZOP will propose mitigation measures and include the follow up actions if it concludes that the location of the current building is in the high accidental risk zone including relocation of the power plant workers. EPGE will be responsible and bear the costs of the relocation of the power plant workers.

1.10 ENVIRONMENT AND SOCIAL MANAGEMENT PLAN

The primary objective of the environmental and social management plan (ESMP) is to record environmental and social impacts resulting from the project activities and to ensure implementation of the “mitigation measures” identified earlier in order to reduce adverse impacts and enhance positive impacts from specific project activities. Besides, it would also address any unexpected or unforeseen environmental and social impacts that may arise during construction and operation phases of the project. The ESMP covers the demolition or pre-construction and construction phases of the project.

The following are the components of ESMP:

- Monitoring Programme – Pre-construction, Construction and Operation

- Institutional arrangements for implementation
- Mode of implementation
- Mitigation measures of negative impacts and technological provisions for improvements

A separate EHS Department comprising of a team of experienced and qualified personnel shall be established to look after the Environment, Social, Occupational Health & Safety functions of the Project. The Environment Social / EHS Group shall be headed by a Senior Level executive of the Project. The Head of EHS will be assisted by well-trained staffs comprising of environmental, social and safety specialists.

The responsibility of environmental and social management of the operating station is mainly to acts as coordinator for environmental and social matters. This group acts as a nodal agency for various groups at projects and corporate level as well as outside agencies like ECD, MONREC.

1.10.1 Monitoring Programme

The purpose of the monitoring program is to ensure that the intended environmental and social measures are achieved and result in desired benefits to the target population. To ensure proper implementation of the Environment and Social Monitoring Programme, it is essential that an effective monitoring program is designed and carried out. In this report, the detailed schedule for monitoring for all phases have been provided. The estimated annual monitoring cost for the project has been estimated to be USD 47,600.

Component	No. of Locations	Total No. of samples/ location	Frequency	Total cost (USD)
Stack Monitoring (Automatic monitoring)	2 stacks	At stack outlet	24 hours/day and 7 days/week	1,000
Ambient Air Quality	4	96	Twice a week	19,200
Water	3 surface water	12	Monthly	5,400
	2 ground water	4	Quarterly	1,200
Waste Water	Effluent	12	Monthly	1,800
Noise	4	12	Monthly	2,400
Soil	4	4	Quarterly	1,600
Social	-	-	Quarterly	15,000
TOTAL				**47,600**

The mode of implementation and agencies responsible for the action has been provided in the ESIA report. Also proposal for a grievance redressal mechanism has been given.

1.10.2 Emergency Preparedness

Well planned emergency procedures, drills shall be employed viz, Emergency Evacuation Plan, Disaster Management Plan and Industrial Safety plan to meet the requirement in case of failure of any pollution control equipment. In case it is not possible to take appropriate corrective measures immediately, the unit will be shut down.

1.10.3 Stakeholder Engagement Plan

Development of the plan should involve consultation with relevant stakeholders, including government authorities and local people. The stakeholder engagement plan will be formulated before the pre-construction stage and the implementation will also be initiated before any activity is started at site. The responsibility of the preparation and implementation of the SEP will be EPGE, with the support of the EPC Contractor. The implementation during the pre-construction and construction phase will be done by the EPC contractor under guidance and supervision of EPGE.

1.10.4 Grievance Redressal

Grievance may be raised by stakeholders due to various reasons such as failure to fulfill commitments, poor management of construction activities, inappropriate planning of vehicle movement, and conflicts between workers and local communities. Therefore, it is imperative to have an internal mechanism in place where the aggrieved party/s can lodge their complaints and get it amicably settled prior to approaching the formal mode of solution available to them i.e. access to legal system through courts.

The proposed Grievance Redress Mechanism (GRM) will be developed for the Project in order to settle as many disputes as possible through consultations. The Grievance Redressal Cell will be formed with members from the Ywama Plant while the HO GRC will have members drawn from EPGE Nay Pyi Taw and MOEE. The GRC will have officials from Ywama Plant, local representative of nearby residential areas, local political leaders. Regular reporting will include a summary of the number of grievances received during the reporting period, total numbers received to date and the status of all the grievance in the grievance process (ongoing, closed). The GRM will be operational by project's effectiveness.

Public Consultation and Information Disclosure

Two round public consultations were carried out, on during the scoping stage and another during the draft ESIA preparation. The public consultation involved directly affected people and local authorities in various manners such as public meeting, questionnaires, interviews and so on. At the scoping stage, meetings were mainly organized with EPGE and Ywama Plant staff and the local communities. A background information document (BID) was developed to further sensitize the local communities. The BID provided an overview of the Project and also outlined ways through which additional issues and comments could be raised with EPGE and the ESIA team. Consultation with the community was held by two methods, informal interaction with the stake-holders and formal public meeting. At the draft ESIA consultation, the public consultation was held with the officials from MoEE, the employees of EPGE at Ywama plant, and the local NGOs, employees from adjacent industries and local people who would be directly or indirectly affected by the project.

The results of the public consultation indicate that most of the affected people are supportive of the power plant project and have a good understanding of the potential impacts and the benefits arising from it. Most of them are concerned about more pollution during construction and operation, road safety, and employment opportunity and expect that appropriate mitigation measures will be adopted. In compliance with EIA process requirements of the government and the World Bank, the summary of the draft ESIA was disclosed at the project site. In addition, the ESIA will be available at the World Bank's website.

Continued engagement is an important part of the Project. Stakeholder Engagement Activities will continue throughout the project life. The process of disclosure and consultation does not end with disclosure of ESIA Report to local communities. Engagement should also be undertaken periodically with local communities to ensure that they are informed on the Project and to present the results of the grievance mechanism.

Chapter-1
Project Context

Project Context outline the development and structure of the ESIA report including the Project background, objectives and scope of Impact Assessment and the ESIA report structure.

1 PROJECT CONTEXT

1.1 PURPOSE OF THE REPORT

This Environmental and Social Impact Assessment (ESIA) report presents a systematic identification and assessment of the potential environmental and social impacts associated with the proposed Combined Cycle Gas Turbine (CCGT) power plant and Project facilities proposed to be installed in the existing power plant at Ywama, Yangon Region, Myanmar (the Project). It also presents a systematic assessment of the feasible project alternatives and determination of the appropriate measures to mitigate the potential adverse impacts. This report has been prepared for Ministry of Electricity and Energy (MoEE) by Greencindia Consulting Private Limited (GCPL) and presents the objectives, methodology and outcomes of the ESIA study.

1.2 PROJECT BACKGROUND

Republic of the Union of Myanmar through MoEE has requested the World Bank (WB) support in scaling-up gas-fired power generation to reduce (in the near to medium term) and eventually eliminate (in the medium to longer term) electricity shortages and improve reliability and quality of power supply in the country.

The WB has initiated the preparation of the Myanmar Electric Power Project (MEPP) to help reduce electricity shortages and improve reliability of power supply in the country through the expansion of gas-fired power generation capacity. The Electric Power Generation Enterprise (EPGE) of the MoEE has identified several existing Gas Turbine (GT) stations as locations for a possible expansion of gas-fired power generation by using Combined Cycle Gas Turbine (CCGT) technology. It concerns the following sites around Yangon: Ahlone, Ywama, Hlawga and Thar Kay Ta. After initial assessment by Tractebel Engineering, it was decided by MoEE that the first CCGT to be installed was at Ywama in Yangon Region. The present report has been prepared for the Ywama Power Plant.

1.3 PROJECT BRIEF

The project involves replacement of two existing gas turbines and relocating one existing gas turbine with stream turbo generators units and its auxiliary systems by making space to install 2 high efficiency Combined Cycle Gas Turbine Power units.

Presently there are three types of power generation units and one Gas-Engine IPP plant in the site with a total generating capacity of 350.9 MW. The details are as follows:

- 52 MW Independent Power Producer (IPP);
- 2x120 MW Mitsubishi M701 D,
- 23.4 MW Hitachi H25 CCGT (to be de-commissioned), and
- 2x18.45 MW John Brown Simple Cycle Power Plant (SCPP) (to be de-commissioned).

The single unit of the Hitachi CCGT and 2 units of the John Brown SCPP will be de-commissioned and replaced by a new Combined Cycle Gas Turbine Plant of capacity in range of 250 to 300 MW. The present lay-out of the plant is given in Figure 1.1.

1. Existing Plants

-3Nos. to be de-commissioned and space for proposed plant

2. IPP Gas Engine Plant

3. Mitsubishi Open Cycle Power Plant

Figure 1-1: Existing Plant Layout

1.4 PROJECT PROPONENT

The proposed project is to be implemented by MoEE. Myanmar's power sector is organized under the MoEE, which oversees all operational functions of the generation and transmission sub-sectors, in addition to policy making and regulatory functions. MoEE was formed by amalgamation of Ministry of Electric Power (MoEP) and Ministry of Energy (MoE) in 2016. The Electric Power sector has functions of policy planning, designing, construction, operation and management of power plants (thermal and hydel) as well as transmission and distribution network. The present project is being supervised by EPGE under the aegis of MoEE. The present structure of the MoEE is provided in **Table 1.1**.

Table 1-1: Organization Structure of MoEE

Ministry	Department	Role & Responsibility
Electric Power Sector (formerly MOEP)	DEPP (Department of Electric Power Planning)	Policy Planning, demand forecast, application of JV/IPP and power generation development planning
	DPTSC (Department of Power Transmission and System Control)	Planning, design, construction and O&M of the national power system
	EPGE (Electric Power Generation Enterprise)	O&M of existing MOEE's power plants
	DHPI (Department of Hydropower Implementation)	Design and construction of MOEE's hydropower projects
	ESE (Electricity Supply Enterprise)	Planning, design, construction and O&M of the distribution network except Yangon and Mandalay Rural electrification

Ministry	Department	Role & Responsibility
	YESC (Yangon Electricity Supply Corporation)	Planning, design, construction and O&M of the distribution network in Yangon
	MESC (Mandalay Electricity Supply Corporation)	Planning, design, construction and O&M of the distribution network in Mandalay
Energy Sector (formerly MOE)	MOGE (Myanmar Oil & Gas Enterprise)	Planning, design, construction and O&M of oil and natural gas production
	MPE (Myanmar Petrochemical Enterprise)	O&M of oil factory, production of petro-chemical products, O&M of methanol factory
	MPPE (Myanmar Petroleum Products Enterprise)	Transportation and market management of oil, petro-chemical products and fossil fuel

Source: MoEE Website

1.5 NEED OF THE PROJECT

Parallel to growth in Gross Domestic Product ("GDP"), electricity demand in Myanmar has increased dramatically in recent years. Asian Development Bank ("ADB") released a report on Myanmar's energy sector in October 2012[2] in which the future power demand was estimated to be doubling from 12,459 million kWh in 2012-2013 to 25,683 million kWh in 2018-2019.

1.5.1 Power Scenario in Myanmar

Even though electricity consumption in Myanmar has doubled during the last 10 years, in2011, total electricity consumption was 6,312 GWh. With a population of about 60 million, Myanmar's per capita electricity consumption was only 100 kWh per year, which was the lowest among the ASEAN countries. The low national average per capita electricity consumption is due to the low electrification rate, low industrial development and lack of investment.

The country's average electrification grew from about 16 percent in 2006 to 26percent in 2011. Yangon City has the highest electrification ratio (67percent), followed by NayPyi Taw (54percent), Kayar (37percent), and Mandalay (31percent). The remaining rural areas are still poorly electrified averaging at about 16percent. Total system installed capacity in 2011 was 3,361 megawatts (MW) consisting of2,520 MW (76percent) hydropower capacity, 715 MW (21percent) gas-fired capacity, and 120 MW (4percent) coal-fired capacity. Although the installed capacity exceeds the 2011 peak load of 1,533 MW, the availability capacity of the gas and coal power plants were low due to poor maintenance. Particularly, during the dry season, the hydropower plants cannot generate at full capacity due to lack of water. Hence, Myanmar's power grid is experiencing significant load shedding during the dry season of up to 400–500 MW.

Power Transmission and System Control Department (PTSCD) is responsible for the development and implementation of transmission network, covering the voltage levels of 66 kV, 132 kV, and 230 kV.

[2]Asian Development Bank, "Myanmar: Energy Sector Initial Assessment", 2012

Distribution systems consist of lower voltage levels - 33 kV, 11 kV, 6.6 kV and 0.4 kV. Two distribution enterprises operate the distribution systems in the country. The Yangon City Electricity Supply Board (YESB) is responsible for the supply of electricity to consumers in Yangon City. The Electricity Supply Enterprise (ESE) covers the rest of the country comprising 13 states and regions, including off-grid generation and distribution. It was reported that technical and non-technical losses of the transmission and distribution system were as high as 30percent in 2003 and reduced to 27 percent in 2011.

1.5.2 Power Generation in Myanmar

Myanmar has a total of 20 gas-fired power plants located in Yangon, Mawlamyine, Thaton, Kyaukse, Myingyan, Kyaukphyu, Thanlyin, Myanaung, Kyunchaung, Man, Dawei and ShweTaung. Myanmar has a total of 62 operational hydropower plants, including 35 small hydropower projects, which are located mostly in Shan State, Kachin State and Sagaing Region. The country's only coal-powered plant is in Southern Shan State. Off-shore and deep-water natural gas production sites are located in the Bay of Bengal in Rakhine State.

The total installed capacity at mid-2016 is 4,764 MW, with 2,820 MW (59.2 percent) from hydropower, 1,824 MW (38.3 percent) from gas, and 120 MW (2.5 percent) from coal. The MOEE owns about 75 percent of total installed capacity and the rest owned by private sector. The available capacity is approximately 50% of the installed capacity. Gas and coal power plants are not fully operated due to poor maintenance, and during the dry season hydropower is curtailed. Of the hydropower capacity, 520 MW is reserved for export to the PRC. Nine new projects are forecast to be added by the end of2016, with the MOEE adding 220 MW and the private sector adding 300 MW. Various other projects of about 1,500 MW are under development for completion by 2020.

1.5.3 Importance of Ywama CCGT Power Plant

Myanmar grid suffers frequent load shedding for several reasons such as:

- Most of the thermal power plants are old and have a poor availability;
- Lack of water for Hydro plants during dry season;
- Transmission constraints to distribute the power generated by the hydro plants located in the north of the country.

Without implementation of new power projects and considering the power demand increase (11%), the current problems will grow. To remedy to the above issues, the following actions should be taken.

- Reinforce the transmission system with a new 500 kV line connecting North and South of Myanmar (expected COD in 2022) in order to improve the hydro power distribution across the country;
- Increase the use of renewable energy resources;
- Increase the natural gas supply capacity via additional domestic gas production, new LNG plants, and install new efficient gas fired power plants

Keeping in mind the availability of natural gas in Myanmar and gas line to the Ywama plant from Yadana off-shore gas fields, installation of a 250-300MW CCGT at the Ywama plant is needed for both reducing the gap between power supply and demand as well as for economic development of the country.

1.5.4 Market Justification

Data provided by the Client are summarized illustrating the Client's expected positioning of the Ywama new CCGT plant in meeting the electricity demand and replacing current generation based on existing low efficiency gas fired plants.

Such positioning is provided for the short term (2018 data) and the longer term. For the longer term (future generation forecast from the new Ywama CCGT), the assessment is based on (i) assumed growth rates of electricity demand as provided by the Client; (ii) impact of arrival of large new high-efficiency CCGT plants as part of the LNG-to-power projects.

- Based on the sole replacement of current (2018) generation using 'EPGE old' (low-efficiency) gas plants, the Ywama new CCGT would be dispatched at 100% during peak load, and not less than 60% during off-peak load;
- Based on forecast of growth of demand, the Ywama new CCGT will operate as base load by the time it enters commercial operation (2022 time-frame), in absence of other earlier developments of power generation by that time;
- Depending on the size and timing of development and implementation of the upcoming large LNG-to-power projects, the Ywama new CCGT may face some reduction of dispatch. However, this will be temporary, as shown by the growth curves of electricity demand;
- As Ywama new CCGT project will be a plant with thermal efficiency higher than all current (2018) and recently commissioned gas fired plants (including IPPs), the Ywama new CCGT should have dispatching priority over these other plants, independently of whether the other plants are IPP or in EPGE portfolio. This dispatching of Ywama new CCGT in priority over the IPP-s will contribute to its base load operation regime.

In addition, the plant will generate 2.5 times electricity output from the same amount of gas, reducing GHG emissions per unit of output. Given that the plant will increase generation, the absolute emissions would marginally increase for the plant if compared to a business-as-usual scenario, in which the obsolete turbines would keep on working for about 5 more years (until the end of their operational life in 2023) and then would be decommissioned and the electricity would be generated at the average efficiency of the existing gas-fired plants in the country. According to the least-cost plan modeled for the project, the decommissioning of the obsolete turbines would increase the need for other fossil fuels such as HFO, coal and LNG to generate the equivalent electricity formerly supplied by the old turbines. This way, the project is expected to reduce carbon emissions by 12.3 million tons of CO_2 equivalent.

Based on the above, it results that a new power plant is justified in Ywama and expected to operate essentially as a base load plant.

1.6 ESIA STUDY

The ESIA report has been prepared by Greencindia Consulting Private Limited, India engaged by EPGE, MoEE, Government of Myanmar to prepare ESIA and Environmental and Social Management Plan (ESMP) reports for Upgrading of Ywama Power Plant. The details of the study team is provided in Annex 1.1

1.6.1 Objectives

The specific objectives of this ESIA are as follows:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be potentially impacted by the Project;
- Identify the aspects of the Project that could potentially result in significant environmental and social impacts on resources/receptors;
- Document how stakeholders have been engaged during the ESIA Process, and how stakeholder feedback has been considered in the ESIA;
- Identify the aspects of the Project that need to be managed, and recommend appropriate and justified mitigation and enhancement measures;
- Determine the significance of residual impacts, considering the implementation of mitigation measures;
- Generate plans for the management and monitoring of impacts, including plans for ongoing stakeholder engagement; and
- To meet international environmental and social requirements.

1.6.2 Scope

It is noted that a scoping study to obtain environmental baseline data and to determine the Terms of Reference (ToR) for the ESIA study was conducted. This report has been prepared to cover the proposed ToR stated in the Scoping Study and to ensure compliance with World Bank Safeguard Policies and Myanmar regulatory requirements. It identifies the potential environmental and social impacts that could be associated with the proposed Project activities and its associated facilities including those of an indirect and cumulative nature.

The study will be used as part of the safeguard documents by World Bank for financing of the project and also by EPGE for submission to Ministry of Natural Resources and Energy Conservation (MoNREC) for environment clearance of the project as per national and WB norms.

The study area for environmental and social impact assessment covers all project operational areas, including where supporting activities take place. The scope of the impact assessment includes Project activities that may affect the existing environment and social setting. Details of the project including location, project overview and components, schedule, project facilities and activities, associated facilities, construction and operational process, are described in the report.

1.6.3 Structure of the Report

The present report is divided into 12 chapters as listed under.

Executive Summary: Summary of the entire ESIA Report

Chapter-1: **Project Context** outline the development and structure of the ESIA report including the Project background, objectives and scope of Impact Assessment and the ESIA report structure.

Chapter-2: **Legal & Administrative Framework** describes the relevant policies, plans, legislative and administrative framework, international protocols and conventions and best practices applicable to the project.

Chapter-3: **Project Description** provides for the description of the project, its location, size, technology, requirements, emission and waste generation are provided in the chapter.

Chapter-4: **Project Alternatives** discusses the various alternatives in technology, lay-out, site orientation, and reason for choosing a particular alternative.

Chapter-5: **Baseline Environment** explains the various parameters of present environmental status from latest secondary data as well as primary data are identified under different aspects, such as air quality, water quality and hydrological aspects, noise levels, soil quality and ecology, demographic characteristics, socio-economic condition, etc.

Chapter-6: **Environment & Social Impact Assessment** explains the description and prediction of the potential impacts of the proposed development including the methodology used for the impact identification for environmental, biological and socio-economic parameters.

Chapter-7: **Risk Assessment** discusses the risks from artificial and natural sources, extent of damage in different scenarios and disaster management plan.

Chapter-8: **Cumulative Impact Assessment** gives the description and prediction of the potential impacts of the proposed development along with other future projects for the impacts identification for environmental, biological and socio-economic parameters.

Chapter-9: **Environment & Social Management Plan** discusses the management plan and enhancement measures incorporating recommendations to mitigate the adverse impact likely to occur on environmental parameters during construction and operation phase. The specific mitigation measures against the significant impacts that have been identified are identified and given in this chapter. The chapter also discusses the schedule of monitoring during construction and O&M stages.

Chapter-10: **Public Consultation and Disclosure** discusses the findings of all the consultation held in connection with the proposed project with state agencies, government officials and local communities and individuals who are potentially to be affected by the project etc, including that by the Project Developers. The discussions will cover the various issues of concern raised and how they have been addressed in the ESIA and disclosure of information.

Chapter-2

LEGAL & ADMINISTRATIVE FRAMEWORK

Legal & Administrative Framework describes the relevant policies, plans, legislative and administrative framework, international protocols, conventions, and best practices applicable to the project.

2 LEGAL & ADMINISTRATIVE FRAMEWORK

2.1 REGULATORY FRAMEWORK OF MYANMAR

2.1.1 Constitutional Provision

The 2008 Myanmar Constitution provides several important references to environmental conservation and sustainable development. Section 390 states that “Every citizen has the duty to assist the Union in carrying out the following matters”:

- Preservation and safeguarding of cultural heritage;
- Environmental conservation;
- Striving for development of human resources;
- Protection and preservation of public property.

Importantly from the point of dealing with Environmental and Social (E&S) impacts of development, the Constitution also limits the granted rights to own and use property (Section 372). According to Article 37(a) of the Constitution of the Government of the Union of Myanmar, “The Union is the ultimate owner of all lands and all-natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union.”As the owner of all lands and natural resources, the Constitution further stipulates in Article 45 that: “The Union shall protect and conserve the natural environment.”

From the social aspect, Chapter 8 of the Constitution contains 55 articles stipulating the fundamental rights and duties of citizens. Article 354, in particular, stipulates the right to freedom of expression, to assemble peacefully, and practice religion freely; though with the caveat that these rights are only guaranteed so long as they are “not contrary to the laws enacted for Union Security”. Article 348 states that the rights contained in the Constitution are guaranteed to all Myanmar citizens regardless of race, birth, religion, official position, status, culture, sex or wealth. In doing so, Article 348 implies rights for minority groups.

Part of Myanmar’s reform process involves updating and enforcing environmental policy and legislation. The Government of Myanmar has publicly stated its commitment to a development path that is economically strong, but also socially and environmentally sustainable for its citizens. The Framework for Economic and Social Reform (FESR) 2013 and the National Comprehensive Development Plan (NCDP) 2011-2030 express this vision.

2.1.2 Myanmar National Environmental Policy 1994

The objective of Myanmar's Environment Policy is aimed at achieving harmony and balance between the people, cultural heritage, environment and natural resources, through the integration of environmental considerations into the development process to enhance the quality of life of all its citizens. Every nation has the sovereign right to utilize its natural resources in accordance with its environmental policies, but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interest of present and future generations. Environmental protection should always be the primary objective in seeking development.

2.1.3 Myanmar Agenda 21 (1997)

With a view to implementing a National Environment Policy (NEP), the National Commission for Environmental Affairs (NCEA) formulated Myanmar Agenda 21 in 1997 under the guiding principles established at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992. The Agenda 21 provided the first framework for integrating environmental considerations into national development plans in Myanmar. The purpose of Agenda 21 is to mobilize and focus national efforts to achieve sustainable development.

2.1.4 National Sustainable Development Strategy, 2009

Subsequently in 2007, the NCEA developed the National Sustainable Development Strategy (NSDS) for Myanmar. It incorporated the aspirations of the Agenda 21 as well as Myanmar's Millennium Development Goals. The NSDS was approved in 2009 and served as the main guiding principal on environmental protection in the country. The aim of NSDS is to achieve sustainable development through three sectors, focused on natural resource management, economic development, and social development. Relevant government ministries are expected to institutionalize NSDS principles into their sectoral development through short-term, medium-term and long-term actions.

Although much of the NSDS guidelines are for adoption and integration into the government legislation and regulation body, some are targeted at the private sector, such as the polluter pay principle, and reduction of energy consumption and greenhouse gas emission from industries.

2.1.5 Legal Provisions Related to Environment Clearance

2.1.5.1 Environment Conservation Law 2012

Until quite recently, Myanmar's legal system provided little guidance to investment projects on environmental conservation. Most conservation measures were spread across various laws, which lacked coherence and did not provide systematic or adequate protection for the diverse eco-systems found within the country

The first initiative towards a separate environmental legislation is the formulation of the Environmental Conservation Law 2012 followed by the Environmental Conservation Rules (2014) and EIA Procedures (2015).

The objectives of the law are as follows:

- To enable implementation of the Myanmar National Environmental Policy;
- to lay down the basic principles and give guidance for systematic integration of the matters of environmental conservation in the sustainable development process;
- to enable a healthy and clean environment and to enable to conserve natural and cultural heritage for the benefit of present and future generation;
- to reclaim ecosystems as may be possible which are starting to degenerate and disappear;

- to enable to manage and implement for decrease and loss of natural resources and for enabling the sustainable use beneficially;
- to enable to implement for promoting public awareness and cooperation in educational programmes for dissemination of environmental perception;
- to enable to promote international, regional and bilateral cooperation in the matters of environmental conservation; and
- to enable to cooperate with Government departments, Government organizations, international organizations, non-government organizations and individuals in matters of environmental conservation

The law also lays down the rules for creation of a central level Environment Conservation Committee ("ECC") under the MONREC. The roles and responsibilities of ECC and MONREC for conservation and protection of environment in the country are also prescribed under the law.

2.1.5.2 Environment Conservation Rules, 2014

MONREC's powers and responsibility for environmental conservation are further elaborated upon in the Environment Conservation Rules ("ECR"), 2014. Articles 52 and 53 of the ECR identify the Environmental Conservation Department ("ECD") as the body which establishes and manages the process of Environment Impact Assessment ("EIA") and Initial Environmental Examinations ("IEE").

2.1.5.3 EIA Procedures, 2015

The EIA Procedures 2015 elaborate on the details of the environmental assessment system and how government organizations and private companies may obtain an Environmental Compliance Certification ("ECC"). The EIA Procedures, 2015 also establish an EIA and IEE screening process, and about which projects require EIA or IEE. Section13 (a) and (b) of the EIA Procedures, 2015 stipulate that the project implementing agency must disclose relevant information about the project to the public at all phases of the EIA and IEE and to conduct consultation meetings. Public disclosure and consultation meetings are further elaborated upon in subsequent sections of the EIA Procedures, 2015 document. Section 102 (b) of the Procedures stipulates that the project implementing agency bears full legal and financial responsibility for project affected persons until they reach socio-economic stability.

Table 2-1: Summary of EIA Procedure

Stages	Description of Procedure
Screening Process	Proponent is required to submit application for screening • Projects having significant negative impact will be asked to conduct EIA Study • Projects with less significant impact will have to conduct a less detailed Initial Environment Examination Study
Scoping	Based on the scoping, the project proponent shall prepare the TOR for the EIA investigations in accordance with applicable guidelines issued or adopted by the ministry
Responsibility	EIA report preparation by a registered third person or organization with prior information to the Department

Stages	Description of Procedure
Project Disclosure and Consultation	Project proponent should provide timely disclosure of all relevant information about the proposed project. Public notice of final EIA detail has to be disclosed not later than fifteen days after submission of the EIA report to the department. The project proponent shall disclose the EIA report to civil society, PAPs, local communities and other concerned stakeholders: (i) by means of national media (i.e. newspapers); (ii) the website(s) of the project or project proponent; (iii) at public meeting places (e.g. libraries, community halls); and (iv) at the offices of the proponent.
Public Comment	After receipt of a EIA report, the Department will invite government organizations, institutions, civil society organizations and PAPs, for comments. The EIA should have all comments during public consultation incorporated.
Environment Compliance Certificate	Upon completion of its review of the EIA Report, the ministry shall; approve the EIA Report with the guidance of the committee, subject to any conditions as may be prescribed, and issue an ECC. The validity is for a period of 5 years and has to be extended 6 months before expiry.
Self-Monitoring and Inspection by MONREC	Self-monitoring compliance reports to be submitted by proponent every 6months.MONREC has the right to monitor and inspect the plant/project to ensure compliance

2.1.5.4 National Environmental Quality Guidelines

The National Environmental Quality (Emission)Guidelines (NEQG), 29thDecember 2015 was issued by the Government of Myanmar to provide performance parameters for the regulation and control of air emissions, noise, vibration, and liquid discharges from various sources in order to prevent pollution and thereby protect human and ecosystem health. These Guidelines were primarily based on the World Bank Group's Environmental Health and Safety (EHS) General Guidelines 2007 that provide technical guidance on good international industry pollution prevention practice for application in developing countries. Other related laws and regulations include the Environmental Conservation Rules 2014, the Myanmar National Water Policy 2015 and the Conservation of Water Resources and River Law 2006.

These NEQG provide the basis for regulation which includes general guidelines for air emission, wastewater, noise and odour. Emission Guidelines also gives emphasis on industrial specific guidelines which include (i) Energy Sector Development, (ii) Agriculture, livestock and forestry development, (iii) Manufacturing (viz., food and beverages manufacturing, garments, textile & leather product, wood manufacturing, chemicals manufacturing, manufacture of glass and ceramics, manufacture of construction materials, metal, machinery and electronics, (iv) Waste Management (viz., solid waste management facilities, wastewater treatment facilities, bio solids and sludge disposal), (v) Infrastructure and service development (viz., shipping - ports, harbors and terminals, health care facilities, tourism and hospitality development, railways, airports, airlines & roads), (vi) Water supply - portable water treatment facilities and (vii) Mining i.e., construction materials extraction and ore and mineral extraction.

According to NEQG the air emissions of any project with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that – emissions do not result in pollution concentrations that reach or exceed ambient quality guidelines or standards, or in their absence current WHO air quality guidelines; and emissions do not contribute a significant portion of the attainment of relevant ambient air quality guidelines or standards to allow additional, future sustainable development. This guideline applies to projects that have either direct or indirect discharge of process wastewater, wastewater from utility operations or storm water to the environment; it is also applicable to industrial discharges environment; it is also applicable to industrial discharges to sanitary sewers that discharge to the environment without any treatment. Noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at operations exceed the applicable noise level guideline at the most sensitive point of reception..

2.1.5.5 National Institutional Setting for EIA and Clearance

The key authority responsible for the EIA is MONREC, a focal agency for overall environmental management in Myanmar. Within MONREC the ECD is the central EIA-relevant authority at the national level. At the regional and local level, the ECD structure is currently being implemented across the country. In 2016, 67 district-level offices and 336 township offices were established.

This model adopts the structure of the Forest Department of MONREC. Sharing institutional responsibilities relevant to the environmental management both between the ECD offices at various levels and with the state, regional, and local governments makes ECD an important component of the national EIA system.

2.1.5.6 General Environmental Impact Assessment Guideline, 2017

The Guideline is to guide Project Proponents and their EIA consultants in the conduct of both IEE and EIA, and to ensure that these assessments include adequate Project descriptions, assessment of potential impact significance, and mitigation measures using sound, professional and scientific tools and methods. The Guideline particularly focuses on preparation of easily understandable IEE and EIA reports, and EMP. The Guideline additionally serves as reference document for MONREC's ECD for use in reviewing IEE and EIA reports and EMP and ensuring that the aforementioned content is satisfactorily covered and also to maintain uniformity in all reports.

2.1.6 Laws related to Environment, Pollution and Ecology

2.1.6.1 Public Health Law 1972

The Public Health Law includes a general provision that empowers the Government of the Union of Myanmar to "carry out measures" relating to environmental health, such as garbage disposal, use of water for drinking and other purposes, radioactivity, protection of air from pollution, sanitation works and food and drug safety. However, detailed provisions do not exist.

2.1.6.2 Forest Law 1992

The Forest Law, 1992 is one of the environmental related laws in the forestry sector. The offences for extracting, moving, keeping in possession unlawfully any forest produce, including fauna and flora are liable to be punished with fine or imprisonment, or for both. For offences relating to teak trees the punishment is heavier. The Courts are empowered to confiscate all forest produce, vehicles, vessels, animals, machinery, tool and equipment in addition to the punishment for the related offence. Forest Officers are also empowered to take administrative actions in respect of forest produce seized.

2.1.6.3 Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994

Under the Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994, the following are considered crimes: hunting without license, breeding protected animals without permission, causing water and air pollution, poisoning water, possessing, selling, transporting or transferring wildlife or any part thereof without permission.

2.1.6.4 Conservation of Water Resources and Rivers Law, 2006

The Conservation of Water Resources and Rivers Law, 2006 prohibits carrying out any actions with the aim to ruin water resources, including rivers, and causing intentional water wastage, and pollution of water resources.

2.1.7 Laws related to Social Aspects

2.1.7.1 Land Acquisition Act 1894

The Land Acquisition Act 1894 provides the basis for the Government of Myanmar to acquire land for public and other purposes and addresses processes for required notice; procedures for objecting to acquisition; land valuation methods; the process for taking possession of land; the process for appeals; and rules for the temporary occupation of land. The Government has responsibility for carrying out the acquisition and distributing compensation but the funds for compensation are to be provided by the company acquiring the land. Compensation must be paid at market value with adjustments, including for crops.

2.1.7.2 Farmland Law 2012

The Farmland Law 2012 pertains to rights and responsibilities to tenure and provides for the processes and management of farmlands. Under Farmland Law 2012 and Vacant, Fallow and Virgin Land Management Law, the State remains the ultimate owner of all land.

While Myanmar has not ratified the International Labour Organization’s Indigenous and Tribal Peoples Convention 1989 (No. 169), it is still obliged for implementing the rights outlined in the Convention and is subject to monitoring by the ILO. The Indigenous and Tribal Peoples Convention provides for the rights of indigenous people to own the land they live on and make decisions about initiatives that affect them. Articles 13 through 16 of the Convention pertain to land rights and that resettlement should as much as possible be avoided unless it is subject to the community’s free and informed consent.

2.1.8 Laws related to Occupational Health & Safety

2.1.8.1 The Health Law 1972

The law is concerned with protection of people's health by controlling the quality and cleanliness of food, drugs, environmental sanitation, epidemic diseases and regulation of private clinics.

2.1.8.2 Occupational Safety and Health Law 2019

Myanmar's parliament has enacted the Occupational Safety and Health (OSH) Law in March 2019, to promote safe and secure working environments for labourers and workers. It is expected to establish the first legal health and safety standards in the country and will be designed in accordance with international and regional standards and compatible to the nation's situation. Till now the country have been following standards stipulated by IFC and World Bank.

The regulations will apply to both domestic and foreign companies, joint ventures, government departments and organizations This includes the hospitality, extractive, transport, construction, retail, services and manufacturing industries. The new law provides for the establishment of a new tripartite National OSH Council - which will involve workers, employers and government - and will require employers to set up OSH committees at workplace level to help prevent accidents.

2.1.9 National Energy Policy 2014

The main objective of the Myanmar Energy Sector Policy is to ensure energy security for the sustainable economic development in the country; and to provide affordable and reliable energy supply to all categories of consumers, especially to those living in the remote areas that are currently without electricity. The policy aims to achieve the Government's overarching objective of poverty reduction and improvement in the quality of life of its people. The policy also aims to increase foreign exchange earnings through energy exports after meeting the national demand. The government will encourage deploying green technologies in a range of sectors including energy and enact policies for clean energy development for low carbon economy. Special emphasis is placed on community–based renewable energy development projects in the remote areas of the country to help expand the rural development program, and to provide livelihood opportunities to the rural poor. Provision of community-level energy infrastructure development activities, with special provisions for women participation, is also intended to help improve children education, health, clean water supply, and reduce exposure to indoor air pollution, as well as overall rural environmental improvement.

As per the policy document, Myanmar needs to increase the electrification rate from the current level of 26 percent to 75 percent by the end of year 2021/2022. In order to achieve the target of 75 percent electrification rate, the country must increase its generation capacity during the next 10 years at the rate between 500 MW to 1,000 MW on the yearly basis reaching a total of about 16,665 MW at the end of the 10 year period.

The Government strategy for new electric power generation plants to be constructed in the next 2030-2031 will be based on energy mix of 38 percent (8896 MW) hydropower, 20 percent (4758 MW) of natural gas, 33 percent (7940 MW) of coal and 9 percent (2000 MW) of renewable sources.

2.2 MYANMAR AS SIGNATORY TO INTERNATIONAL AGREEMENTS

Republic of the Union of Myanmar is signatory to a number of international agreements and conventions relating to environmental management, community rights and Indigenous Peoples. The international conventions are not always translated into national legislation. Some of the key agreements are listed in Table 2-2.

Table 2-2: International Agreements Relevant to Environmental & Social Issues

Agreements/Conventions	Status	Objectives/Relevance
A. ENVIRONMENT		
ASEAN Agreement on the Conservation of Nature and Natural Resources (1985)	RoUM signed in 1997	Commits to development planning, the sustainable use of species, conservation of genetic diversity, endangered species, forest resources, soil, water, air and addressing environmental degradation and pollution
United Nations Convention on Biological Diversity, 1992	RoUM ratified in 1994	Promotes development of national strategies for the conservation and sustainable use of biological diversity. Often seen as the key document regarding sustainable development.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), 1982	RoUM joined in 2005 and has 5 Ramsar sites	The conservation and sustainable utilization of wetlands, i.e. to stem progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.
Kyoto Protocol, 1997	Accession by Myanmar in 2003	Sets international guidelines on restrictions of GHG emissions in order to prevent climate change; Project will emit green-house gases from power generation through heavy fuel combustion
Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES), 1973	Accession by Myanmar in 2003	To ensure that international trade in specimens of wild animals and plants does not threaten their survival and it accords varying degrees of protection to more than 33,000 species of animals and plants.
Stockholm Convention on Persistant Organic Pollutants, 2001	Accession by Myanmar in 2004	UNEP called for global action to be taken on POPs which is defined as chemical substances that persists in the environment, bio-accumulation in the food chain and cause adverse impact on human health.

Agreements/Conventions	Status	Objectives/Relevance
B. SOCIAL AND CULTURAL		
UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972 (World Heritage Convention)	Signed in 1994	Promotes cooperation among nations to protect heritage from around the world that is of such outstanding universal value that its conservation is important for current and future generations.
Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) 1979	Signed in 1997	The Convention defines what constitutes discrimination against women and mandates actions on a national level to put an end to discrimination.
International Covenant on Economic, Social and Cultural Rights (ICESCR)	RoUM ratified in 2017	This could protect the rights of minority ethnic groups
Intended Nationally Determined Contribution (INDC) to the UNFCCC	Submitted in September 2015, prior to the COP21.	Sets national intention on restrictions of GHG emissions in order to prevent climate change

2.2.1 Ratifications to ILO conventions

Myanmar is signatory to certain ILO Conventions, the details for which are provided in Table 2.3. Among the fundamental conventions, Myanmar is signatory to 3 out of 8 conventions, none for the 4 governance conventions and 21 out of 177 technical conventions.

Table 2-3: Myanmar Ratification to ILO Conventions

Conventions	Ratification Date	Present Status
Fundamental Conventions		
Forced Labour Convention, 1930	March 1955	In force
Freedom of Association &Protection of the Right to Organize Convention, 1948	March 1955	In force
Worst Forms of Child Labour Convention, 1999	December 2013	In force
Technical Conventions		
Hours of Work (Industry) Convention, 1919	July 1921	In force
Unemployment Convention, 1919 (No. 2)	July 1921	In force
Night Work (Women) Convention, 1919	July 1921	Not in force since 2017
Night Work of Young Persons (Industry) Convention, 1919	July 1921	In force
Right of Association (Agriculture) Convention, 1921	May 1923	In force
Weekly Rest (Industry) Convention, 1921	May 1923	In force
Minimum Age (Trimmers and Stokers) Convention, 1921	November 1923	Not in force since 2017
Medical Examination of Young Persons (Sea) Convention, 1921	November 1922	Not in force since 2006
Workmen's Compensation (Accidents) Convention, 1925 (No. 17)	February 1956	In force

Conventions	Ratification Date	Present Status
Workmen's Compensation (Occupational Diseases) Convention, 1925	September 1927	In force
Equality of Treatment (Accident Compensation) Convention, 1925	September 1927	In force
Inspection of Emigrants Convention, 1926	January 1928	Not in force since 2018
Seamen's Articles of Agreement Convention, 1926	October 1932	Not in force since 2006
Minimum Wage-Fixing Machinery Convention, 1928	May 1954	In force
Marking of Weight (Packages Transported by Vessels) Convention, 1929	September 1931	In force
Holidays with Pay Convention, 1936	May 1954	In force
Convention concerning Statistics of Wages and Hours of Work, 1938	November 1961	In force
Maritime Labour Convention, 2006 (MLC, 2006)	May 2016	In force

2.3 APPLICABLE WORLD BANK SAFEGUARDS POLICIES

2.3.1 WB Environmental Screening Guidelines

The Bank undertook environmental and social screening of the proposed project to determine the safeguard policies triggered for the project, its categorization, and the appropriate extent and type of EA. Screening principles and procedures, as well as other conceptual and procedural details of ESIA process, are described in OP/BP 4.01 Environmental Assessment. The Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. The Bank establishes three categories.

- **Category A** is assigned to a proposed project if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project’s potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the “without project” situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the Borrower is responsible for preparing a report. In category A projects, there are usually 2 consultations required, one during the scoping stage and one during the ESIA preparation stage.
- **Category B:** A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas including wetlands, forests, grasslands, and other natural habitats are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than for Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A EA. Like Category A ESIA, it examines the project's potential negative and positive environmental impacts and recommends any measures

needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.

- **Category C:** is assigned to a proposed project if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.
- **Category FI:** A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts.

It has been found during the environmental and social screening that the proposed project, which will be a brown-field project, would not have significant adverse impact on the neighbouring receptors. Issues such as gaseous emission (mainly NO_2), higher noise level can be mitigated. Concerns such as involuntary resettlement, disturbance of natural habitats etc will not be of any significance. Thus, the present project has been categorized as a Category B project as per World Bank screening guidelines. This has also been confirmed during the scoping exercise.

2.3.2 Environment & Social Safeguard Policies

The World Bank's environmental and social safeguard policies are a cornerstone of its support for programmes aimed at sustainable poverty reduction. The objective of these policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for lenders (including banks) and borrower staff in the identification, preparation, and implementation of programmes and projects. Safeguard policies have often provided a platform for the participation of stakeholders in the project design, and have been an important instrument for building a sense of project "ownership" among local populations.

The WB has ten (plus one) environmental and social policies which are known as safeguard policies. The safeguard policies triggered for the project only include the Bank Policy on Environmental Assessment (OP/BP 4.01)

The relevance of the safeguard policies to this project is considered in Table 2-4.

Table 2-4: Implication of World Bank Operational Policies on Project

OP/BP No	Summary of OP	Whether triggered with Reason	Implication
4.01	**Environmental Assessment:** The Environmental Assessment (EA) covers impacts on the natural environment (air, water and land); human health and safety; physical cultural resources; and trans-boundary and global environment concerns.	**Yes** The partial dismantling of the existing power plant and construction of a new unit of 250 to 300 MW is expected to have certain environmental impact on host environment. The expected impacts during construction may be increased levels of dust, noise, vibration; hazardous waste generated during the	• The project qualifies as a Category B project and thus ESIA/ESMP has been prepared • The ESIA/ESMP prepared will have to be made publicly available to project-affected persons (PAPs) and Non-Govt Organizations

OP/BP No	Summary of OP	Whether triggered with Reason	Implication
		dismantling of the old plant; construction-site waste generation; traffic disturbance and safety; impacts related to labor influx; and health and safety issues for workers and community. Impact during operations will include emission of NO_2, increased noise pollution, discharge of waste-water to the river, abstraction of ground water, etc. It is expected that the project is likely to have some minor adverse environment impacts that are considered diverse, or unprecedented. However, the impact beyond the site or facilities will be minimum. An EIA for a Category B project is required to identify and assess potential negative and positive environmental and social impacts, compare these with those of feasible alternatives (including the no project alternative), and recommend mitigation measures to reduce negative impacts and enhance benefits. The EIA process and this EIA report have been conducted and prepared in line with OP 4.01.	• Two stage consultation, one during scoping and one during ESIA has been carried out.
4.03	Private Sector Activities OP/BP 4.03	**No** This policy is not triggered as the project does not support any private sector led economic development that will be designed, owned, constructed and/or operated by a Private Entity.	
4.04	**Natural Habitat:** The World Bank supports the protection, maintenance, and	**No** As the project is a brown-field project, and will be implemented within the	The project will conduct a full and independent ESMP which will include recommendations on

OP/BP No	Summary of OP	Whether triggered with Reason	Implication
	rehabilitation of natural habitats and their functions. The conservation of natural habitats is essential for long term sustainable development. Natural habitats comprise land and water areas where (i) the ecosystems' biological communities are formed largely by native plant and animal species, and (ii) human activity has not essentially modified the area's primary ecological functions.	boundary of the existing plant, there is no acquisition of land. There is a patch of unused land within the plant which has to be cleared of vegetations. Also, additional land will be required for storage and lay-down areas. This land has some vegetation and has to be cleared. However, no destruction of natural habitats is envisaged as these patches of land are small (about 2.0 Ha) and are surrounded by residential areas. During initial studies, it was found that there is no faunal presence in these patches of land.	suitable mitigation measures to avoid or prevent, minimize, mitigate, or compensate for such adverse impacts and improve environment performance.
4.36	**Forests** The objective of this policy is to assist borrowers1 to harness the potential of forests2 to reduce poverty in a sustainable manner, integrate forests effectively into sustainable economic development, and protect the vital local and global environmental services and values of forests.	**No** The project is not likely to have impacts on forests or natural habitats since the only known site where the project activities will take place is an active power plant in an industrial area of urban Yangon, existing sub-stations and, potentially, other elements of the existing electricity network infrastructure. Activities under the project are therefore not expected to adversely impact or lead to the degradation of forests.	
4.09	**Pest Management** In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management.	**No** The project is not likely to finance or affect the use of pesticides.	

OP/BP No	Summary of OP	Whether triggered with Reason	Implication
4.10	**Indigenous Peoples:** This policy is designed to ensure that the development process fully respects the dignity, human rights, economies and cultures of Indigenous Peoples. The policy requires projects to identify impacts on indigenous peoples and develop a plan to address the impacts, both positive and adverse.	**Yes** Although this project is not expected to negatively impact any Ethnic Peoples, some of the sub-stations may be located in areas where there are IPs living or working. Because of that, OP 4.10 has been triggered on a precautionary basis, mainly to ensure that they are meaningfully consulted..	A Community Participation Planning Framework (equivalent to an Indigenous Peoples Plan) was prepared and included as a stand-alone section of the project's ESMF
4.11	**Physical Cultural Properties:** This policy addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic or other cultural significance.	**No** The project will be implemented within the boundary of existing power plant. None of the 188 historical structures notified in Yangon is located near the power plant. Also as there is no plan for erection of any transmission line, there is no risk of any cultural properties being affected.	However, keeping in mind if by chance any cultural properties are found, mitigation measures will be mentioned in the ESMP.
4.12	**Involuntary Resettlement:** This policy aims to address and mitigate risks of physical relocation, loss of land and other assets, sources of income and means of livelihood by local people due to proposed sub-projects. The policy also applies to the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.	**Yes** As this Component A of the project is a brown-field project and there is no displacement or acquisition of land, there is no issues related to involuntary resettlement. For component B, the improvement of the sub-stations and the deployment of mobile substations are expected to take place in the existing physical footprint of the substations. However, OP/BP 4.12 has been triggered on a precautionary basis, in case some additional small strips	A Resettlement Policy Framework (RPF) has been prepared and included as a stand-alone section of the project's ESMF.

OP/BP No	Summary of OP	Whether triggered with Reason	Implication
		of land are required to accommodate the new equipment.	
4.37	**Safety of Dams**	**No** The project does not involve the construction of dams nor are the project activities vulnerable in any way to any upstream dam. Therefore, the policy is not triggered.	
7.50	**Projects on International Waterways**	None of the project activities are to be carried out on an international waterway.	
7.60	**Projects in Disputed Areas**	No project activities are to be conducted in a disputed area.	

2.3.3 World Bank Group Environmental, Health, and Safety Guidelines

As the introduction to the EHS Guidelines states, these guidelines are technical reference documents with general and industry-specific examples of good international industry practice. For the proposed Plant, relevant EHS Guidelines are given below

2.3.3.1 The EHS General Guidelines[3]

These guidelines are designed to be used together with the relevant Industry Sector Guidelines. The chapter on environment addresses air emissions and ambient air quality, energy conservation, waste water and ambient water quality, water conservation, hazardous materials management, waste management, noise and contaminated land. The chapter on occupational health and safety provides guidance and examples of reasonable precautions to be implemented in managing principal risks to workers. The community health and safety chapter complement the guidance provided in the preceding environmental and occupational health and safety sections, specifically addressing some aspects of project activities taking place outside of the traditional project boundaries, but nonetheless related to the project operations, as may be applicable on a project basis. The Guidelines also cover construction and decommissioning.

2.3.3.2 Guidelines for Thermal Power Plants[4]

The guidelines include information relevant to combustion processes fueled by gaseous, liquid and solid fossil fuels and biomass and designed to deliver electrical or mechanical

[3] http://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final%2B-%2B General%2BEHS%2B Guidelines.pdf?MOD=AJPERES

[4]http://www.ifc.org/wps/wcm/connect/dfb6a60048855a21852cd76ab515bb18/FINALTHERMAL%2BPp ower.pdf?MOD=AJPERES

power, steam, heat, or any combination of these, regardless of the fuel type (except for solid waste, which is covered under separate Guideline for Waste Management Facilities), with a total rated heat input capacity above 50 MJ/s on High Heating Value basis.

2.4 GAP ANALYSIS BETWEEN ROUM PROVISIONS AND WORLD BANK POLICIES

The following section provides the gap analyses on RoUM laws and regulations relative to the World Bank OPs 4.01 and 4.04 that have been triggered by the project. The analysis of the gaps are given below in Table 3-5.

Table 3-5: Gap Analysis for Legal Provisions applicable to Ywama Plant

Aspect	World Bank Provisions	RoUM Provisions	Gaps/Project Measures
WBG OP 4.01			
Environment Assessment Process			
An EA considers natural and social aspects in an integrated manner that considers national & international obligations, treaties and agreements.	Assess the adequacies of applicable legal and institutional framework and ensure that no projects contravening international obligations are financed.	EIA Procedures (2015) Article 7:Projects that involve involuntary resettlement or have adverse impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to that, all such Projects shall adhere to international good practice accepted by international financial institutions on Involuntary Resettlement and Indigenous Peoples	OP 4.01 Policy Procedures will be applied to ensure the projects do not contravene any obligations, treaties or agreements whether or not an EA is a requirement under national regulations.
Analysis of Alternatives	Provide for assessment of feasible investment, technical and siting alternatives, including the "no action" alternative, potential impacts, feasibility of mitigating these impacts, their capital and recurrent costs, their suitability under local conditions, and their institutional, training and monitoring requirements associated with them.	Not included	OP 4.01 Policy Procedures will be implemented to ensure that the assessment of the potential project impacts review possible alternatives including the option of “no action”. However, site alternatives are not required for this project.

Aspect	World Bank Provisions	RoUM Provisions	Gaps/Project Measures
Information Disclosure and Public Consultation			
There is requirement of information disclosure and public consultation	There is requirement of information disclosure and consultation with affected population and local NGOs. Category A project requires consultation during ToR and after ESIA.	As per the EIA Procedure 2015, information disclosure through web-site, press and media and public consultation at all stages of EIA and IEE is required.	OP 4.01 Policy Procedures Procedures (2015) Article13 will be implemented to provide guidance on public consultation and disclosure such that project affected groups and local NGOs are informed both during the scoping stage and ESIA stage
Monitoring & Evaluation			
Internal and external Independent monitoring are required	Compliance required with measures agreed with the Bank on the basis of the findings and results of the EA, including implementation of any EMP.	EIA Procedures (2015) Self monitoring compliance reports to be submitted by proponent every 6 months. MONREC has the right to monitor and inspect the plant/project to ensure compliance	OP 4.01 Policy Procedures and EIA Procedures (2015): EPGE will be providing 6 monthly compliance reports for ESMP implementation

2.5 STATUS OF PRESENT STUDY

As mentioned earlier, the approach to the ESIA comprises of four phases: Screening, Scoping, Impact Assessment and Disclosure.

2.5.1 Screening

Screening is the process of deciding on whether an EIA is required, and if EIA is needed to what detail. This may be determined by size of the project, nature of the project, its impacts etc. Guidelines for whether an EIA is required will be country specific depending on the laws or norms in operation. As per World Bank Guidelines all Thermal Power Plants including gas-based ones fall under Category A or B and has to carry out ESIA study. As described in Section 2.3.1, as per World Bank requirements, the present project falls under Category B.

Also as per the Myanmar EIA Procedure 2015, natural gas power plants above 50MW have to carry out EIA study. Thus for the Ywama Power Plant, an EIA/EMP is required and has to be cleared by MONREC.

2.5.2 Scoping

Prior to scoping, field visits were conducted and preliminary studies conducted to get a holistic understanding of the project. Extensive meetings were conducted with MoEE and EPGE officials at corporate and plant level to take their views of the project. A draft scoping report was prepared for the project and areas of probable impacts identified. The draft scoping report, so prepared, was also shared with the local stakeholders and consultation held to understand their perception about the project. The Terms of Reference for the ESIA report was also prepared and integrated from the scoping report.

2.5.3 ESIA Report

The present document is the ESIA report which has been prepared based on the ToR decided in the scoping phase.

Chapter-3
PROJECT DESCRIPTION

Project Description provides for the description of the project, its location, size, technology, requirements, emission and waste generation are provided in the chapter.

3 PROJECT DESCRIPTION

3.1 PROJECT BRIEF

The proposed project is a brown-field project and involves installation of CCGT Power Plant of capacity 250 - 300MW. The plant will replace 2 units of John Brown Frame 5 Gas Turbine; one unit of the Hitachi H.25 Gas Turbine; Shin Nippon Steam Turbine. Allocation of gas from Yadana field is already in place and water for the project will be drawn from Hlaing River. There is also no requirement of additional land. The power will be evacuated through the proposed GIS sub-station being constructed adjacent to the proposed plant site.

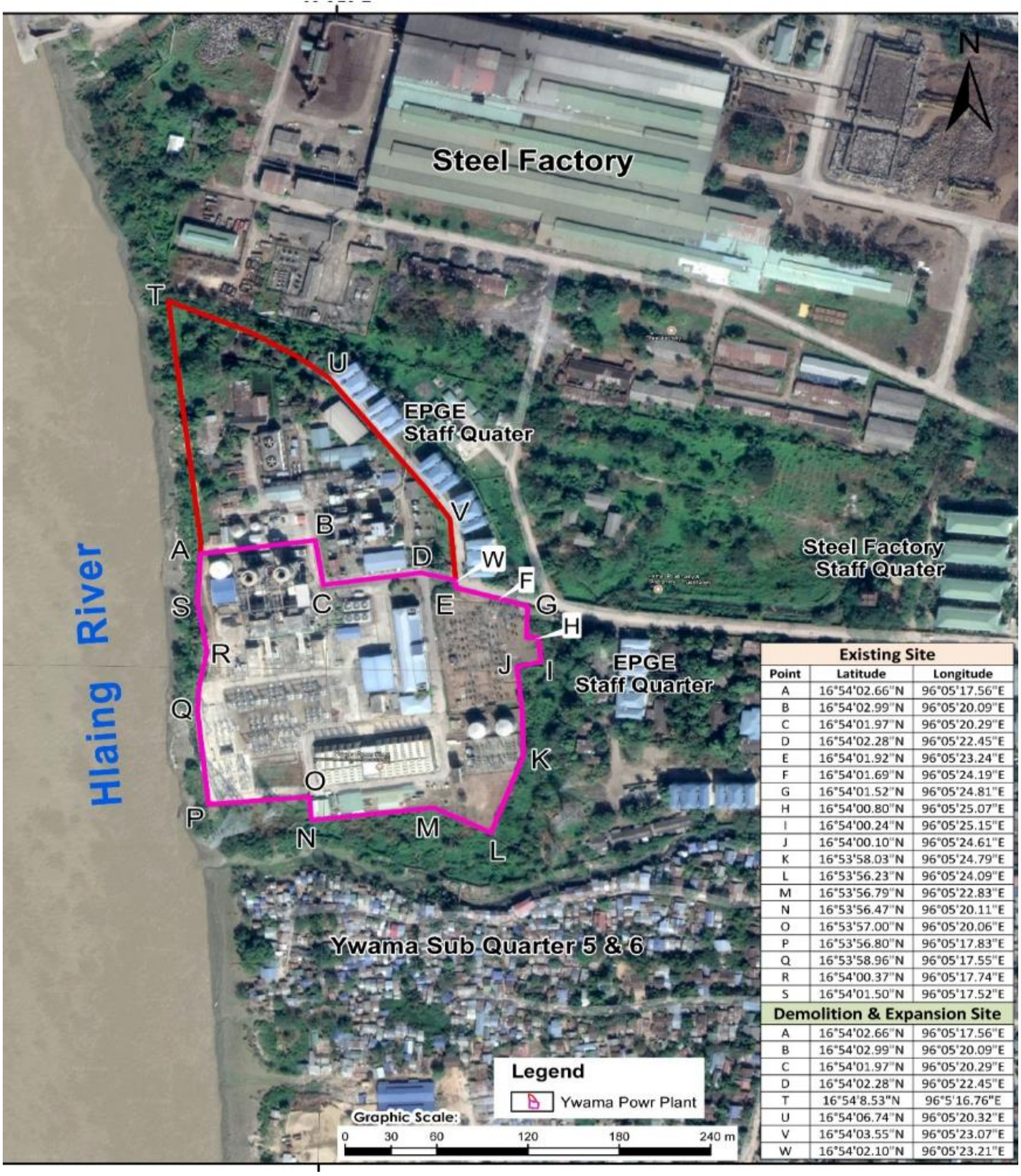
3.2 PROJECT LOCATION

The site for the Project is situated at InseinTownship in suburbs of Yangon city. It is located adjacent to the Hlaing River, which is a wide tidal channel. The Yangon International Airport is about 4.2km (aerial distance), while the Myanmar Industrial Port is 16.2km away from the Ywama Power Plant.

The geographical coordinates of the Ywama Power Plant extend from latitude 16°54'07.58"N to 16°53'56.23"N and longitude 96°05'25.15"E to96°05'17.20"E (Refer **Figure 3.2**). The detailed coordinates are provided in **Annex 3.1**.

The total area of the Ywama power plant is 8.9 ha (22.54 acres). After dismantling of three of the generating units, the area for the new CCGT will be about 2.4ha (6.0 acres). The expansion project will be located entirely within the boundary of existing plant. The area identified for the proposed plant is given in **Figure 3.1**. The site is plain and contours vary between 3.7 to 3.8 m above mean sea level.

Figure 3-1: **Existing and Proposed Plant Area**



Point	Latitude	Longitude
Existing Site		
A	16°54'02.66"N	96°05'17.56"E
B	16°54'02.99"N	96°05'20.09"E
C	16°54'01.97"N	96°05'20.29"E
D	16°54'02.28"N	96°05'22.45"E
E	16°54'01.92"N	96°05'23.24"E
F	16°54'01.69"N	96°05'24.19"E
G	16°54'01.52"N	96°05'24.81"E
H	16°54'00.80"N	96°05'25.07"E
I	16°54'00.24"N	96°05'25.15"E
J	16°54'00.10"N	96°05'24.61"E
K	16°53'58.03"N	96°05'24.79"E
L	16°53'56.23"N	96°05'24.09"E
M	16°53'56.79"N	96°05'22.83"E
N	16°53'56.47"N	96°05'20.11"E
O	16°53'57.00"N	96°05'20.06"E
P	16°53'56.80"N	96°05'17.83"E
Q	16°53'58.96"N	96°05'17.55"E
R	16°54'00.37"N	96°05'17.74"E
S	16°54'01.50"N	96°05'17.52"E
Demolition & Expansion Site		
A	16°54'02.66"N	96°05'17.56"E
B	16°54'02.99"N	96°05'20.09"E
C	16°54'01.97"N	96°05'20.29"E
D	16°54'02.28"N	96°05'22.45"E
T	16°54'8.53"N	96°5'16.76"E
U	16°54'06.74"N	96°05'20.32"E
V	16°54'03.55"N	96°05'23.07"E
W	16°54'02.10"N	96°05'23.21"E

Figure 3-2: **Geographical Co-ordinates of the Ywama Power Plant**

3.2.1 Access to the Site

The site is situated 20km (approx) north-west of Yangon at Insein town-ship. The road from Yangon to the Ywama plant is of asphaltic concrete pavement. The plant is located along the Hlaing River and off the Bayint Naung Road (Figure 3.3). The access road of length 650m to the plant off the Bayint Naung Road is a two-lane paved road with a total width of about 7.0m (Figure 3.4).

Figure 3-3: **BayintNaung Road in front of Plant**

Figure 3-4: **Access road to plant from BayintNaung Road**

3.2.2 Features in the Vicinity of the Site

The power plant site is located in an area having mixed land-use of industrial, commercial and residential facilities. On the northern side of the project site there is a steel mill located adjacent to the site. Further to the north, immediately after the steel mill is the Shwe Pyi Thar Industrial Zone (Zone-4), which has middle scale and small-scale manufacturing/processing units and warehouses.

On the Eastern side of the Ywama Power Plant are residential colonies. These include residential colonies of Ywama Power Plant, Municipal Corporation and Steel Mill. The major concern during pre-construction and construction phase will be the close proximity of the residential colonies to the plant. Further down in the eastern side is the Ywama and Insein townships.

The sub-quarters 5 & 6 of Ywama Township is located in the southern side of the plant. This area is densely populated with unplanned development of settlements which include shanties and temporary houses. The Ywama Monastery is also situated in this area at a distance of about 500m from the plant.

The Western boundary of the plant is adjacent to the Hlaing River, which is about 510m wide near the plant. The opposite shore of the river is also an industrial area (Shwe Lin Ban Industrial Zone) and has predominance of small-scale manufacturing and textile units.

The maps showing the land-use for 500m and 2.0km radius around the plant site is given in **Figures 3.5** and **3.6** respectively, while **Figure 3.7** gives pictorial representation of the surrounding areas to the project site.

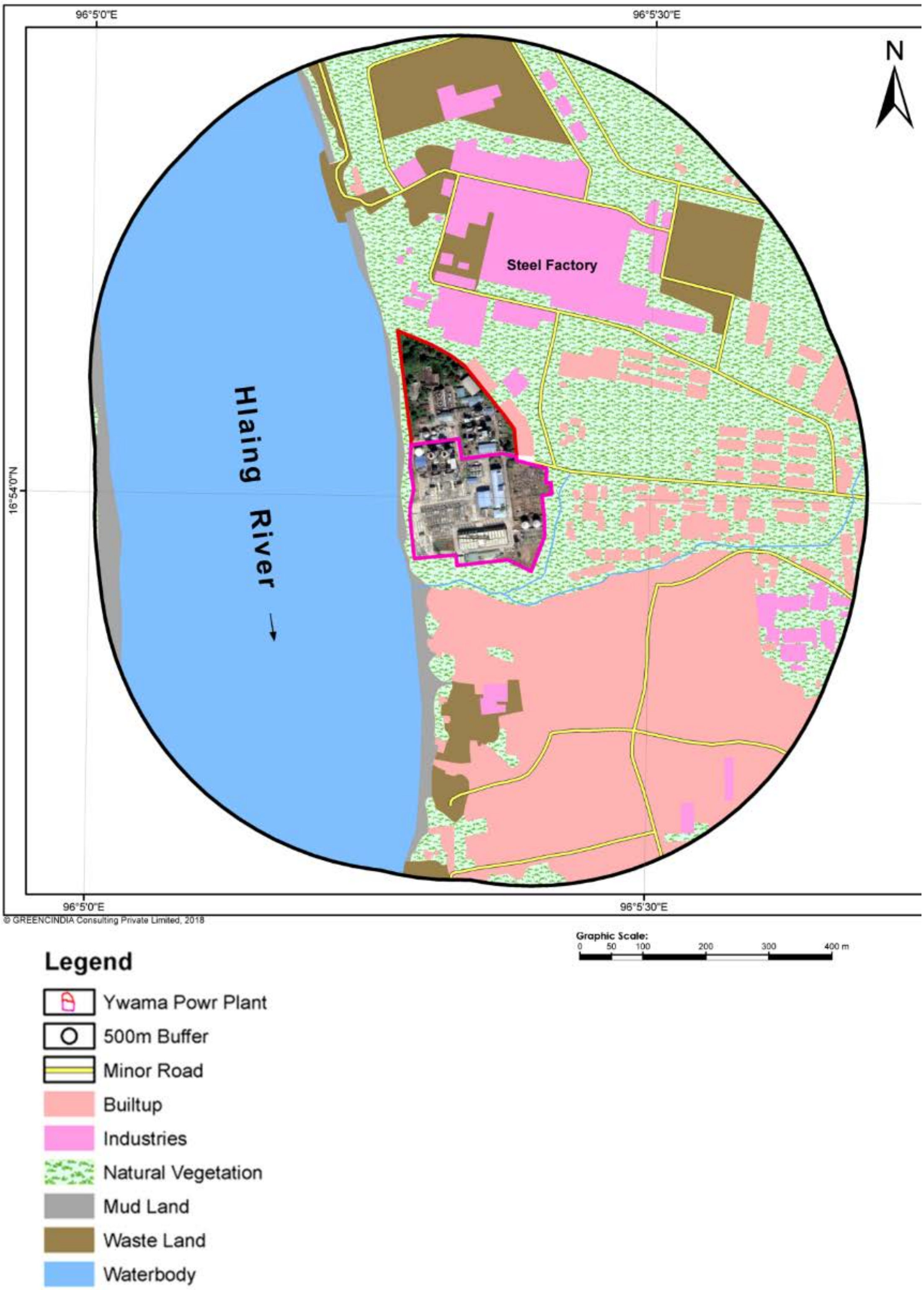


Figure 3-5: Area Surrounding the Project Site (Within 500m Radius)

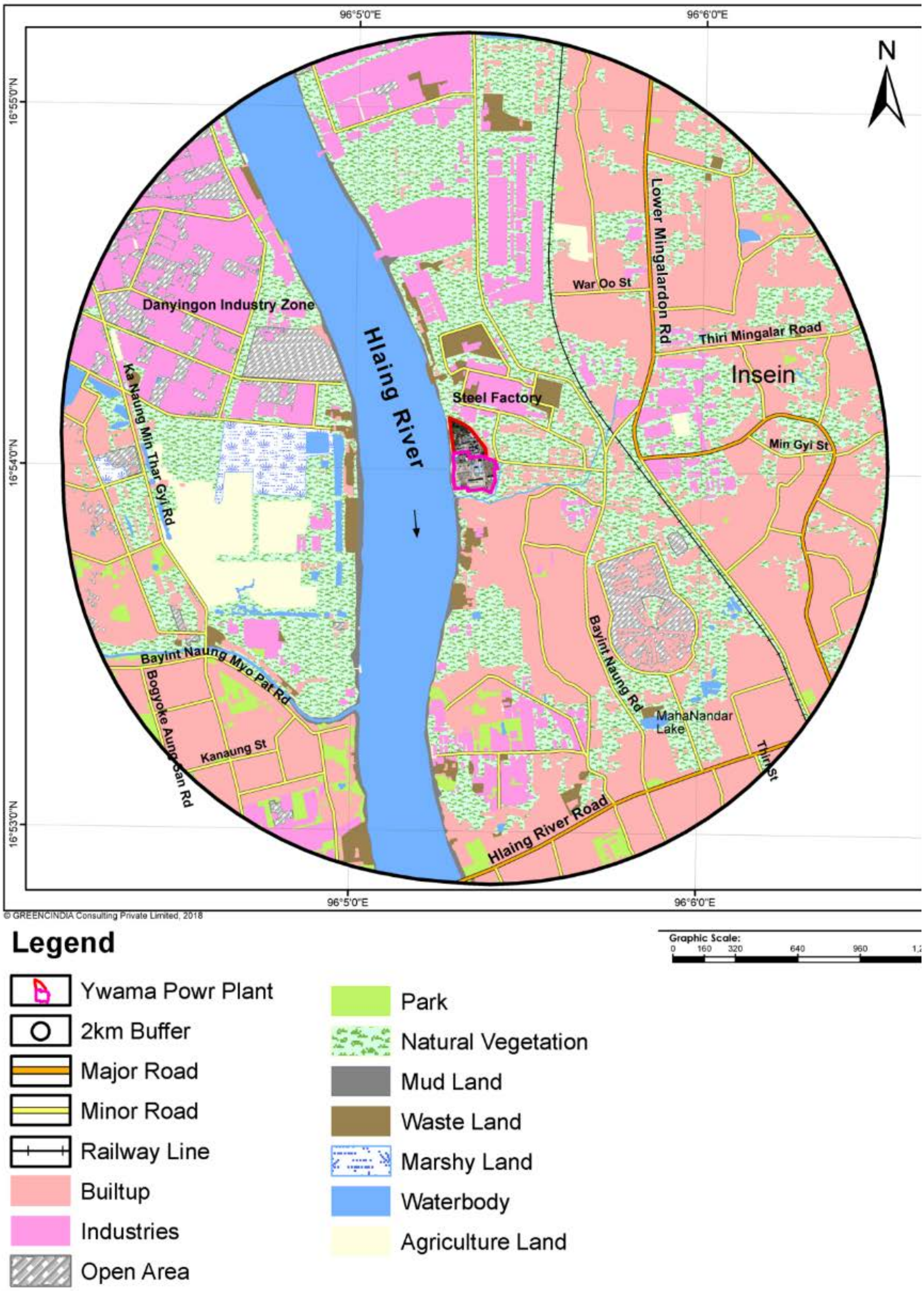
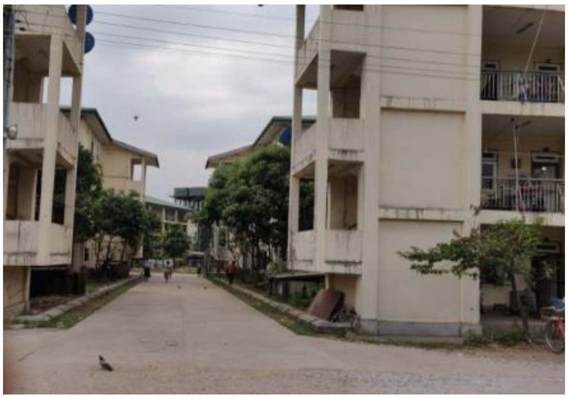


Figure 3-6: Area Surrounding the Project Site (Within 2km Radius)



East: **Steel Plant Housing Complex** **West:Shwe Lin Industrial Zone**

North:ShwePyiThar Industrial Zone **South: Ywama Sub-Quarters 5&6**

Figure 3-7: Vicinity of the Project Site

3.3 PROJECT CONFIGURATION

The combined cycle technology is selected for the Project. The capacity which can be installed is constrained by the surface made available after the demolition of existing units and by the power export capacity of the High Voltage (HV) lines and sub-station. It has been decided with EPGE that the configuration of the combined cycle can be either the 1-1-1 configuration or the 2-2-1 configuration. Only a range of power capacity (e.g. between 250MW and 300MW) have been determined. The CCGT will be of:

- either in the 80-120 MW ISO size per Gas Turbine ("GT"), which would be configured as a 2-2-1 [2 GT, 2 Heat Recovery Steam Generator("HRSG's") and 1 Common Steam Turbine("ST")] plant;
- or in the 180–190 MW ISO size, which would be configured as a 1-1-1 (1 GT, 1 HRSG's and 1 ST) plant.

For both configurations, by-pass stack between each Gas Turbine and HRSG will be provided.

The gas turbine air intake will be static type without inlet air cooling. Depending on the gas turbine model, the natural gas will be pre-heated to about 180°C to increase the global efficiency of the CCGT. The diffuser between the GT exit and HRSG inlet is noisy equipment. In order to reduce the noise level of the gas turbine, it is recommended to insulate it properly (acoustically and thermally) and install it.

The HRSGs shall be designed for cycling operation what means frequent start-ups and load variations. The typical drum type with natural circulation is recommended without rejecting the Benson once-trough circulation. HRSG's may be vertical or horizontal type.

The steam turbine can be made of 2 or 3 bodies with axial, lateral or downdraft steam exhaust. The ST will be located inside a building. A typical flow diagram of a CCGT Power Plant is provided in Figure 3.9.

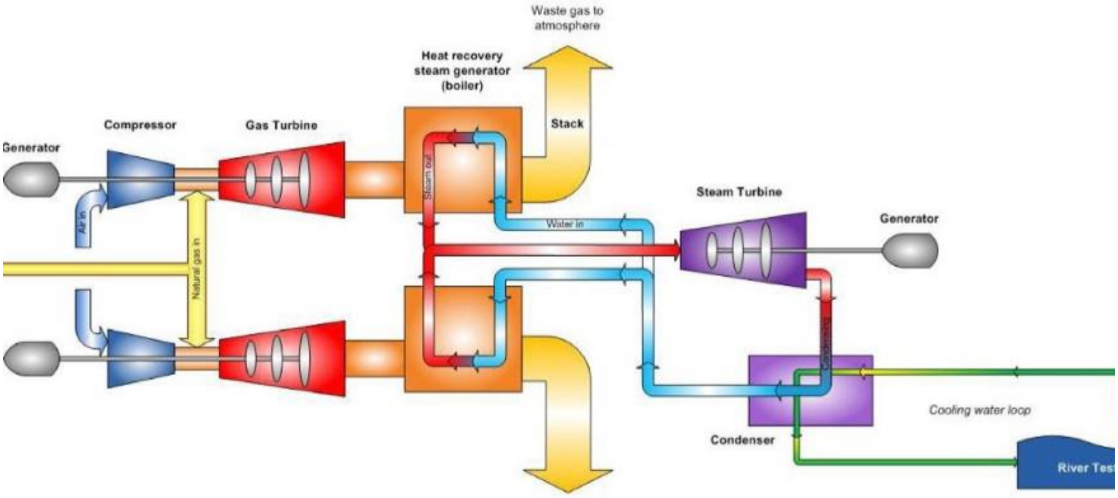


Figure 3-9: Flow Diagram for Typical 2-2-1 CCGT Plant

3.3.1 Advantage of Combined Cycle

In combined cycle power plants, the heat rejected by the higher temperature cycle is recovered and used by the lower temperature cycle to produce additional power and gives high efficiency. The heat in the exhaust gases of the simple gas turbine plant can be used to generate steam in the waste heat boiler and the steam generated in the boiler is used to drive the steam turbine for generating electrical power. The higher temperature cycle is known as topping cycle whereas the lowering temperature cycle is known as bottoming cycle. The topping cycle for the proposed plant will operate in Brayton Cycle while the bottom cycle will have enough temperature to operate in Rankine Cycle. The heat in the exhaust gases of the simple gas turbine plant can be used to generate steam in the waste heat boiler and the steam generated in the boiler is used to drive the steam turbine for generating electrical power. Some of the advantages of a CCGT Plant are given below.

- The efficiency of the combined cycle plant is better or higher than the turbine cycle or steam cycle plant. The efficiency of combined cycle power plant will be of the order of about 45 to 50%.
- The combined cycle power plant is more suitable for rapid start and shutdown than the steam power plant. Therefore, these plants accept load variations quickly and help in maintaining the stability in the electrical grid.
- The cooling water requirement of the combined cycle plant is much lower than the normal steam turbine power plant having same capacity output. In these types of plants almost 2/3rd of the power is generated by the gas turbine plant which requires very little or no cooling water. Conventional cooling water system with evaporative cooling tower is recommended. The water is to be drawn from river, treated in a Water Treatment Plant ("WTP"). The water

is to be de-mineralized and supplied to boilers. Less water requirement for combine cycle plants is also major advantage while selecting the configuration of the plant.

- Combined cycle plants have the advantage of high ratio of power output to the area occupied. Therefore, for designing a CCGT plant space requirement is not a major concern.
- The superior efficiency of the combine cycle power plants over conventional reheat cycle plants not only conserves the fossil fuels but also drastically reduces the emissions and waste per unit of electricity generated.

3.4 PROJECT LAYOUT

Layout drawings with the various gas turbine models have been elaborated considering the following constraints:

- Shape and area of the available land;
- Location of main interfaces (River water intake, 230 kV switchyard); and
- Nearby habitations

The following equipment, system, process and non-process buildings are shown on the layouts;

- Gas turbine GT 1
- Gas turbine GT 2 (for 2-2-1 configuration)
- Auxiliaries of GT 1 (and 2)
- By-pass stack of GT 1 (and 2)
- HRSG 1
- HRSG 2 (for 2-2-1 configuration)
- Step up transformer GT 1
- Step up transformer GT 2 (for 2-2-1 configuration)
- Step up transformer ST
- Steam turbine building
- Intake water station
- River water treatment
- Pumping station of River water
- Service water tank
- Cooling tower
- Utility building (demineralization, Fuel Farm(FF), compressed air)
- Demineralization water tank
- Waste water treatment plant
- Gas station
- Electrical building (for the ST, HRSG's and BOP)
- Emergency Diesel (in enclosure)

Layout optimization is crucial for the success of the project; it must manage the installation of the new CCGT, the accessibility, maintenance facilities and noise issues.

GE and MHPS have provided preliminary layout confirming the feasibility to install one 2-2-1 CCGT with by-pass stacks and cooling tower. These layouts are preliminary and not finalized because some equipment / systems are missing such as the settling facilities, workshop/warehouse, pumping station, etc.

It has been confirmed by EPGE that areas located outside the CCGT fence may be used. It concerns some additional space in front of the EGAT GT'S, free space for workshop/warehouse behind the existing 33 and 66 kV AIS station and space for the settling pond under the existing 230 kV line.

The MHPS layout with the H-100 machines is very tight. The GE layout with the6F.03 machines provides more margin and flexibility. The 1-1-1 configuration provides more space for the equipment and for maintenance.

3.5 MECHANICAL SYSTEMS

3.5.1 Gas Turbine

The (pre)-selected gas turbines for the project are the GT13E2 of GE, SGT5-2000E of Siemens (for 1-1-1 configuration) and the 6F.03 of GE and H-100 of MHPS (for 2-2-1 configuration). The gas turbines will be installed inside a building, due to close proximity to residential areas.

Air Inlet Filter: Static filter will be used in the air inlet as the dust level in the area is not very high. Static filters consist of pre-filters and high efficiency filters. These filters are protected upstream by a rain hood, anti-bird grid, water separator for large droplets and a coalescer for fine droplets and mist. These filters become clogged with time and must be replaced when the pressure drop becomes excessive. It is therefore important to check that the frontal speed is not too high, and that the different filtration levels are correctly selected for the site air quality. Coalescing filters have a more frequent replacement than pre-filters and must therefore not be in common with the pre-filters.

Cleaning System: To keep the gas turbine performances as constant as possible (apart from non-recoverable wear degradation), the gas turbines will be provided with an on-line and off-line cleaning system based on injection of de-mineralized water. A detergent is added in case of off-line cleaning. The purpose is mainly to clean the compressor blades which suffer of fouling by the dust.

Exhaust Diffuser: The diffuser between the GT exit and HRSG inlet is a noisy equipment. It is recommended to insulate it properly (acoustically and thermally) and install it inside an enclosure; such solution will also limit the temperature loss between GT and HRSG (which is emphasized when by-pass stack is installed). A maximum 1°C temperature loss will be requested to the Bidders. The diffuser will not be equipped with a hot silencer (a cold silencer at HRSG stack is foreseen); that component suffers by the high temperature and pulsation generated by the flue gas at GT exit. It has however the advantage to make uniform the flue gas flow and temperature before entering the HRSG.

GT Installation: The turbine, generator and GT Auxiliary packages shall be installed indoors in enclosures. This will be done to reduce the noise level keeping in mind residential areas adjacent to the plant premises.

By-pass Stack: Each gas turbine will be equipped with a bypass stack. The bypass system is designed to divert the flue gases from the HRSG to a bypass stack allowing the plant to operate in simple cycle mode. The advantage is to keep the gas turbines running during maintenance period of the steam system or if the HRSG or the steam turbine trips. It also allows fast start-up of the gas turbine. Finally, it allows early power generation when the HRSG and steam turbine are still under construction phase.

3.5.2 Heat Recovery Steam Generator

The HRSG to be used for the plant will be most preferably vertical gas path type as it takes up less space. Natural circulators will be preferred in the HRSG as it requires less equipment and maintenance although both natural and assisted circulators are equally efficient. The HRSG will be with 2 or 3 pressure levels with reheat.

3.5.3 Steam System

Steam generated by the HRSG is conveyed to the steam turbine through steam pipes. Pressure and temperature drop in those pipes must be minimized. It is maximum 3°C for the temperature and 3-4% of nominal pressure for the HP level and less for the lower pressure level(s).

The steam turbine by-pass capacity will be limited to 60% of the steam flow mainly for CAPEX reason. This option is taken with the condition that an automatic relieve valve is provided (in addition to the safety valve) in case of evacuation of the steam to the atmosphere during transient.

3.5.4 Steam Turbine

The number of steam turbine bodies will depend on the supplier's standard. The ST exhaust may be axial, lateral or downdraft. The Low Pressure (LP) body is sized according to the vacuum in the condenser and the length of the Last Stage Blades (LSB) selected by the ST manufacturer.

The number of LP bodies and LSB defines the exhaust section of the ST and consequently the speed of the steam. High speed leads to vortices and losses while low speed affects the turbine stage efficiency. LSB are not available for any length but for typical lengths developed by the manufacturers. Manufacturers will therefore optimize the LP body (highest efficiency & lowest cost) based on the selected vacuum in the condenser and available LSB.

3.5.5 Condenser

The water-cooled condenser will be surface type and made of 2 independent bodies on the water side. This will allow isolating a half-condenser in case of leak from a condenser tube.

The tubes will be made of titanium to be protected against corrosion by salty water and the carbon steel tube plates will be cladded with titanium. A ball-cleaning system is provided to eliminate any deposits in the tubes. The passage of the balls will also prevent the development of aquatic organisms

The water boxes of each half-condenser will be in carbon steel protected by an epoxy or rubber coating. They will also be shaped to ensure a good distribution of the cleaning balls through the tubes bundles.

Each water box will be provided with an isolation valve upstream and downstream. Vacuum of the condenser (steam side) will be done using vacuum pumps. Ejectors are less recommended due to steam consumption and therefore less flexible for start-up. The condenser will be equipped with total and cationic conductivity meter to quickly detect any tube leak.

3.5.6 Condensate System

The condensate system has the function to convey the condensate from the condenser hot-well to the condensate pre-heater (first HRSG module). 2 x 100% condensate extraction pumps will be installed. They are sized to satisfy with one pump only the water flow needed during the opening of the steam turbine by-pass (normal flow + de-superheating water). Another arrangement with 3pumps is acceptable if the emergency flow is high compared with the nominal flow.

During low flow operation, recirculation is made back into the condenser hot-well. A polishing unit, if installed, allows treating the condensate water and protecting the HRSG tubes in case of undetected leaks in the condenser tubes. Polishing units are also recommended.

3.5.7 Feed Water System

The water from the condensate pre-heater is discharged in the deaerator. The deaerator has the function to complete the removal of gasses and incondensable which was partially done in the condenser. The deaerator can be a de-aerating tower and feed water tank or a spray-type deaerator (Stork design). Both types are acceptable.

Condensate entering the deaerator must be about 10°C colder than the saturation temperature inside the deaerator to flash and guarantee a good deaeration. The deaerator can be a stand-alone deaerator or combined with the low-pressure drum of the HRSG. That last solution is recommended.

The deaerator provides the feed water to the feed water pumps (common pumps for HP and IP levels). Two pumps of 100% capacity each will be provided. During low flow operation, recirculation is made back into the deaerator.

Those pumps will control the level in the drum. It can be done with the pump running at fixed speed and pressure control valve, or with the pump running at variable speed with pressure control valve used only at very low flow. Variable speed is made using hydraulic coupling or electrical motor with frequency converter. Variable speed is preferred (especially when operating in sliding pressure mode) and to keep the system simple, hydraulic coupling is recommended.

3.5.8 Cooling Tower

The mechanical wet draft cooling tower has been selected for this plant. The make-up water will be from the Hlaing River. The cells of the cooling towers must be designed assuming salty water. The towers could be equipped with a system to abate the white panache created by the evaporation of the water. Such system is necessary due to the vicinity of the existing habitations. The impact on the auxiliary power consumption is +300 kW.

The tower should preferably be designed with the water collector installed in elevation. It provides a high saving in pumping power. The number and size of cells shall be selected by the bidders to obtain the best vacuum considering the space available.

The tower will not be redundant thermally but hydraulically. It means that it shall be possible to isolate one cell for cleaning or repair purpose while keeping 100% of the circulating water in the N-1 cells. The de-concentration purge or tower blow down is discharged to the river using thermal diffuser in order to comply with the World Bank criteria. The wet cooling tower system will consist of the following:

- A surface condenser with titanium in case of salty water
- Mechanical draft cooling towers
- A pumping station, located next to the basin of the tower, equipped with pumps (2x50%) to circulate in Glass Reinforced Pipes (“GRP”) pipe the cooling water between the cooling tower basin and the condenser.
- A chemical agent injection system to control biological fouling and scale.
- The blow-down system discharging concentrated water in the Hlaing River

3.6 ELECTRICAL SYSTEM

3.6.1 Plant Electrical System

The electrical power system of the plant can mainly be classified according to voltage level as follows:

- 230kV Transmission System
- 11kV GTG and STG Power Generation System
- 6.6kV Power Distribution System
- 400/230VAC Power Distribution System
- 400VAC Emergency Power Supply
- 220VDC Power Distribution Supply
- 230VAC UPS Power Distribution Supply

3.6.2 Equipment System Composition

The plant electrical system consists of the electrical equipment which is classified into the following main systems.

- Metering System
- Generator and auxiliary system
- Generator Circuit Breaker
- Isolate Phase Bus duct
- Generator Step-up Transformer
- Unit Auxiliary Transformer
- Auxiliary Transformer
- Medium Voltage Power Distribution System
- Low Voltage Power Distribution System
- DC Power Distribution System
- Emergency Power System (“UPS”)

- Emergency Diesel Generator
- Lighting and Small Power System
- Earthing and Lightning Protection System
- Fire Alarm and Detection System
- Communication System
- Digital Fault Recorder System ("DFR")
- Cathodic Protection System

3.6.3 A C Generator

The turbine generators are included in the turbine package (GT and ST) which will be compliant with the following functional characteristics:

Generators will be sized to evacuate the output of the gas turbines and the steam turbine at maximum turbine load, ambient conditions and the grid code requirements. Air cooled generators are preferred solution. They are provided with brushless excitation system.

The generators are designed to operate in parallel with the external grid to which they are connected through step-up transformers. Synchronizing of generator will be performed with a generator circuit breaker. The generator will can supply rated active power between 49.5 Hz and 50.5Hz, and ±10% of nominal rated voltage, within the power factor range of 0.85lagging to 0.90 leading with the generator cooling media at maximum temperature and at maximum ambient temperature.

Anti-condensation heaters shall be provided for the air circuits, generator windings, and excitation system and control cubicles. Heaters shall can maintain the air temperature above the dew point to prevent condensation. These heaters shall automatically switch on when the generator is taken out of service. Temperature detectors shall be provided to monitor the maximum operating temperature of the generator.

3.7 POWER EVACUATION

The power generation in the new CCGT plant will be at about 11kV voltage level. The 11kV power generated will be stepped–up to 230kV voltage level using generator step-up transformers. The power from the new CCGT plant will be transmitted to the new 230KV GIS sub-station by underground cables. The new 230kV GIS sub-station will be connected to the existing 230kV AIS by underground cables, from where power will be evacuated to 230kV grid. Figure 3.8 illustrates the power evacuation process of Ywama Power Plant at present, during rehabilitation and after when the new plant will also be commissioned.

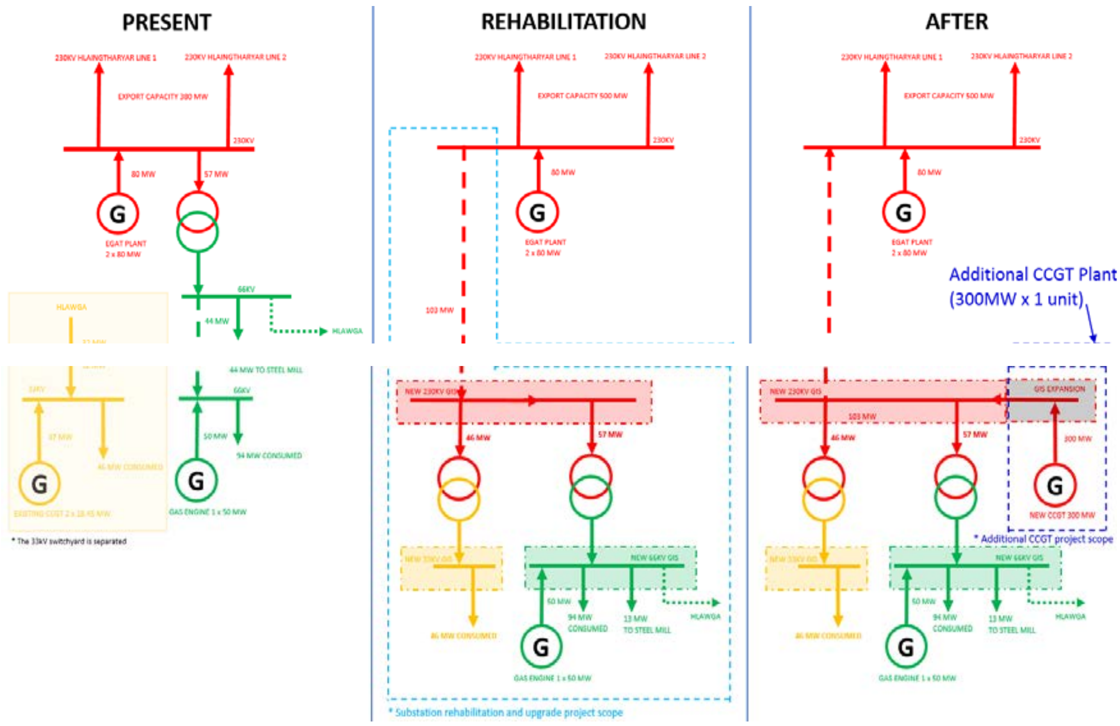


Figure 3-10: Line Diagram of Evacuation

3.8 FUEL SUPPLY

The natural gas for the proposed plant will be provided from the Yadana off-shore gas fields. The quality of gas from this field is poor containing about 70% methane and 25% nitrogen. Based on the quality, the requirement for the proposed plant has been estimated to be about 80 MSCFD.

There are 2 gas stations on site directly connected to the Moge gas station through one 20" pipe to the first gas station feeding the 2 MHI gas turbines and one 10" pipe feeding the two John Brown gas turbines, the Hitachi gas turbine and the IPP Gas Engines. The length of the gas pipe from MOGE station to the Ywama site is 4.4 km. One 6" pipe has been installed in 2014 and is crossing the Ywama area to feed the IPP Gas Engines. This pipeline will have to be realigned due to the construction of the new plant (refer Figure 3.5). The existing line from MOGE-5 gas station to the Mitsubishi gas turbines is a 20" pipe, which will also be used to supply gas to the new CCGT. As the Gas Engines consumes 25 MSCFD, about 100 MSCFD space remains for the new CCGT which will consume about 80 MSCFD. Thus, this pipeline can be used for the proposed plant.

The new gas station will be equipped with scrubber to eliminate the condensates which may be present in the gas, filtration and fiscal metering. "Fine" pressure control will be made in the gas turbine fuel gas skid. Gas heating is not necessary as they will be no gas expansion. After the last filter, the gas line is in stainless steel. One chromatograph will be provided if needed for the process of the gas turbine. Relief valves used to depressurize the gas pipe at each shutdown or to remove the possible condensate accumulated in the gas line before start-up must be equipped with a silencer. The layout of the gas pipelines within the plant area is depicted in **Figure 3.11**.

Figure 3-5:Gas Pipelines in the Plant Area

3.9 PLANT WATER SYSTEM

3.9.1 Water Intake System

Water will be extracted from the Hlaing River. The River bank is located at about 20 meters from the site boundary. That water will be used as make-up for the cooling tower and service water (if required). Presently service water is sourced from wells installed in the plant.

It has been calculated that about 16800m^3/day make up water will be required for cooling towers on the basis of which the pipeline diameter and pump specification will be designed. For Ywama, it is recommended to use floating deck method for water abstraction from the river. In this system, pumps are installed on a floating deck located at a sufficient distance for the river bank to have enough depth for pumping. However, for this plant, it has to be ensured that there is no interference with the fluvial traffic.

3.9.2 Raw Water Treatment

It has been found that water of Hlaing River has high turbidity and TSS and thus is required to be treated before use in the plant. The water quality parameters showed significant variation in water quality of the river and the water quality monitoring data were compared to the water quality standards for different uses. The physico-chemical characterization of river water has been done to design the raw water treatment plant. Wastewater of the plant will be discharged away from river bank to facilitate dilution and dispersion within a short distance from the discharge point to reach baseline river quality. It will maintain the baseline water quality of the river. Hlaing River receives wastewater from adjacent industrial zones and residential areas through different channels. According to the Fishery Department of Myanmar the stretch of the Hlaing River is restricted for fishing due to high traffic volume.

River water quality was monitored for relevant parameters for comparison with environmental standards for human consumption and aquaculture as given in Chapter 5. While this will provide the plant designers some broad data, they may not suffice specific requirements of water quality for plant and process design. Therefore, the river water quality may have to be monitored by FS Consultants for various parameters not limited to TDS, total hardness, chloride and sulphate which are important parameters for plant operation e.g., TSS.

Treatment of turbidity can be carried out by either settling ponds or clarifier. In case of the Ywama Plant, a settling pond of about 20 x 50 meters will be installed by the contractor since this activity falls within the scope of the EPC contract. The settling pond will be located within the existing footprint of the power plant.

3.9.3 Cooling Water System

A mechanical wet draft evaporative cooling tower has been selected for this plant. The de-concentration purge or tower blow down is discharged to the river using thermal diffuser in order to comply with the World Bank criteria. The temperature of discharged water will be within 3^{0}C above river water temperature. The make-up water will be from the Hlaing River. The cells of the cooling towers must be designed assuming salty water.

The towers could be equipped with a system to abate the white panache created by the evaporation of the water. Such system may be necessary due to the vicinity of the existing habitations. The River bank is located at about 20meters from the site boundary.

Presently service water is sourced from wells installed in the plant. After expansion, some service water will be drawn from river also. All effluents after treatment to meet World Bank norms will also be discharged to the river.

The water process diagram for the plant is given in **Figure 3.12**.

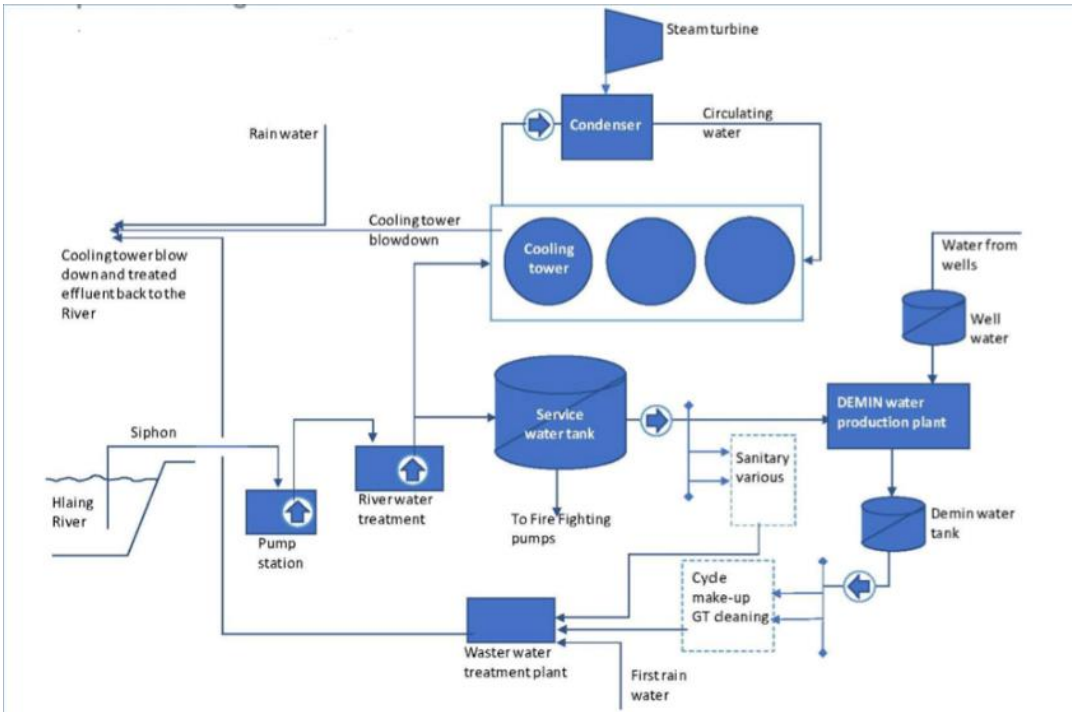


Figure 3-6:Water Process Diagram

3.9.4 De-mineralized Water

The make-up water feeding the de-mineralized plant will be water from the Hlaing River after WTP. Due to the high TDS water of the river, it has been preferred to use Reverse Osmosis for de-mineralization. This technology is very suitable when concentrations of minerals are high. It consists of high-pressure pumps to force the passage of water through a semi-permeable membrane by counteracting the osmotic pressure of the water (loaded with minerals).

3.9.5 Fog Production

Under certain ambient conditions, plumes of water vapour (fog) can be seen rising out of the discharge from a cooling tower. If the outdoor air is at or near saturation, and the tower adds more water to the air, saturated air with liquid water droplets can be discharged, which is seen as fog. This phenomenon typically occurs on cool, humid days, but is rare in hot climate like that of site.

Theoretically, this phenomenon can be prevented by decreasing the relative humidity of the saturated discharge air. For that purpose, in hybrid towers, saturated discharge air is mixed with heated low relative humidity air. Some air enters the tower above drift eliminator level, passing through heat exchangers. The relative humidity of the dry air is even more decreased instantly as being heated while entering the tower. The discharged mixture has a relatively lower relative humidity and the fog is invisible. Standard type cooling tower can be changed to hybrid model if required by the ESIA.

Even with this precaution, the location of the cooling tower must be carefully selected to avoid any probable fog towards the nearby houses near the north-eastern corner of the site. They should preferably be kept near to the river in NW corner as predominant wind is from S and SE as can be seen from wind rose.

3.9.6 Waste Water Treatment

The sources of effluents from the power plant are as follows:

- Effluents coming from the water steam cycle (the purge of boiler drums, the various losses of the circuit, especially at start-up);
- Oily effluents resulting from various losses from oil tanks;
- Sanitary effluents from toilets;
- Rainwater considered as oily water during the first minutes of rain fall;
- The effluents of the demineralization unit; and
- The blow-down from the cooling towers

The treatment process to be practiced in the proposed plant, of each of the streams is given in **Table 3-1**.

Table 3-1: Waste-water Treatment

Sl. No.	Effluent Stream	Treatment/Disposal Method
1	Water from Cycle	pH neutralized and discharged to Hlaing River
2	Oily Effluents	Passed through oil filters and collected oil will be stored in containers and disposed for external treatment
3	Sanitary Effluents	Septic Tanks and soak pits.

Sl. No.	Effluent Stream	Treatment/Disposal Method
4	Cooling Tower Blow-down	Discharged to Hlaing River without treatment or sent to evaporative tank
5	Effluents from DM unit	Brine from RO process will be discharged to Hlaing River Water from RO membrane cleaning will be neutralized and discharged to Hlaing River

Source: Feasibility Study Prepared by Tractebel Engineering

3.10 FIRE FIGHTING

The purpose of this system is to distribute fire-fighting water throughout the plant. The system is sized for a single risk requiring the largest water quantity and one hydrant full open. That single risk can be,

- A fire inside the Gas Turbines enclosure (that risk is excluded from the design of the fire-fighting because the GT's have already their own fire-fighting protection with CO2 discharge or other system like water mist)
- The fire of the oil tanks of the steam turbine
- The fire of the oil tank of the step-up transformers

The fire-fighting system will be designed according to the NFPA 850[5] standard as guideline. The system will include 2 fire pumps (the first driven by an electric motor and the second by a diesel engine) and redundant jockey pumps having the function to keep the system under pressure. The fire loop will be buried, and the piping will be in GRP or High-Density Poly Ethylene ("HDPE"); parts aboveground will be in galvanized steel. The plant will also be equipped with portable or wheeled fire extinguishers.

3.11 ACTIVITIES DURING PRE-CONSTRUCTION STAGE

As mentioned earlier three units will be decommissioned and dismantled to make space for the proposed CCGT. The demolition concerns are the 2 John Brown Frame 5 Gas Turbine; one Hitachi H.25 Gas Turbine; Shin Nippon Steam Turbine; cooling tower; water treatment plant; warehouse; and oil tanks. After demolition, a surface of 2.4 ha (6 acres) will be made available for the proposed project(Figure 3.8).

[5]The National Fire Protection Association (NFPA) 850 provides recommended practice for fire safety for gas, oil, coal, and alternative fuel electric generating plants, including high voltage direct current converter stations and combustion turbine units used for electric generation.

2x18.45 MW John Brown Turbines | 23.4 MW Hitachi CCGT

Steam Turbine of 23.4 MW Hitachi CCGT | Other Structures to be Dismantled

Figure 3-8: Plants/Structures to be De-commissioned

The two Mitsubishi 2x120 MW701D gas turbines (second hand) recently installed and operating in open cycle will remain in operation, in addition to the recently constructed 50 MW Gas Engines IPP plant. These Gas-engines are not owned by EPGE (Figure 3.8).

Equipment located in front of the existing MHI's GT must also be demolished. The IPP Gas Engines Plant is fed from the John Brown gas station through a 6" pipe. As that station will be demolished, that supply pipe shall be realigned; it is suggested to connect the existing pipeline to the gas station feeding the EGAT plant.

The dismantling process will consist of mechanical, hydraulic and electrical unbolting, cutting or disconnecting and lead to use of mobile crane of adequate capacity and boom height. Significant gaseous emission is not expected from these activities but some gaseous emissions and noise will take place during use of trucks used for transporting the dismantled machineries and scraps. The 2 John Brown plants to be scrapped is reported not have any asbestos and thus asbestos disposal problem is not foreseen. However, the Hitachi CCGT plant, which will be re-installed at Hlawga, has asbestos as insulation materials.

During dismantling of the oil tanks, the soil may get contaminated if there is uncontrolled spills of oil. Although the tanks will be emptied and most of the area is paved, contaminants may percolate to soil through cracks. The removal of entire quantity of floor and contaminated soil will be very costly. As such, in-situ bioremediation is recommended. The application of microorganisms or microbial processes to remove or degrade contaminants from soil is called bio-remediation. This microbiological decontamination is claimed to be an efficient, economic and versatile alternative to physico-chemical treatment of soil contaminated with petroleum products.

3.11.1.1 Manpower Requirement

The manpower requirements for the pre-construction Phase have been estimated to be approximately 300, which will include semi-skilled and unskilled workers. As all the semi-skilled and unskilled workers are planned to be recruited locally, there will not be any requirement of residential camps for them.

3.11.1.2 Logistics

Due to lack of space in the plant, dismantling will have to be done in stages as there will be not enough storage space. Temporary storage will be done at the lay-down area identified outside the site, from where they will be sent for disposal. The machineries will be further dismantled in the lay-down area before transportation by road to respective destinations. The John Brown machines will be sold as scraps to recyclers while the Hitachi CCGT machine will be most probably installed at Hlawga. Demolition, evacuation, discharge and site preparation shall conform to the World Bank criteria[6].

The quantity of waste to be generated and probable impact of the decommissioning from waste-water, solid wastes, etc. is provided in Chapter 6.

3.12 CONSTRUCTION STAGE

3.12.1 Activities during Construction Phase

Site formation and leveling works will be required within the Project site where site preparation from the stage as left by contractors after PC stage, excavation, pile driving, foundation casting, backfilling and stockpiling of materials will be carried out and there will be potential to cause fugitive dust impact. The excavated materials suitable for backfilling will be temporarily stockpiled onsite. Construction equipment (electric and diesel-powered) will be operating in different areas of the entire work site area. Materials handling, trucks movements within the work sites, wind erosion of the open uncovered areas are the potential sources of fugitive dust emissions. Construction dust arising from the dust generating activities and air emissions from construction vehicles and non-road machinery within the construction site boundary are the key concerns during construction of the Project.

3.12.1.1 Site Clearance

The land left after pre-construction stage will be mostly paved with abandoned foundations left from dismantled plants. The first activity will be to clear this land.

Site preparation in readiness for construction work may require some vegetation clearance and top soil removal as most of area left after dismantling will be paved; removing planted trees felling with erection activities; dismantling paved areas and existing portion of foundations of dismantled plants as needed for constructing new foundations and structures; stripping off of concrete debris; ground leveling and compaction. It is recommended that only the required area should be broken to minimize waste generation and handling. The paved areas may be judiciously used without damaging it, wherever possible.

Regarding final landscaping, areas within the plant not covered by concrete paving, gravel or crushed limestone shall be covered by grass. The topsoil shall be reused for the area of grass surface around the facility after the construction phase. The grass

[6] The Management of Brownfield Redevelopment – A guidance Note document 55009 – dated March 8th, 2010

surface shall be of short stemmed, native species grass, and shall be completed by sodding method.

3.12.1.2 Piling, Foundation and Excavation

From the Civil Engineering Specification of FS of Engineering Consultant, it is noted that piling and sheet piling technique will be followed in the project's civil engineering activities. Sheet piling for dewatering, river construction, or trenching shall be steel or wood if temporary and removed upon completion of construction. Only steel piling shall be used if piling is to be left in place after construction.

Sheet Piles is mostly used to provide lateral support. Usually, they resist lateral pressure from loose soil, the flow of water, etc. They are usually used for cofferdams, trench sheeting, shore protection, etc. They are not used for providing vertical support to the structure. They are usually used to serve the following purpose:

- Construction of retaining walls.
- Protection from river bank erosion.
- Retain the loose soil around foundation trenches.
- For isolation of foundation from adjacent soils.
- For confinement of soil and thus increase the bearing capacity of the soil.

The foundation of all buildings, structures, pipe supports, duct banks, cable trenches, manholes, tanks and equipments shall be of reinforced concrete supported on piles. The foundation component of the Generation Building shall be reinforced concrete slab and beam on concrete piles or reinforced concrete mat on pile. The foundation of the Central Control Building shall be designed as a reinforced concrete supported on piles. The foundations of miscellaneous buildings and structure shall be designed as a reinforced concrete supported on piles. The foundation component for the Stacks shall be reinforced concrete foundation supported on piles.

The site services shall cover electric cables, plant pipe work, telephone cables, fuel gas, domestic water, fire fighting, de-mineralized water, service water, potable water, service air etc. All these services shall be provided to meet the demands identified, to ensure smooth operation of the Plant as described in particular specification (electrical, mechanical, etc.). They shall be located to reduce the amount of excavation.

It is mentioned that the pile capacities shall be determined by geotechnical investigation. The pile sizes and length shall be determined during the detailed geotechnical analysis. As such, quantum of earth to be removed and backfilled is not readily available. It is presumed that piles will cause the soil to be displaced vertically and radially as they are driven to the ground. To assess this, references were taken from other past projects and it was assumed that a total of about 18000 m^3 of soil will be displaced and will be used for leveling inside the plant.

3.12.1.3 Delivery of Construction Materials to Site

Construction materials such as building blocks, cement, sand, steel bars, ballast will be bulky and thus will require to be delivered on site by a fleet of trucks driving in and out of the Construction site. During this exercise dust is likely to be generated from the following activities:

- Handling of sand, cement and ballast which are dusty
- Ballast could contain loose dust particles
- Site clearing of area of holding ballast, building blocks and sand will expose the site to wind action

3.12.1.4 Construction Materials

The construction materials which will be used in the plant during pre-construction and construction stages are provided below in Table 3-1.

Table 3-1: Construction Equipment

Equipment	Number of equipment	Engine power HP
Automobile	2	136.3
Pick-up 4x2	4	136.5
Jeep 4x4	2	253
Truck Mixer	1	360
Concrete Mixing Plant	1	148
Concrete Vibrator	2	1.1
Truck Tractor	1	500
Generator	4	312
Rough Terrain Crane	3	240
Man lift– 33 m	1	75
Man lift– 43 m	2	74
Steel Bar Bending Machine	2	7.4
Steel Bar Cutting Machine	2	5.4

Source: Tractebel FS

3.12.1.5 Manpower Requirement

It is estimated that a total of about 800 people will be involved in construction of the plant. This will include technical experts as well as semi-skilled and skilled workers. No residential arrangements are required for the manpower as the experts will be residing in Yangon while the workers will be locally recruited.

3.12.1.6 Facilities

The Contractor shall furnish all construction and temporary facilities, equipment, materials and supplies required for the execution of the Works. Temporary structures for Contractor's offices, changing rooms, canteen, toilets, warehouses and other uses shall be provided by the Contractor. Temporary structures shall be sufficiently foreseen for all workers on site. All temporary structures and facilities provided by the Contractor will remain the property of the Contractor. When the Works are complete, all such temporary structures, buildings, concrete slabs and footings, scaffolding, tools and facilities shall be removed from the Site, and the areas involved shall be restored to their original or intended condition. These facilities shall be regularly and systematically maintained and cleaned throughout the Works to ensure proper and efficient operation.

3.12.1.7 Logistics

It has been suggested that all heavy machines and equipment for the proposed plant including turbines will be transported to the site by Hlaing River. Thus a temporary jetty has to be built from where the machineries will be carried to the plant by cranes. The lay-down area adjacent to the site will be used for assembling and fitting of machineries. The civil construction materials will be brought by road and stored in the lay-down area and subsequently transferred to the site in smaller vehicles as per requirements.

The quantity of waste to be generated and probable impact of construction from waste-water, solid wastes etc. are provided in Chapter 6.

3.13 TIME-FRAME

The time schedule includes the tendering phase from pre-qualification process to bidder selection including contract signature and the EPC contractor activities from Notice to Proceed ("NTP") till Commercial Operation Date ("COD"). Tasks of the tendering phase have a total duration of 17months and includes:

- Prequalification process (about 5 months)
- Bidding phase (about 6 months starting **2 months** after initiation of the prequalification process) which includes:
  - the redaction of the technical Specifications (**2 months**)
  - the preparation of the binding offers by selected bidders (**3 months**)
- Bid evaluation (about **4 months** after reception of the offers)
- Pre-award clarification (about **3 months** after bid evaluation approved by government and World Bank) ending by the Contract Signing and NTP.
- Mobilization (about **2 months**)

The execution of the project by the EPC Contractor starts at NTP to end at the COD. The duration is estimated at 32 months. This is a best estimate considering the site complexity (small site, limited access, distant temporary areas and monsoon period). Major events for a 2-2-1 configuration are as follows:

- First gas turbine on foundation 16 months after NTP. There a one-month gap for the second gas turbine;
- Power from the grid available 18 months after NTP;
- Fuel gas available at site fence 20 months after NTP;
- Steam turbine installed after 22 months; and
- Commissioning and performance test completed 32 months after NTP.

In case of 1-1-1 configuration, the total duration is slightly lower because only one gas turbine (but larger) is installed and more space are available on site for the construction. Total duration from NTP to COD shall be 30 months.

3.14 PROJECT COST

3.14.1 Cost for Dismantling

The estimated cost of demolition work is 600,000USD. The demolition cost of the existing power plants was based on the number of buildings/ structures, size of buildings/structures, types of buildings/structures, foundations, site clearing and preparation, etc. The cost per unit used was based on past projects. However, this estimation does not account for scrap credit, which is needed to be estimated, and furthermore if asbestos is present in the plant, its cost must be added to the demolition cost. Therefore, the demolition cost is not considered a significant element of the Project cost.

3.14.2 Capital Cost for Construction

The total investment cost for the plant option providing the largest power output, equivalent of 300MW (net at site) is estimated at around SU$ 300 million including contractor (EPC), owner costs, dismantling, and contingencies.

Operation Cost

The OPEX cost (fuel excluded) includes LTSA, fixed and variable costs. Based on similar projects, they are estimated between 4.5 and 6 USD/MWh. This range is valid for each configuration.

Chapter-4

Project Alternatives

Project Alternatives discusses the various alternatives in technology, lay-out, site orientation, and reason for choosing a particular alternative.

4 ANALYSIS OF ALTERNATIVES

4.1 NO PROJECT ALTERNATIVES

The rationale behind the proposed Ywama Combined Cycle Gas Turbine Power Plant Project is that current demand for electricity outstrips supply (generation) and, that current electricity supply is unreliable and suffer interruptions. The project is replacement of old power generating units with new modern units and increase power generation from the plant with reduced pollution, environmental impacts and social impacts. If the Project does not go ahead, the wider benefits to the stability and availability of electricity and associated benefits to the national economy with reduced cost per unit of pollutants emitted will not be realized and Myanmar's economic development may, therefore, be hampered.

The proposed 250-300 MW new units of the power plant will reduce generation of pollutants like NO_2 to cost effectively meet gaseous emission limits. This also will generate less noise pressure level during operation by locating them inside enclosures and hence less noise pollution in nearby residential areas. Thus, overall improvement in the environment is envisaged with the new plant. The details are provided subsequently in the report. However, there may be various alternatives of the proposed plant to meet the need which is described below:

One of the potential alternatives considered is the No Project Alternative. This involves retaining the status quo of the Site, i.e. no new development at site and the old plants will be retained. Presently there are 3 plants (2 units of 18.45 MW John Brown Simple Cycle Power Plant and single unit of 23.4 MW Hitachi CCGT) installed in the proposed site. These plants are old and thus do not have reliable production.

Furthermore, if power demands are not met, it is likely that power production using private diesel generators will increase resulting in higher emissions of air pollutants than a gas-fired power plant. **Thus the 'No Project Alternative' is not considered to be a viable alternative.**

4.2 PROCESS AND FUEL ALTERNATIVES

4.2.1 Conventional Coal Based Thermal Power Plants

Conventional steam producing thermal power stations generate electricity through a series of energy conversion stages: firstly fuel is burnt in boilers to convert water into high pressure steam, which is then used to drive a turbine to generate electricity. In coal fired power alternative, the coal is pulverized (to enhance combustion efficiency), then fed into the combustion chamber of a boiler and burned.

Coal combustion generates TPM, SO_2, NO_2 and CO.TPM emission depend on ash content of coal. The boilers capture some TPM as bottom ash. Un-captured TPM in boiler goes to bag filters or ESPs and collected as fly ash. Considerable fly and bottom ash are generated from coal fired TPPs bringing disposal problem. The ash that will not be collected as bottom ash in boiler and fly ash in ESP/Bag Filter will go to the stack. If ash is collected in wet form, it will go to ash ponds needing large areas and water and heavy metal seepage problems from ash ponds leaching to ground water. Emission of SO_2 is also an issue with coal fired power plants. High Sulphur coals produce high SO_2 emission and needs to be controlled by Flue Gas Desulfurization (FGD) to meet emission limits. NOx is also an issue which is to be reduced by low.

4.2.2 Petroleum Coke based Thermal Power Plants

Abbreviated Pet coke, it is a final carbon-rich solid material that derives from oil refining, and is one type of the group of fuels referred to as cokes. Pet coke is over 80% carbon and emits 5% to 10% more carbon dioxide (CO_2) than coal on a per-unit-of-energy basis when it is burned. On per-unit-of-weight basis, as pet coke has a higher energy content, pet coke emits between 30 and 80 % more CO_2 than coal per unit of weight. This will enhance climate change. Pet coke emits very high SO_2 due to high percentage of sulphur in pet coke reaching up to 6%. However, as a fuel, it becomes an economic solution.

4.2.3 Diesel Generator Sets

If unreliable power supply exists, to meet power needs, a large number of small DG sets will be setup by expanding commercial establishments and industry near the busy localities. These are known to be polluting units with high emission of SO_2 and NO_2 released at low heights creating dispersion problems. Noise from DG sets is also a matter of concern to the locality.

4.2.4 Gas-based Thermal Power Plant

CCGT Based: Combined Cycle Power stations (like the present CCGT proposal) burn fuel (natural gas) in a combustion chamber and the exhaust gases are used to drive the turbine. Waste heat boilers capture energy from the exhaust gases for the production of steam, which is then used to drive another turbine; this process is generally more efficient than conventional systems.

Gas Engine Based: Engine-driven Power Stations have shorter erection periods, higher overall efficiency (low fuel consumption per unit of output) and moderate investment costs. Modern and highly efficient gas engines arranged in combined power plants can present an alternative to CCPP plants. As well as delivering highly efficient CHP capabilities, these engines can participate in the balancing energy market due to their high flexibility, a factor which can further increase profitability. Their modular construction with unit sizes of around 10 MWe allows operation that is tailored to requirements, and simultaneously offers high efficiency across the entire load range.

4.2.5 Fluidized Bed Combustion

Advanced coal utilization technology (e.g. Fluidized Bed Combustion) tends to be more efficient than conventional and combined cycle systems. Integrated coal gasification combined cycle (IGCC) power plant is one of the most environmentally friendly coal-fired power generation technologies. Most importantly, coal gasification, generating Syngas(gas from coal combustion or high energy waste gases from refineries), which is rich in Hydrogen content, offers the immediate opportunity to generate power with near zero greenhouse gas emissions if CO_2 can be captured and disposed off in deep sea beds or geological formations, but at great cost. This is the pathway to a future hydrogen economy. IGCC uses a combined cycle format with a gas turbine driven by the combusted syngas, while the exhaust gases are heat exchanged with water/steam to generate superheated steam to drive a turbine.

4.2.6 Nuclear Energy

Nuclear power is generated from the controlled use of nuclear reactions to yield energy (electricity and heat). Nuclear energy is produced when the natural radioactive decay of material, such as uranium, is accelerated to produce heat, which is used to boil water, which in turn generates steam which is used to drive turbines. Nuclear power provides 11% of global electricity generation. However the installations of nuclear power plants in the developing nations are still few and have not been utilized as a source of power.

The use of nuclear power is controversial because of the problem of storing radioactive waste for indefinite periods, the potential for possibly severe radioactive contamination by accident or sabotage, and the possibility that its use in some countries could enable the development of nuclear weapons.

4.2.7 Hydroelectric Power

Hydroelectric power stations can produce a great deal of power very cheaply without emissions. Either a dam is built to trap water, usually in a valley where there is an existing lake, or a smaller run-of-river installation can be used. Water is allowed to flow through tunnels in the dam, to turn turbines and thus drive generators and so produce electricity. After passing through the turbine, the water re-enters the river on the downstream side of the dam.

While producing low emission power, hydro schemes can cause significant environmental and social impacts. Dam construction can mean significant land-take due to submergence, and can cause large-scale resettlement of communities and reduction in the availability of productive land. Changes in water flow downstream in dry seasons can also reduce the water available for existing use, affecting livelihoods (fishing, agriculture, industry) and lifestyle and cause flooding during monsoon if the dam releases excess water due to its reduced holding capacity. It is often a highly political issue, particularly where the dammed river crosses international boundaries.

4.2.8 Wind Power

Wind power generation is becoming popular as a non-conventional power. Wind drives the propeller, which turns a generator to produce electricity. Normally, wind farms are located near the consumers by occupying large areas of land. In addition to the actual wind farm, other project features associated with wind conversion systems include: construction camps; maintenance facilities; sub-stations; transmission lines and access roads. Being near the local communities, the setting up of wind turbines can attract considerable protest from local communities. This relates to noise, visual intrusion and effect on birds. However, in terms of environmental impact, this is a favored power generation source as there is no environmental pollution. The only drawback is impact on energy output due to erratic nature of the wind environment.

4.2.9 Photovoltaic / Solar Power

Solar Photovoltaic (PV) and Concentrating Solar Power (CSP) are the two main types of solar energy. PV power involves the absorption of the sun's energy using photovoltaic cells made of semiconductor material. These cells are connected together to form a solar panel. Sunlight on the cells forms an electric field across the layers of the panel to produce a direct electrical current. Using an inverter, direct current is then transformed into alternating current which can be used by a commercial or residential property or exported into electricity grids. CSP absorbs sunlight heating into a receiver. The receiver in turn adapts the sunlight into mechanical energy through turbines, forming solar thermal electricity.

The cost, intermittency, and availability of unencumbered land close to the transmission network, has limited so far the penetration of solar PV compared to conventional coal, gas, and nuclear-powered generators has kept PV power generation from being in widespread use. There are a few applications, however, in which PV power is economical e.g. developing countries that lack a power distribution infrastructure, and remote or rugged areas where running distribution lines is not practical. In Myanmar, the use of solar PV in mini-grid ore Solar Home Syustems has increased substantially over the pas few years.. As the country becomes more familiar with grid-connected solar PV technologies, PV power can make it an attractive choice even when conventional generating systems.

4.2.10 Geo-thermal Power

Mining the earth's heat generates geothermal power. In areas with high temperature ground water at shallow depths, wells are drilled into natural fractures in basement rock or into permeable sedimentary rocks. Hot water or steam flows up through the wells either by pumping or through boiling (flashing) flow.

Three types of power plants are used to generate power from geothermal energy:

- Dry steam plants take steam out of fractures in the ground and use it to directly drive a turbine that spins a generator.
- Flash plants take hot water, usually at temperatures over 200 °C, out of the ground, and allow it to boil in steam generators and then run a turbine.
- In binary plants, the hot water flows through heat exchangers, boiling an organic fluid that spins the turbine.

4.2.11 Energy from Biomass and Wastes

Biomass is a renewable energy resource derived from the carbonaceous waste of various human and natural activities. It is derived from numerous sources, including the by-products from the timber industry, agricultural crops, raw material from the forest, major parts of household waste and wood. Biomass fuel's low sulphur and nitrogen (relative to coal) content and nearly zero net CO_2 emission levels allows biomass to off-set the higher sulphur and carbon contents of the fossil fuel. Availability of bio mass is, however, seasonal. Any power plant using bio mass, therefore, will keep provisions to mix it with other fuels like pet coke or coal generally in FBC boilers in varying proportions depending on availability of bio mass. When high percentage of coal/ pet coke is used, the problems of coal/pet coke fired boilers will remain.

However, energy from biomass and/or waste, as an alternative to fossil fuels, provides a contribution towards the reduction in landfill disposal. There are several ways of capturing the stored chemical energy in biomass: direct combustion (the burning of material by direct heat) is the simplest biomass technology and can be economically feasible / efficient if the biomass source is close by. Pyrolysis refers to the thermal degradation of biomass by heat in the absence of oxygen, resulting in the creation of gas, fuel oil and charcoal.

It is now widely acknowledged that crop-based bio-fuel plantations that are grown purely with the intention to provide a fuel source exacerbates food insecurity and so is viewed less positively from an environmental perspective.

The comparative analysis of environment and social impact of the various fuels used for power generation is given in Table 4-1 below.

Table 4-1: Comparative Analysis of Impact of different Power Plants

Sl No	Type of Plant	Pollutant	Environment Impact	Social Impact
1.	Coal-based TPP	PM, SO_2, NO_2, CO, effluent and sanitary wastes, ash generation	• Emission of PM from coal and ash handling as well as stack emissions. • Gaseous emissions from coal combustion • Deposition of dust /ash on vegetation and crops causing stunted growth and loss of crops • High intake of process water leading to resource depletion and generation of waste-water leading to risk of pollution of surface and ground water	• Health related issues due to dusts and GHGs • Involuntary resettlement • Influx of workers thus disturbing the social fabric of the area
2.	Pet coke based TPP	PM, SO_2, NO_2, CO, effluent and sanitary wastes, ash generation	• Emission of PM from fuel and ash handling as well as stack emissions. • Very high emissions of SO_2 and CO from pet-coke combustion • Deposition of dust /ash on vegetation and crops causing stunted growth and loss of crops • High intake of process water leading to resource depletion and generation of waste-water leading to risk of pollution of surface and ground water	• Health related issues due to dusts and GHGs • Involuntary resettlement

Sl No	Type of Plant	Pollutant	Environment Impact	Social Impact
3.	Diesel Generator Sets	CO, SO_2, NO_2, HC, spent oil	• Very high emissions of SO_2 and CO from pet-coke combustion • High noise level leading to rise in ambient noise level • Soil contamination from spent oils and grease	• Health related issues due to gaseous emissions • High noise level leading to discomfort and inconvenience
4	Gas-based TPP	NO_2	• Emission of NO_2 may lead to increase in concentration in the ambient air	• Health related issues due to gaseous emissions
5	Plant based on CFBC Boilers	CO_2,fly ash, water pollution from effluents	• Emission of PM from coal and ash handling. • Emission of CO_2 may lead to increase in concentration in the ambient air • Generation of fly ash may lead to pollution of air, water sources and contamination of soils	• Health related issues due to dust and gaseous emissions
6	Nuclear Power Plants	Radioactive wastes	• High risk of environmental contamination in case of leakage or improper disposal of radioactive wastes • Otherwise it is environment friendly as it does not use fossil fuels and there is no emission.	• There is risk of health impact on workers and local population in case of leakage or improper disposal of radioactive wastes
7.	Hydro Power Plants	-	• Dependent on availability of water and is not reliable in summers • Large ecological depletion due to acquisition of large areas of land for construction of reservoirs • Adverse impact on aquatic life • Risk of flooding and inundation of command areas	• Large-scale land acquisition and displacement. • As in most cases, these projects are located in forest and interior areas, indigenous people are also affected • Risk of flooding leading to loss of livelihood and infrastructure
8	Wind Power	-	• No environmental impact except for impact on avian population	• Due to continuous noise and vibration from fans and turbines, people near to the towers may get affected
9	Solar Power	Water pollution	• Risk of pollution of water sources from cadmium	• The land required per unit of production of

Sl No	Type of Plant	Pollutant	Environment Impact	Social Impact
			and lead in the solar panels which are carcinogenic in nature • During panel washing, water can contaminate soil in the vicinity of the plant	power is very high as compared to other sources. Thus there are issues related to large-scale land acquisition and displacement.
10	Geo-thermal	Water pollution	• The hot water pumped from the earth to the surface contains pollutants such as sulphur, which can lead to water pollution.	
11	Power from Bio-mass & Wastes	Dioxin, Furan, VOCs	• Impact from emission of mainly dioxin and VOCs to air • Improper handling of MSW and other solid wastes, used as raw materials may lead to contamination of soil and ground water	• Irritants such as foul odour, spills on roads, etc

4.2.12 Advantages of Present Proposal as regards process and fuel

As the proposed project is a natural gas based project to be located inside the existing plant area, no additional land will be needed. Also, the auxiliaries and trained manpower of the existing plant will be used. Cleaner burning than other fossil fuels, the combustion of natural gas produces negligible amounts of sulfur, mercury and particulates. Burning natural gas does produce nitrogen oxides (NOx), which are precursors to smog.

DOE of USA analyses indicate that every 10,000 U.S. homes powered with natural gas instead of coal avoids the annual emissions of 1,900 tons of NO_2, 3,900 tons of SO_2, and 5,200 tons of particulates. Reductions in these emissions translate into public health benefits, as these pollutants have been linked with problems such as asthma, bronchitis, lung cancer, and heart disease. However, noise emission, even if controlled at great cost, will result in high noise pressure level if residential areas are very near. The noise pressure level will marginally exceed day time and night time standards as they are almost adjacent. After some distance, the noise pressure level will come down below the permissible limits. This is described in Chapter 6 in details.

As described above, non renewable energy production will cost much high per square meter of land needed and hydro power generation will create submergence and displacement problems. Nuclear power plants have problems of storing radioactive waste for indefinite periods, and potential for possibly severe radioactive contamination by accident or sabotage. Solar PV will create problems with disposal of heavy metals. Wind power will cause noise, visual intrusion and effect on birds. Energy from bio-mass and wastes will create pollution problems due to emission of dioxins and furans, are generally not accepted by people and creates legal issues. In Geothermal, the hot water that is pumped to the surface may contain pollutants such as sulphur.

Power plants fueled by natural gas release about 40 percent less carbon dioxide than coal-fired plants, according to an analysis from scientists at the National Oceanic and Atmospheric Administration. Thus it is apparent that in term of environmental and social impact, gas-based power plant is the best solution in terms of environment and social safeguards.

4.3 PROJECT LOCATION AND LAYOUT ALTERNATIVES

4.3.1 Project Location

The proposed project is proposed to be located inside the boundaries of the existing Ywama Power Plant. This will avoid procurement of land and its related environmental and social impacts. As the project can be located inside the existing plant, no alternate sites were explored or considered. Putting alternative locations for the proposed plant would have required additional land procurement, rehabilitation & resettlement, employing trained man power, laying new transmission lines, additional inventories and sources of water and laying its related pipeline, again needing land. These have been avoided by putting the proposed plant within the existing location as all the facilities are available.

4.3.2 Alternatives for Plant Layout

Three alternative layouts, as given in the Feasibility Study report by Tractebel, have been analyzed for the project on the basis of shape of the available land, location of main interfaces (road access, river, power evacuation route, etc), and adjacent residential blocks.

Layout 1: The layout prepared by Tractebel for a 1-1-1 configuration has located the steam turbine and cooling towers towards the south-eastern part of the site while the gas turbine and HRSG is on the western side. The 1-1-1 configuration provides more space for the equipment and for maintenance (**Figure 4.1**).

Layout 2: The GE Power layout for 2-2-1 configuration has located the steam turbine and cooling towers towards the northern and western side of the site away from the residential areas, while the gas turbine is on the southern side in an east-west orientation (**Figure 4.2**).

Layout 3: This layout also with a 2-2-1 configuration has placed the cooling tower on the western side of the site near to the river. Here the steam turbine and gas turbine are both towards the eastern and southern side (**Figure 4.3**).

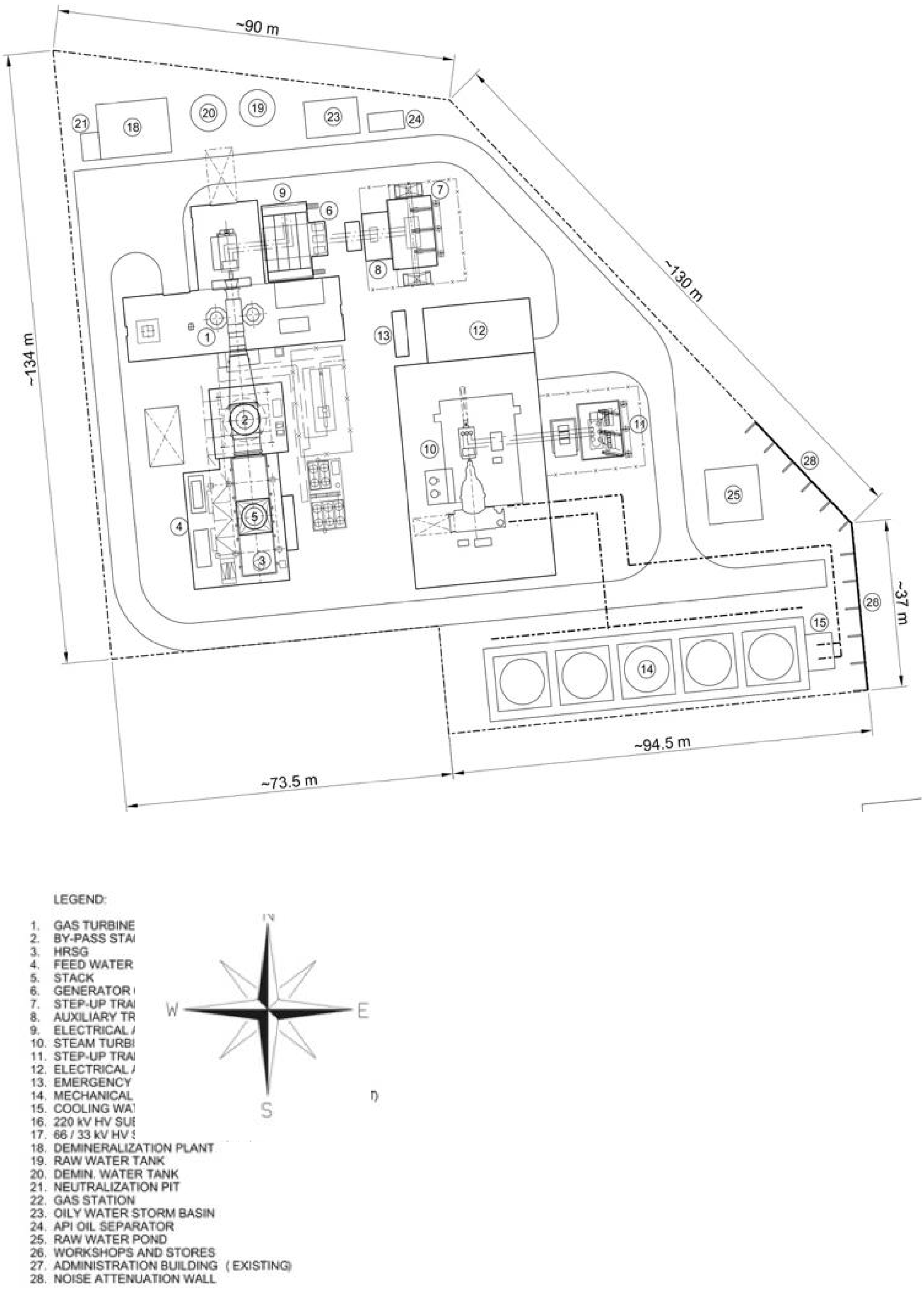


Figure 4-1: 1-1-1 Configuration on Lay-out Option 1

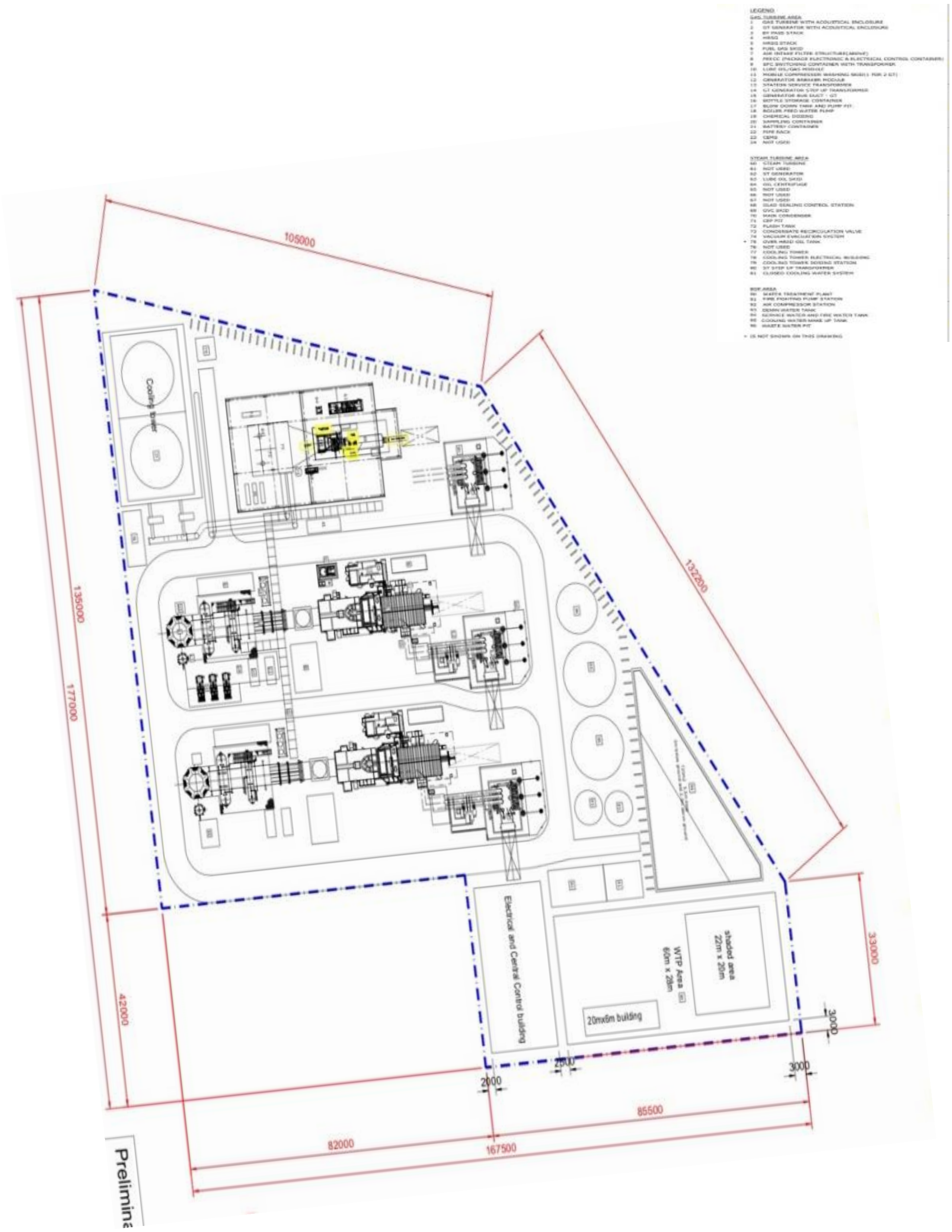


Figure 4-2: 2-2-1 Configuration on Lay-out Option 2

Figure 4-3: 2-2-1 Configuration on Lay-out 3

4.3.2.1 Social and Environmental Issues of Alternate Layouts

As mentioned, there are residential areas adjacent to the Eastern boundary of the site. The main concern is the ground level concentration of NO_2, clouding (fog) from the cooling tower and noise from the turbines and their impact in the 10 km study area including the same on the adjacent residential area located in East. The combustion of natural gas produces NO_2 which are dissipated by tall stacks. Gas turbines also produce noise.

Cooling towers produce a fog when warm, moisture-laden air leaving the tower is cooled below its dew point. The droplet size of the fog is quite small; nearly all of the particles are in the 1-3 micron diameter range. The plume is visible when water vapor it contains condenses in contact with cooler ambient air, like the saturated air in one's breath fogs on a cold day. Under certain conditions, a cooling tower plume may present fogging hazards to its surroundings. The water evaporated in the cooling process is "pure" water, in contrast to the very small percentage of drift droplets or water blown out of the air inlets. The predominant wind being from South and South East will carry the NO_2plume and the cooling tower cloud away from the residential area which is in East. The observations on the layouts are as follows:

- The layout under Fig. 4-2: 2-2-1 Configuration, with CT in W Part and ST & GT on E &S Part of Site, indicates that while one of the 2 Gas Turbines of the 2 CCGT units is very near to the residential area, the other of the units is slightly away from the residential area. The Cooling Towers are away from the houses located and near the river in west and with the predominant wind from South and South East, the clouds will move away from the residential areas. Clouds, though not an environmental pollutant yet will create social objections due to nuisance value of clouds which are avoided in this alternative. It is reported that fog inhalation is capable of inducing cough and changes in breathing patterns in healthy subjects.
- The layout in Fig. 4-2:1-1-1 Configuration with ST & CT in SE Part and GT&HRSG on W Part of Site will have a greater environmental impact as the wind from south may increase the probability of clouding and NO_2ground level concentration in direction of the houses. The main effect of breathing in raised levels of nitrogen dioxide is the increased likelihood of respiratory problems. Nitrogen dioxide inflames the lining of the lungs, and it can reduce immunity to lung infections. This can cause problems such as wheezing, coughing, colds, flu and bronchitis. Increased levels of nitrogen dioxide can have significant impacts on people with asthma because it can cause more frequent and more intense attacks. Children with asthma and older people with heart disease are most at risk.
- The layout in Fig. 4-2: 2-2-1 Configuration with ST & CT in N&W Part and GT on S Part of Site, both the turbines are towards the buildings, thus increasing the impact from high noise levels. Noise being unwanted sound, is naturally a disturbance to the ears. Unwanted sound (noise) can damage physiological health. Noise pollution can cause hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects. Exposure to high noise levels causes hearing loss.

It is observed that the 1-1-1 layout and the 2-2-1 layouts having configuration with ST & CT in North &West part of the site and GT on Southern part of Site will need rehabilitation of the nearby residential area to prevent them from the exposure to high noise level and related illness and to prevent them from nuisance of cloud from Cooling Tower.

Thus, the layout under 2-2-1 Configuration, with CT in Western Part and ST & GT on Eastern &Southern part of Site, indicates that this is the most feasible alternative from the environment and social point of view.

4.3.3 Lay-down Areas Alternatives

Due to paucity of space inside the plant area, spaces for lay-down area have to be identified outside the plant site. For the present project, two sites were identified by Tractebel. The sites identified are given in **Figure 4.4**.

Figure 4-4: Lay-down area

- Site 1 is a vacant land of about 2 ha which is located inside the Steel Factory about 100 m from the plant site. This land can be taken on rent and used as the lay-down area during dismantling and construction. This area is very convenient as it is located just at the entry of the Power Plant and transportation of material to and from the plant will be easiest from this location. No rehabilitation is required.
- Site 2 is also a vacant land measuring about 3 ha and located north of the steel plant in the Shwe Pyi Thar Industrial Zone (Zone 4). Transport from this Site to the plant can be done by road or using the Hlaing River. However, the process will be cumbersome and will require lots of resources and time for transportation. No rehabilitation is required.

After analysis and discussion with EPGE officials, it was agreed that EPGE may take land for lay-down area on rent. It was decided that Site 1 is preferred as it has easy access to the plant and thus would be under direct supervision of the plant officials and EPC contractor.

Social and Environmental issues: No rehabilitation is required at Site 1. Fugitive dust emission during material storage and transportation is the major environmental concern due to the siting of the lay-down area. As the site is located adjacent to residential and commercial areas of Insein Township, the only issue is to ascertain that there is maximum possible effort to provide dust suppression because of less distance between the lay-down area and residential area. Also, screening has to be provided to avoid dust from spreading to the residential areas during site preparation and operation causing dust related illness. Another issue will be disturbance due to movement of heavy vehicles, which may raise safety issues and excessive noise. This is to be avoided by not allowing any activity during night. Some vegetation including trees will have to be removed to prepare the site. It will be ensured that minimum trees are removed from the site.

4.4 TECHNICAL ALTERNATIVES

4.4.1 Heat Recovery Steam Generator

Horizontal Gas Path or Vertical Gas Path HRSGs: The differences observed in the past regarding cycling capabilities, footprint and prices do not exist anymore. Both horizontal and vertical HRSG's are therefore acceptable; however, the most compacted solution (typically the vertical one) is preferred.

Natural circulation versus assisted circulation: This is about the circulation in the evaporators, which is made either by using the differential densities between liquid and water/vapour mixture to create a natural circulation, or with circulating pumps. Assisted circulation was used in the past for horizontal boiler. It is no more the case and both technologies are accepted; preference is given to the natural circulation (less equipment, less maintenance)

Drum type versus Once-Through (OT) circuit: HRSG were historically drum type. Once-through HRSG (OT or also called Benson type) is the result of the Market deregulation asking for higher cycling. OT circuit is usually limited to the High Pressure ("HP")steam, others pressure levels remaining drum type. In contrast to recirculation or natural circulation units, OT units are characterized by continuous flow paths from the evaporator inlet to the super-heater outlet without a separation drum in the circuit. A separator is however still provided but for the start-up phase only. There is no significant price difference between drum and Benson HRSG. Operating a Benson HRSG differs from the well-known drum type. Benson HRSG will not be analyzed in this Feasibility Study ("FS") but will not be rejected if proposed by bidders.

A HRSG is an energy recovery heat exchanger that recovers heat from a hot gas stream. It produces steam that can be used in a process (cogeneration) or used to drive a steam turbine (combined cycle). HRSG will not produce any environmental pollutant in its process. In social aspect, its impacts are also negligible.

Stacks: As for the by-pass stack, the elevation of the HRSG stack above ground shall comply with World Bank Rules. It is estimated that a stack of 40m above ground will be enough to facilitate proper dispersion. However, the final height shall be selected by Engineering, Procurement & Construction (EPC) contractor. The HRSG stack will be provided with a (cold) silencer. The stack will not be provided with a damper; however, possibility for later installation will be asked to the bidders. The stack will be insulated up to the exhaust to avoid condensation inside the stack and risk of corrosion. A CEMS to continuously monitor the flue gas emissions will be installed in the HRSG stack.

Table 4-2: Alternative Analysis for HRSG Types

Sl. No.	Alternatives	Technical	Economical	Environment	Social
Type of Unit	Horizontal Path HRSG	Horizontal path HRSG units are the most popular type of steam generator. The flow of gas is horizontal while the water is heated in vertically-arranged	The differences observed in the past regarding cycling capabilities footprint and prices do not exist anymore between.	The main cause of environmental impact from the project is atmospheric emissions of NO_2 and CO.	As there is no difference in environmental degradation due to change of HRSG Type, there is

Sl. No.	Alternatives	Technical	Economical	Environment	Social
		evaporator tubes. However, it needs more space which is a problem at Ywama. Natural Circulation is most common with Horizontal path HRSG units. Drums for circulation are common.	Horizontal Path and Vertical Path.	This is generated at GT and remains the same while passing through HRSG of all types except of reduction of temperature. However, for Assisted Circulation condition, some green house gases may be generated due to use of power by pump at the source of Power Generation.	no difference in social impacts except for Assisted Circulation where some GHGs may be formed.
	Vertical Path HRSG	With vertical gas flows across horizontal evaporator tubes, this drum-type HRSG is ideal when site space is at a premium, for example, in add-on applications. As such, this is preferred for Ywama in a tight space situation.			

Sl. No.	Alternatives	Technical	Economical	Environment	Social
Type of Circulation	Natural Circulation	Natural Circulation is most common with Horizontal path HRSG units. This is because while the flow of gas is horizontal, the water is heated in vertically-arranged evaporator tubes. In Vertical Path Units, Assisted Circulation is needed. A heat recovery steam generator (HRSG) with a vertical separator design as part of the high pressure (HP) module natural circulation system has been developed to increase unit availability in a modern, combined cycle plant that is subjected to rapid startup and shutdown conditions and during extreme load change rates.	Less as compared to Assisted Circulation.		
	Assisted Circulation	This is needed when natural circulation is not feasible. As it needs pump and other equipment, it needs more maintenance. This is needed for Vertical path units. As Vertical Path Unit is preferred, Assisted Circulation cannot be avoided.	More as compared to Natural Circulation.		
Drum Type	Drum Type	The standard horizontal HRSG units employ drum separators. A separator is however possible in Vertical Path but	There is no significant price difference between drum and Benson HRSG.		

Sl. No.	Alternatives	Technical	Economical	Environment	Social
		for the start-up phase only			
	Once Through (Benson HRSG) (Siemens' development of the Marc Benson Once Through (OT) technology started in 1924 with the acquisition of the patent rights)	The horizontal once-through HRSG employs the same basic arrangement as the standard horizontal HRSG, but eliminates the high-pressure drum. This results in greater thermal flexibility, high efficiency, and the ability to support unlimited daily cycling. As Vertical Path Unit is preferred in the present case, Assisted Circulation cannot be avoided.	There is no significant price difference between drum and Benson HRSG.		

Ref. GE POWER HRGS Selection Criteria, SIEMENS Documents

4.4.2 Plant Cooling

Plant cooling can be with dry or wet techniques. Dry techniques include the direct and indirect concepts. In the direct concept like Air Cooled Condenser, the steam enters in contact with the ambient air through a heat exchange surface. Wet techniques also can be with direct or indirect cooling. In direct cooling or once-through principle, the water taken from a large water body is used for condenser cooling and the hot water is discharged to the same water body. For the indirect concept or re-circulating concept, the cooling water re-circulates and is cooled down by the ambient air in cooling tower and only the loss of water due to evaporation and drift is made up from the water body. In such cases, some blow down water is to be discharged to balance the TDS after treatment

Cooling towers are divided into natural and forced circulation of the ambient cooling air. The natural circulation principle is abandoned due to the large foot print required and scarcity of land at Ywama Plant. For Ywama CCGT plant, various options were explored, including the dry cooling system. The options are provided below in **Table 4.3**.

Table 4-3: Cooling Systems Alternatives

Sl. No	Type	Remarks
1	Air Cooled Condensers	Rejected due to large footprint, large capital cost and has lower efficiency than water cooled condensers. This system is preferred where there is scarcity of water.
2	Direct or Once-through cooling	Rejected as the availability of large quantity of water from Hliang River is not dependable in lean seasons and thermal pollution will be high

Sl. No	Type	Remarks
3	Wet Cooling with Mechanical Draft Tower	Selected due to its lower footprint, less requirement off water and lower thermal pollution from discharged water

Source: Feasibility Report Prepared by Tractebel

4.4.3 Water Intake

Re-circulating wet cooling is the most common choice of cooling system for current plant construction. Re-circulating wet cooling is similar to once-through cooling in that the steam is condensed in a water cooled, surface condenser; but different in that the heated cooling water is not returned to the source water body. This could have affected the fishes in river. Instead it is pumped to the cooling component, typically a mechanical draft cooling tower and then re-circulated to the condenser. In the cooling tower a small faction (typically 1% to 2%) is evaporated in order to cool the remainder. Once the system is filled, the only water withdrawn from the environment is make-up water sufficient to replace that lost to evaporation, blow-down, and drift. This amount is calculated as 700m^3/h, typically 10 to 15gpm /MW of steam generating capacity. Thus the water drawn from river as make-up is a small fraction of circulating water, only 1 to 2%. As such, only make-up water will be extracted from the Hlaing River due to circulating type of wet cooling tower selected.

The River bank is located at about 20 meters from the site fence. Water will be used as make-up for the cooling tower and service water. Based on the recommendation of the previous section, the circulating wet cooling tower is selected for the plant cooling; that solution needs maximum 700 m^3/h make up water when assuming the river water salty. The water can be off-taken from the River by gravity, by siphon or by pumping using a floating deck. For the selected solution, it is advisable to minimize any structure inside the River not to hamper the river transport and obtain "more easily" the necessary permits from the competent authorities. A pre-treatment of the River water is necessary due to the high turbidity and TSS. It is discussed in a further section. The various options are given below in **Table 4.4**.

Table 4-4: Water Intake Alternatives

Sl. No	Conveyance System	Description
1	Gravity Flow Type 1	In this system, water is taken from the river and supplied through gravitational force to the treatment plant inside the site. This is dependent on the water level fluctuation in the river and there is chance of sedimentation
2	Gravity Flow Type 2	This system has a pumping station in the River bank. It has the advantage not to hamper the River transport but requires excavation work in the River bank. The pump will transfer the water to the treatment system.
3	Siphon Solution	The water is conveyed to the pumping station by siphon via above ground pipes. Vacuum pumps or water ejectors are provided to prime the system.

4	Floating Deck	Pumps are installed on a floating deck located at a sufficient distance for the River bank to have enough depth. **This system is selected** due to the following advantages: • It follows the level of the river • No modifications required on the river bank

Source: Feasibility Report Prepared by Tractebel

4.5 TRANSPORTATION OF PLANT AND MACHINERIES

All equipment/machineries for the plant will be transported from Yangon Port to the power plant. The two options of transportation are by road via Strand Road and BayintNuang Road and the other is through the River Hliang by barge.

Option 1-By road: The route by road is about 15.25km and follows the arterial Kyee Myindaing Kanner Road and Bayint Nuang Road. This route is a four-lane divided and has the capacity of carrying the heavy materials required for the plant. It has been estimated by the Technical Consultant that the width of the machineries will be about 4.4m and thus there will be enough space for maneuvering the vehicles. However, there is a bottleneck at the Byant Nuang Flyover, which has a height clearance of about 2.9m. For the oversized machines, the height will be a problem and a diversion will be required via Pyay Road and Insein Road, where the traffic density is high and some sharp turns will be encountered. It is necessary to transport all machineries during the night to avoid traffic congestion and create minimum disturbance to normal traffic.

Option 2-By Hliang River: As mentioned, the second option is transporting the machines by the river. Loading and unloading will not be a problem as the plant is located on the bank of the river. The width of the river is enough to carry the over-sized machines. From the bank of the river, machines can be directly installed by cranes. However, a jetty has to be built for it at the boundary of the plant. If a jetty has to be constructed, there is requirement of permission to be taken from appropriate authorities. The other aspect to be considered is that if the transportation of machineries is done through river, the machines have to be directly installed in the foundation and cannot be stored in the lay-down area. Thus, a warehouse/space has to be rented at the port by EPGE for storage and assembly.

Environmental Implications: The transportation of the machineries by road will cause pollution from heavy vehicular movements. The slow movement of these vehicles and the subsequent traffic congestion may lead to increased level of emission. However the duration will be very less. Also dust will be generated near the residential areas due to traffic movements. If the transportation of equipment is done through barges, no impact is foreseen from the environment point of view.

Social Implications: Transportation by road will lead to increased risk of accidents as the route passes through heavily congested areas. In addition to that, there will be other inconveniences to the local residents such as increase in noise, traffic jams and disturbances during the night time. However, for transportation by river, no social impact is envisaged as the water way is already used for commercial purposes.

Presently it is evaluated that transportation by river will be more feasible. However, both the options will be kept open and the final decision is to be taken by the EPC contractor.

Chapter-5

Baseline Environment

Baseline Environment explains the various parameters of present environmental status from latest secondary data as well as primary data are identified under different aspects, such as air quality, water quality and hydrological aspects, noise levels, soil quality and ecology, demographic characteristics, socio-economic condition, etc.

5 ENVIRONMENTAL & BIO-PHYSICAL BASELINE

5.1 INTRODUCTION

Baseline data generation forms a part of the ESIA study, which helps to evaluate the predicted impacts on the various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact assessment methodologies. This further helps in preparing an Environmental and Social Management Plan (ESMP) outlining the measures for improving the environmental quality and scope for future improvements for environmentally sustainable development. The baseline environmental study also helps to identify the critical environmental attributes, which are required to be monitored during project implementation and operation.

This chapter illustrates the description of the existing environmental status of the study area with reference to the prominent environmental attributes. The existing environmental setting is considered to adjudge the baseline conditions which are described with respect to climate, atmospheric conditions, air quality, hydro-geological aspects, water quality, soil quality, vegetation pattern, ecology, socio-economic profile, land-use, places of archaeological importance etc.

The primary baseline monitoring data includes ambient air quality, noise levels, water quality, soil quality, ecological features of the plant and other affected areas. Ecology (aquatic and terrestrial), land use, geology, hydro-geology, demography is based on the secondary data collected from various Government and Semi-Government organizations. This ESIA report incorporates the baseline data generated in November 2018.The sampling methodologies for the various environmental parameters required for the study, frequency of sampling, method of sample analysis, etc. are given in **Table 5.1**.

Table 5-1: Methodology for Sample Collection and Analysis

Sl. No	Component	Primary Data					Secondary Sources/ References
		Frequency of Sampling	No. of Locations	Parameters	Instrument	Method	
1	Meteorology	1 year	1	-	-	-	1-years data from meteorological station at Kaba-Aye
2	Ambient Air Quality	24 hourly samples twice a week	4	PM_{10}	Respirable Dust Samplers (APM 460 BL) with gas attachment	Gravimetric	-
				SO_2		West &Gaeke	-
				NO_2		Jacobs &Hochheiser	-
				$PM_{2.5}$	Fine Particle Sampler	-	-
				CO	NDIR	Infrared Analysis	

Sl. No	Component	Primary Data					Secondary Sources/ References
		Frequency of Sampling	No. of Locations	Parameters	Instrument	Method	
3	Noise Level		4		Integrated sound level meter.	Measurements were taken by following CPCB, India procedure	-
4	Water Quality	Once in study period	3 GW 6 SW	Physical, chemical & heavy metals	Spectro-photometer Atomic Absorption Spectro-photometer Flame Photometer	Titrametri, gravimetric, photometric, AAS	APHA IS10500: GW IS:2296 Class C :SW
5	Soil Quality	Once in study period	3		Kjeldal Nitrogen, PH meter, conductivity meter, hydrometer	Gravimetric, photometric	Agriculture Handbook
6	Ecology	Once in study period	Study Area	Flora, fauna	Field data collection	Quadrant	Published Report
7	Socio-economic	Once in study period	Core zone & buffer zone	Demographic social, economic & infrastructure	Survey Schedule	Group Discussion	-

Source: Greencindia Consulting Private Limited, India

5.2 PHYSICAL FEATURES

5.2.1 Topography

Insein Township is generally a plain area about 30m above the mean sea level with a gradual gradient from the East and North East to the West. The level towards the plant area decreases to about 4m AMSL, which shows a major slope towards west towards the Ywama Plant. As the whole area under study is urbanized and levels have been modified, the gradient has been somewhat modified. There are some hilly terrains in the East of Insein Township. The Hlaing River flows on the West of the project site and flow from the North to the South into the Yangon River, which flows into the Andaman Sea (**Figure 5.1**).

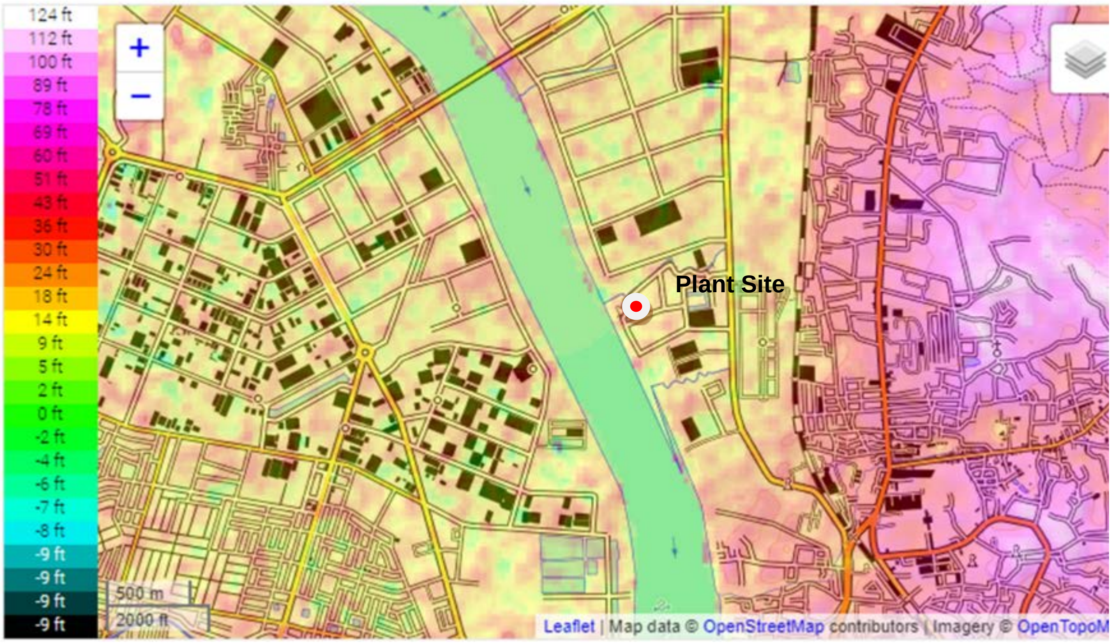


Figure 5-1:Topographic of Yangon Region

5.2.2 Geology and Geomorphology

This area almost fluvial food plain, other is lower coastal plains where there may be few surface drainage channels. In and around Yangon river areas, the water table is often high; relatively young and subjected to a minimum of dissection. A high-water table minimizes run-off and restricts system that may form between floods. Many major streams in level regions are constructional. They build up their own flood plains and have little contact with the underlying material of the area. Some major streams in level areas, however, are erosion prone. Examples of such streams may be found in coastal plains and in lake-beds.

Yangon is situated in the southern part of the Central Lowland which is one of the three major tectonic provinces of Myanmar. The Taungnio Range of the Gyophyu catchments area of Taikkyi District, north of Yangon, through the Thanlyin Ridge, south of Yangon forming a series of isolated hills probably resulted from the progressive deformation of the Upper Miocene rocks as the eastern continuation of the subduction or stretching and compression along the southern part of the Central Basin and regional uplifting of the PeguYoma. Yangon is rich in groundwater resources conserved by unconsolidated Tertiary-Quaternary deposits. In Yangon, ground-water is mostly extracted from Valley filled deposits and Ayeyarwady sandstones. **Figure 5.2** shows the geo-morphology of the Yangon region.

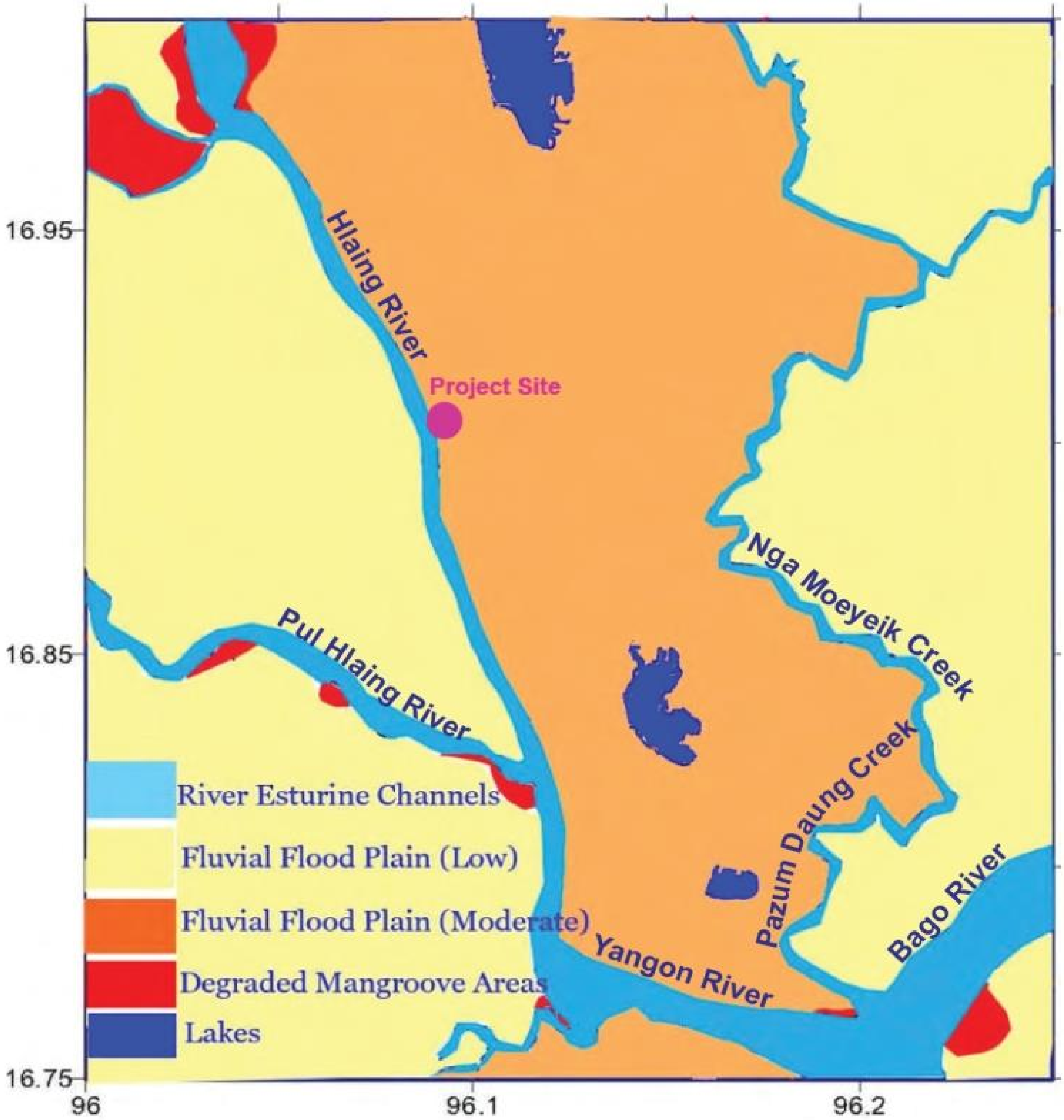


Figure 5-2: **Geomorphology of Yangon Region**

5.2.3 Tectonic Setting

Yangon is situated in the southern part of the Central Lowland which is one of the three major tectonic provinces of Myanmar. The Taungnio Range of the Gyophyu catchments area of Taikkyi District, north of Yangon, through the Thanlyin Ridge, south of Yangon forming a series of isolated hills probably resulted from the progressive deformation of the Upper Miocene rocks as the eastern continuation of the subduction or stretching and compression along the southern part of the Central Basin and regional uplifting of the Pegu Yoma (Aung Lwin 2012).

5.2.4 Seismicity

In 17 December 1927, a six-grade earthquake hit Yangon and caused certain amount of damages. It was felt 15,000 sq.km from Kyangin to Dedaye along the western slope of Bago Yoma. In July 1930 Bago earthquake with M = 7.3 affected Yangon, vibration spread caused damage to the buildings and 500 persons and 50 persons were killed in Bago and Yangon, respectively.6 The last record of the earthquake that struck Yangon is 1978, M = 5.7. In the recent seismicity map epicenters draw our attention: one is along N–S trending Sagaing fault and second one is along NNW–SSE trending Bago anticline.

On the seismic aspect, Yangon is located at the boundary between Zone II and Zone III. The old and new satellite towns in the eastern area are in Zone III, and the old City is in Zone II. However due to population increase in Yangon, the risk of damage from earthquake will be higher even for a low intensity episode. The prevailing geological structures along with surface geological condition, soil characteristics, and tectonic setting have made Yangon an earthquake prone area. As the population increases in Yangon, urban development has been taking place, at present, mostly on alluvial deposits. Now there are many high-rise buildings in many parts of Yangon. Damage potential to the buildings and loss of lives in a future earthquake with magnitude of 6 or 7 on Richter scale in Yangon would be much larger than that in 1927 and 1930.

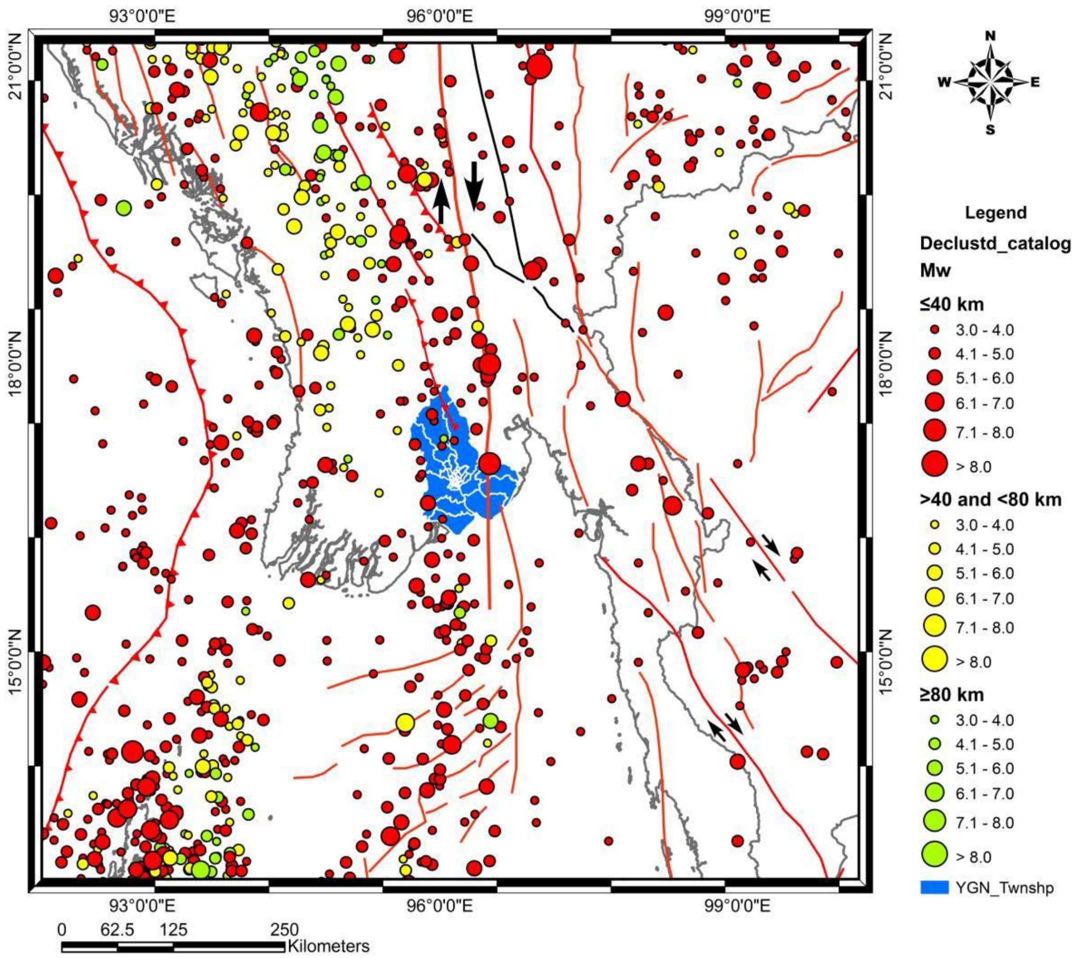


Figure 5-3: The seismicity of Yangon region
(Data Source – ANSS earthquake catalog, 1963 – 2009)

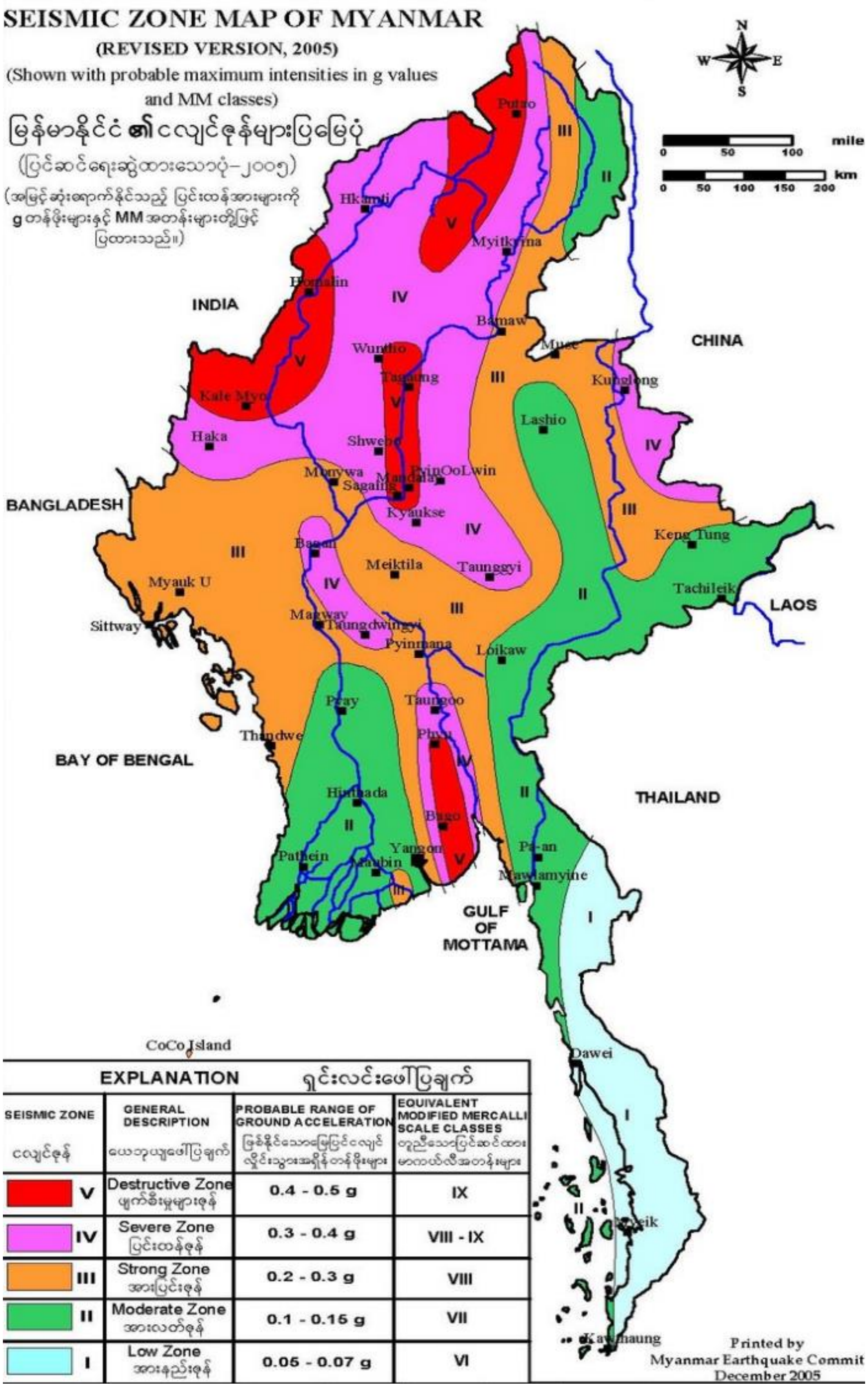


Figure 5-4: Seismic Zones in Myanmar

5.2.5 Geology

The geological structure of the central part of Yangon Region is Miocene consolidated sediments overlain by the Quaternary sands, silts and clay, and that of the outskirt of Yangon City is widely distributed with the Quaternary sediments, consisting of thick, high plastic, stiff clay underlain by sand and silt. The Yangon area is underlain by alluvial deposits (Pliestocene to Recent), the non-marine fluvialtile sediments of Irrawady formation (Pliocene), and hard, massive sandstone of Pegu series (early-late Miocene).

Alluvial deposits are composed of gravel, clay, silts, sands and laterite which lie upon the eroded surface of the Irrawaddy formation at 3-4.6m above Mean Sea Level ("MSL"). The rock type in Yangon is mainly soft rocks, which consist of sandstone, shale, lime-stones and conglomerate.

Yangon area is underlain by alluvial deposits, the non-marine fluviatile sediments of Irraway Formation, and hard, massive sandstone of Pegu Series. The alluvial deposits are composed of gravel, clay, silts, sand and laterite, which lies upon the eroded surface of Irraway Formation at 4.6m above MSL. The central part of Yangon area is occupied by the anticlinal ridge as a backbone, 30m above MSL and covered with sands, sand rock, soft sandstones, shale, clays, and lateritic of Irraway Formation. The hard compact sandstone and shale of Pegu series can be found at the northwest corner of Hlawga Lake with NNW–SSE strike dipping to the east. Alluvial deposits are found in the surrounding areas of the ridge whereas lateritic soils can be found along the ridge. In the geological map, two anticlines can be seen trending NNW-SSE direction and are cut by NNE-SSW trending transverse fault. From the geological point of view, it can be concerned for the initial review of faster displacement possibility in some area such as in the eastern part of the city where the top soil is clays.The geological condition of the ground surface in Yangon is divided in three categories:

- Alluvium
- Irrawaddy formation
- Pegu group.

Generally, the Yangon area is covered by alluvium. The Irrawaddy Formation comprises the bedrock along the Bago Yoma, the Arzamigone Sandstone in the north of the Shwedagon Pagoda, and Danyingone Clay in the east of the Arzamigone Sandstone. The Pegu Group comprises the Besapet Alternation, Thadugan Sandstone, and Hlawga Shale distributed in the north of the Yangon area.

(a) Alluvium: The topsoil layer is clayey soil layers, and these layers are brownish gray in color. The thickness of these clayey soil layers is minimum 4.0m and maximum 8.0m. It has low to medium plasticity. Also then gray color material is fine to medium grained silty sand and clayey sand layers are well observed in this project area.

(b) Irrawaddy Formation: This formation is yellowish fine sandstone or sand-rock of the Irrawaddian Group. The outcropping areas can be seen in the left bank of Yangon-Thanlyin crossing of Pegu River. It is characterized by loosely cemented sandstone with trace grit.

(c) Pegu Group: This formation is mainly composed of sand and shale inter-beds. Outcropping areas are found along the anticlinal ridges of the Danyingone and ThanHlyn areas. Most of them are composed of reddish brown oxidized lateritic soil. Figure 5.5 shows the geological profile of the Yangon region.

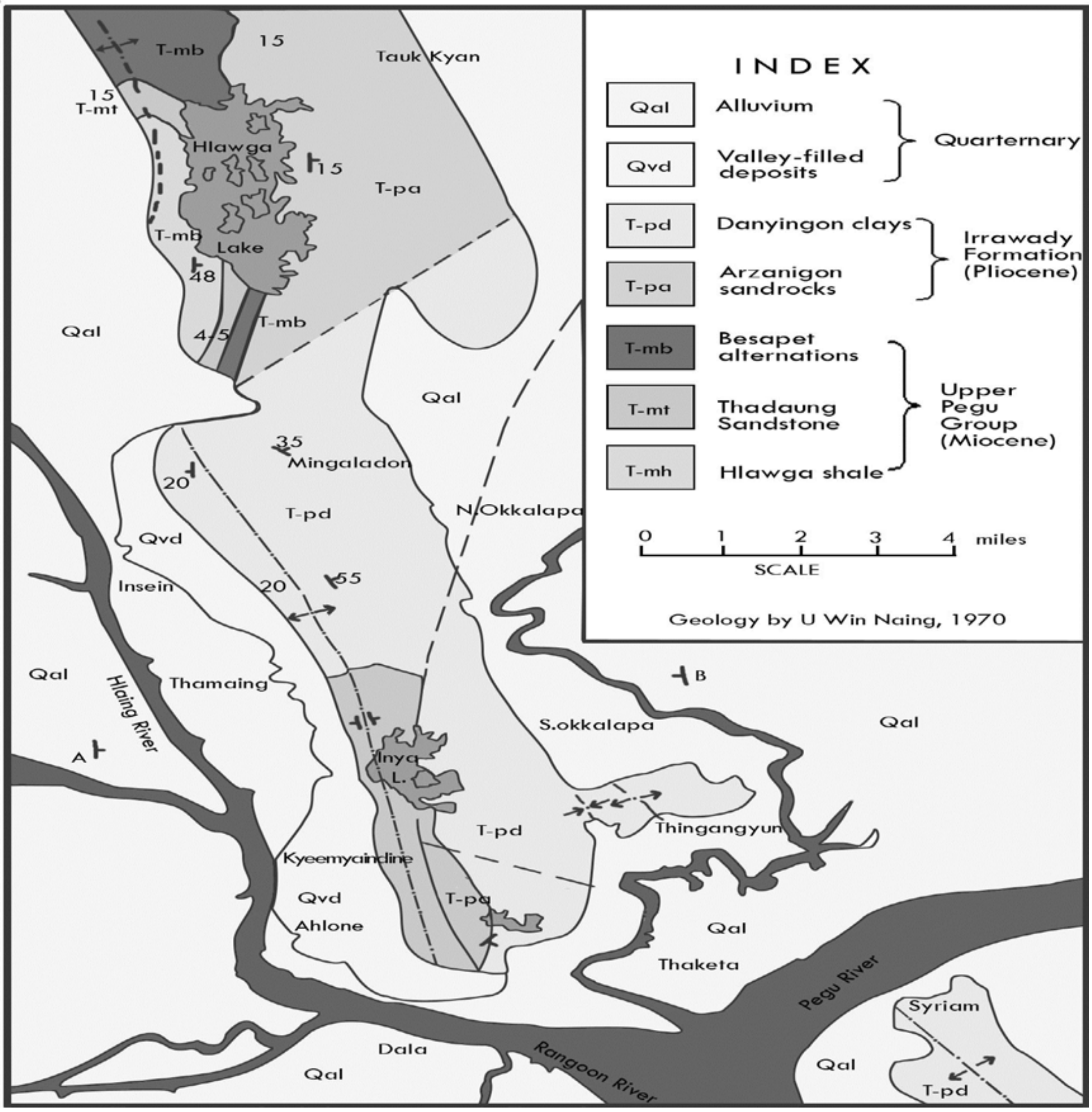


Figure 5-5: **Geological Profile of Yangon Region**

5.2.6 Hydrology

Yangon is rich in groundwater resources conserved by unconsolidated Tertiary-Quaternary deposits. In Yangon, groundwater is mostly extracted from Valley filled deposits and Ayeyarwady sandstones. Groundwater availability is generally based on the distribution of permeable and relatively impermeable rocks. The nature of openings in the rocks determines permeability of rocks. Based on local geological considerations, potential groundwater source of Yangon can be roughly divided into two sub regions, namely the low potential area and high potential area. Low potential areas are areas with those rock units of Hlawga Shale, Thadugan Sandstones and Basepet Alternation of upper Pegu Group (Miocene epoch) and Danyingon Clays of Irrawaddy rocks. These rocks and formations are a dense, massive and consolidated nature and have impervious characteristic. High potential areas are underlain by Pliocene Series and recent Formations. High potential area covers approximately 85 percent of the Yangon city including Insein. Stand pipe piezometers were installed at a depth of up to 30m from the existing ground level while a pumping well was installed upon completion of the soil investigation works.

The Insein Township, including the project site is Valley filled deposits and Arzarnigon sandstones. The areas included in this zone are the areas to the east of Hlawga Lake and western flanks of Shwedagon - Mingaladon Ridge, the areas to the south and west of Kandawgyi Lake and the area to the west of Inya Lake. The thickness of Valley filled deposits range from 120 feet to 300 feet depending on the structural conditions. The groundwater discharge of Valley filled deposit is toward the Hlaing River and Yangon River and recharge is coming from the anticlinal ridge. The gradient of groundwater flow is toward the river is 0.01. The Valley filled deposits form the principal aquifer and yields comparatively high amount of water ranging from 7,200to 25,000 gallons per hour. Water quality is good with total dissolve solid(TDS) generally between 60 and 150 ppm, and pH value of 7.5.

Arzarnigon sand rocks do not form the principal aquifer but it is a good aquifer. It gives a considerable amount of water. Yield of this aquifer varies from place to place depending upon aquifer thickness. Groundwater discharge from this aquifer moves down slope direction toward Ngamoeyeik Creek in the east and toward Yangon River in the south. The gradient of groundwater is lower than the Valley filled deposit. There are at least three water-bearing horizons in this aquifer.

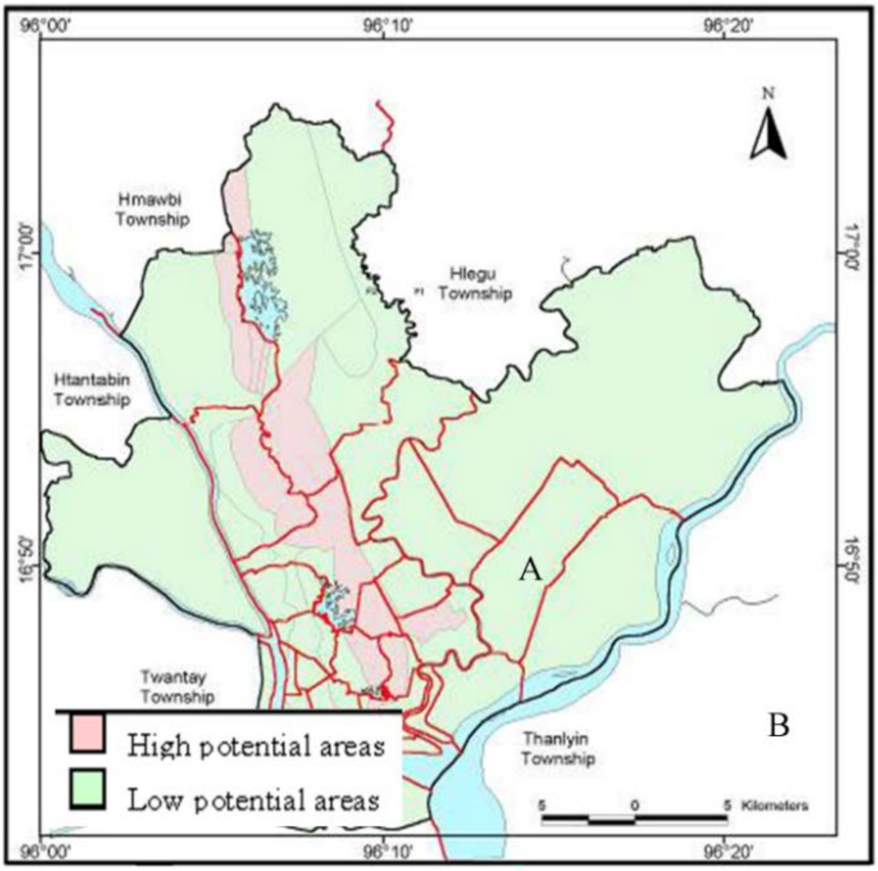


Figure 5-6:Low and high potential areas of groundwater availability in Yangon City

5.3 LAND USE

Studies on land use aspects of eco-system play an important role for identifying sensitive issues, if any, and taking appropriate actions for maintaining the ecological balance in the development of the region. The objectives of land use/land cover studies are:

- To determine the present land use pattern;
- To analyze the impacts on land use due to plant activities in the study area; and
- To give recommendations for optimizing the future land use pattern vis-a-vis growth of plant activities in the study area and its associated impacts.

5.3.1 Land-use Pattern Based on Remote Sensing Data

Remote sensing satellite imageries were collected and interpreted for a maximum of 5-km radius for analyzing the land use pattern of the study area. Based on the satellite data, land use/land cover maps have been prepared. Based on the above sources, the land-use distribution of the study area is given in **Table 5.2. Figure 5.7** shows land-uses and land cover within 500m, 2km and 5km around the project site.

Table 5-2: Land-use of the Study Area

Land-use	5-km Radius		2-km Radius		500 m Radius	
	Area in ha	Area in %	Area in ha	Area in %	Area in ha	Area in %
Built-up area (settlements)	3099	37.1	486	33.3	27	19.9
Industrial area	1081	13.0	186	12.7	9	7.1
Ywama Power Plant	6	0.1	6	0.4	6	4.3
Airport Area	136	1.6	-	-	-	-
Open Area	495	5.9	62	4.2	-	-
Natural Vegetation	1794	21.5	407	27.9	33	24.5
Park/Golf Course	447	5.4	27	1.9	-	-
Mud Land	36	0.4	16	1.1	3	2.3
Waste Land	210	2.5	28	1.9	9	6.8
Marshy Land	179	2.1	17	1.1	-	-
Water-body (Hliang River)	633	7.6	184	12.6	47	35.2
Agriculture Land	233	2.8	41	2.8	-	-
Total Area	**8348**	**100**	**1459**	**100**	**134**	**100**

Source: Greencindia Consulting Private Limited, India

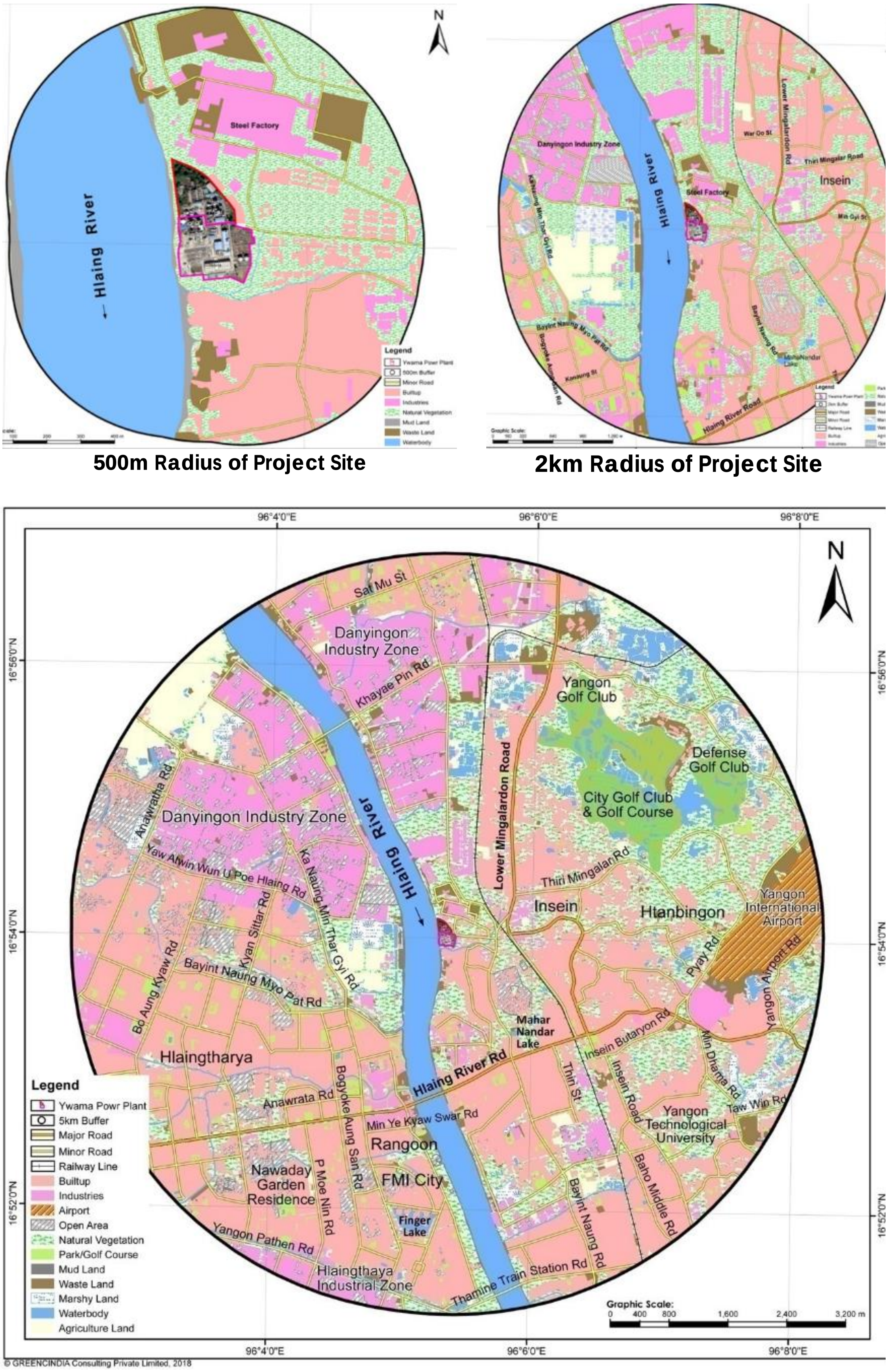


Figure 5-7: Land-use Pattern within 500m, 2km & 5km of Project Site

5.3.2 Land use Pattern in 5km radius of Project Site

As the Ywama Power Project is located in an urban area (Insein Township), the land use pattern of the 5km study area is mainly built-up areas consisting of residential, industrial and commercial uses (37.1percent). This is followed by open areas with natural vegetation (21.5percent) and industrial areas (13.0 percent). The other main features of the area consist of water bodies (Hliang River and surface water bodies), parks and open area, airport area, marshy land and waste land. The land-use/land-cover break-up of the 5-km radius area is depicted through a pie chart in **Figure 5.8**.

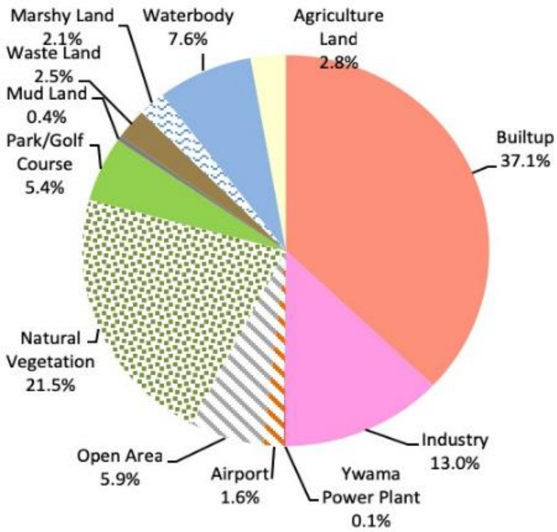


Figure 5-8: Land use Pattern within 5-km

5.3.3 Land use Pattern in 2km radius of Project Site

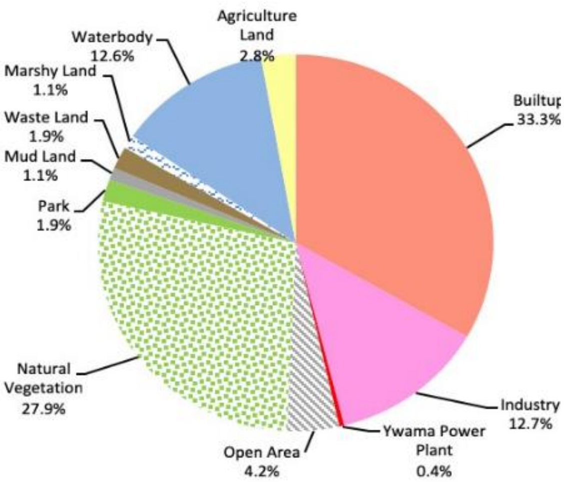


Figure 5-9: Land use Pattern within 2km

In the 2-km radius area, the features are almost similar to that of the 5km area, with the exception of the airport area. In this area also, the main land cover is settlements of Yangon (33.3 percent), followed by natural vegetation consisting of scrub lands (27.9 percent) and industrial areas (12.7 percent). Hliang River and drains connecting to the river takes up about 12.6 percent of the total area. Other major features include open land, parks, infrastructures such as road, pavement, bus-stands, etc, mud flats and waste land. **Figure 5.9** depicts the land-use break-up of the 2km radius area around the Ywama Power Plant.

5.3.4 Land use Pattern in 500m radius of Project Site

The land-use of the 500m radius depicts the land cover of the immediate vicinity of the power plant. The main feature of the area includes Hliang River on the western side of the plant and it occupies 35.2 percent of the area. On the eastern side of the plant there are residential colonies of EPGE, Municipality and adjoining steel mill. The residential areas of Ywama Sub-quarters 5 and 6 continue on the southern side. The Ywama Monastery is also located in the south-eastern direction at distance of 500m. Settlements take up 19.9 percent of the total reference area. On the northern side, the steel mill is located upto 500m and accounts for 7.1 percent (Figure 5.10).

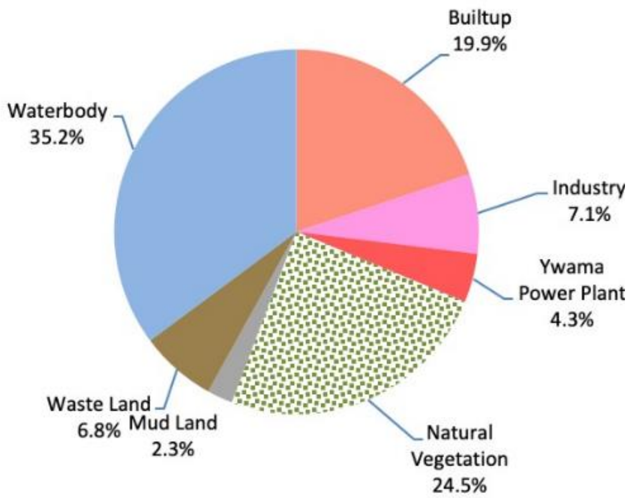


Figure 5-10: Land use Pattern within 2km

5.3.5 Land-Use Pattern of the Project Site

As already discussed the proposed project site is within the Ywama Power Plant and thus has an industrial use.

5.3.6 Land-Use of the Route from Yangon Port to Ywama Power Plant

The land use of the route from Yangon Port to Ywama Power Plant was studied for land-use, 500m on both side of the road. The length of the route is 15.25km from the exit of the port area to the entry point of the access road at the plant. The route is covered by two roads, viz. Kyee Myindaing Kanner Road and Bayint Nuang Road. The road is a four lane divided road with heavy traffic density during day-time. However during night, the density is less and has more traffic of goods vehicle.

The land-use on both sides of the river is mostly residential cum commercial with average buildings of 6 - 8 stories. After exit from the port, on the left side of the road , between the river and Kyee Myindaing Kanner Road, there is industrial area for about 3 kms. These are mainly small scale industries. On the right hand side, for the entire route, the land-use is residential cum commercial.

Some important institutions located along the route are the Marine College, Army Training Centre and offices of Government Departments. There are also five monasteries and temples along the route. The land-use along the route to project site is given in **Figure 5.11**.

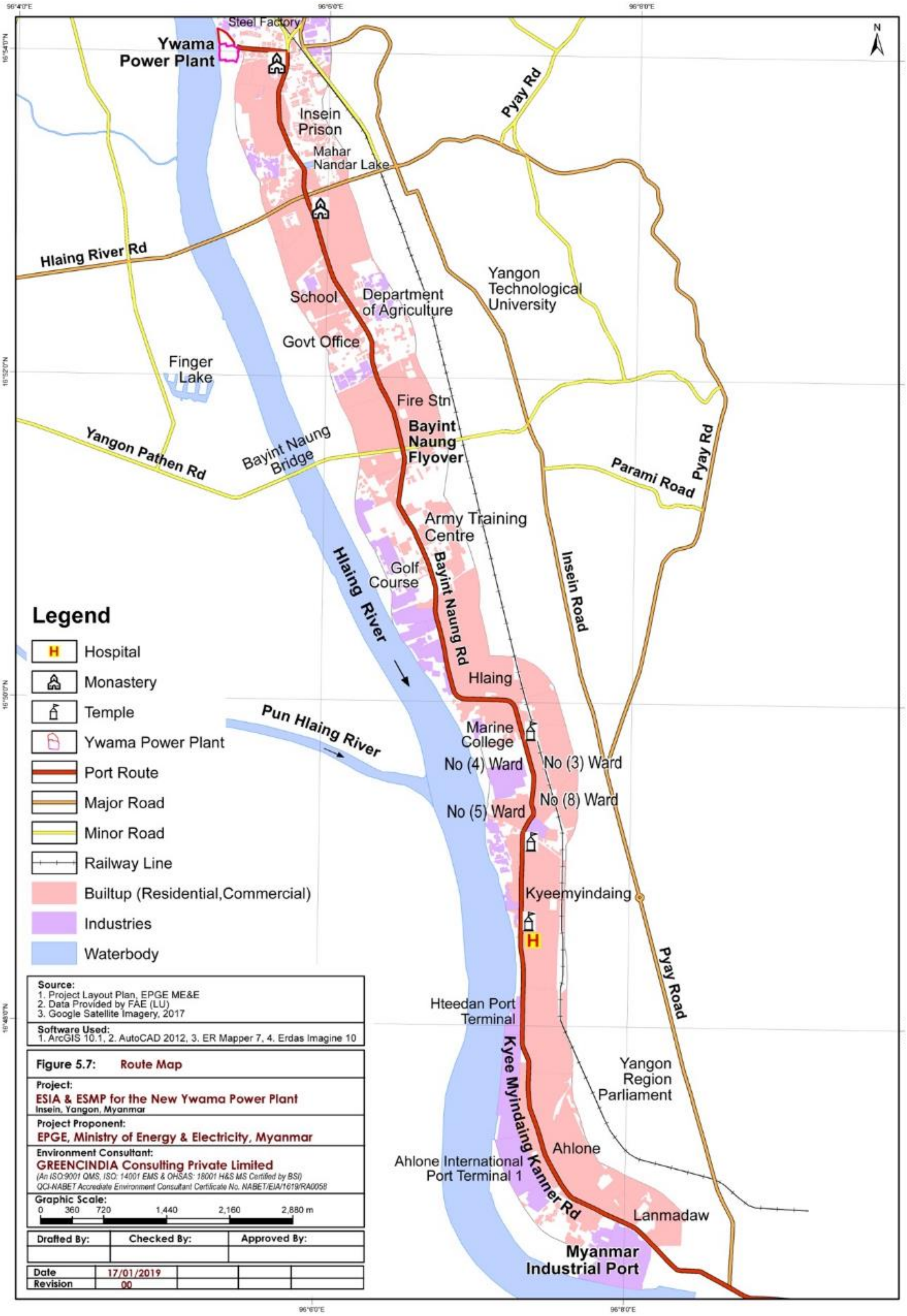


Figure 5-11: Land-use Pattern along the route to Project Site

5.4 DRAINAGE PATTERN

5.4.1 Drainage Pattern of Yangon Region

Yangon is geographically situated in a region that is influenced directly by the south-west monsoon. Severe floods occur frequently in every monsoon season in some parts of Yangon City since storm water increases due to the rapid urbanization and destruction of natural drainage. The Yangon region receives average annual rainfall of 2500mm. However, rainfall intensity that mainly induces flooding problem is considerably high. Maximum 24 hour rainfall observed during the last 35 years was 343 mm, 13.54 inches in 2007[7].

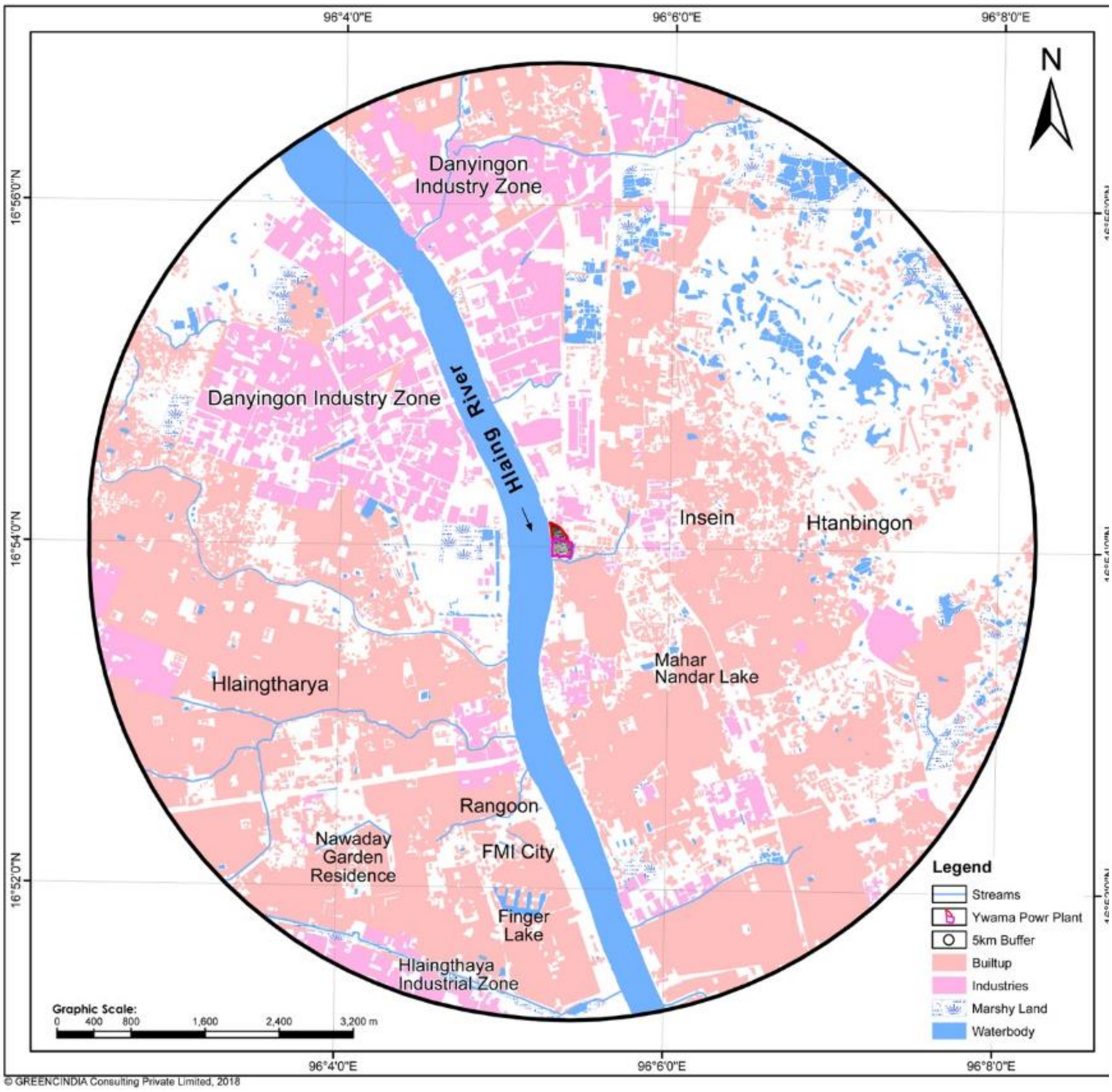


Figure 5-12: Area Drainage within 500m of Project Site

The city is bordered by tidal rivers to the south, west and south-east (the Yangon, Hlaing and Bago Rivers). The tidal Pan Hlaing and KokKoWa rivers flow into the Hlaing River from the north and west, and the Twante canal flows into the Yangon River and these two bodies of water bring heavy sedimentation into the Yangon River. The Nga Moeyeik

7 Flood Mitigation of Yangon City Downtown Areas, (2014), "Design Report on Storm Water Drainage," National Engineering & Planning Service (NEPS)

Creek flows through centre of Yangon, and where it becomes tidal its name is changed to Pazundaung Creek.

This area almost fluvial food plain, other is lower coastal plains where there may be few surface drainage channels. In and around Yangon river areas, the water table is often high; relatively young and subjected to a minimum of dissection. A high-water table minimizes run-off and restrict system that may from between floods. Many major streams in level regions are constructional. They build up their own flood plains and have little contact with the underlying material of the area. Some major streams in level areas, however, are engaged in eroding and are, therefore destructive. Examples of such streams may be found in coastal plains and in lakebeds.

5.4.2 Drainage/Water-bodies in Vicinity of Ywama Power Plant

The natural slope of the area is towards the southern side. As mentioned, the River Hlaing flows adjacent to the plant site on the western side. it is found that there are many drainages joining the River near the plant. As the whole area around the plant comprises of settlements, there are artificial drains with domestic sewage flowing to the river. There are many static water bodies in the area, which are mainly lakes and reservoirs. The area drainage of the 5km radius is given in **Figure 5.12**.

5.5 HAZARD RELATED TO NATURAL DISASTER

It has been estimated that about 50 percent of the total number of disasters in Myanmar was related to floods followed by storm (23 percent), earthquake (15 percent), and mass movement-wet (12 percent), whereas 73 percent of the total affected people by disasters were due to storm followed by floods in 1980-2011[8]. Similarly, storm is a major cause of disaster-related death and biggest estimated damage cost (86 percent). Earthquake (11 percent) and flood (3 percent) are next on the estimated damage cost. This pattern of disasters is due to Cyclone Nargis in 2008 affected 2,400,000 people, left 138,000 fatalities and estimated damage cost for infrastructure of USD 4,000,000 to Myanmar.

5.5.1 Floods

Many floods are caused by storm rainfalls from the south-west monsoons in July to October. The topography of the country is characterized by the central plain (delta), which is surrounded by steep mountains on the west side and highlands on the east side. Rainfall in the mountains and highlands causes flood damage in the central plain and coastal areas. Flooding spanned over the long term at the delta near the river mouth. Notable examples of flood event in Myanmar include:

- The flood of October 2006, triggered by a large scale monsoon which hit Thailand and Myanmar, caused damage, including human losses and property losses in Mandalay, the eastern areas, and the central areas.
- The flood of June 15, 2010 was caused by storm rainfall, which was recorded at 340 mm/day in Rakhine in the western region.

[8]Natural Disaster Risk Assessment and Area Business Continuity Plan Formulation for Industrial Agglomerated Areas in the ASEAN Region

- The flood of October 2011, which was triggered by a Cyclone, caused damages in Magway and Mandalay in the central areas and Sagain in the northern region. Flash floods hit Pakokku and collapsed a bridge.
- The flood in July to September 2015 affected 12 of the 14 Myanmar states, resulting in 103 deaths and 1 million people affected. The worst affected regions were in the West - Magway Division, Sagaing Division, Chin State and Rakhine State. Yangon was also affected by the flood, but the severity was less.

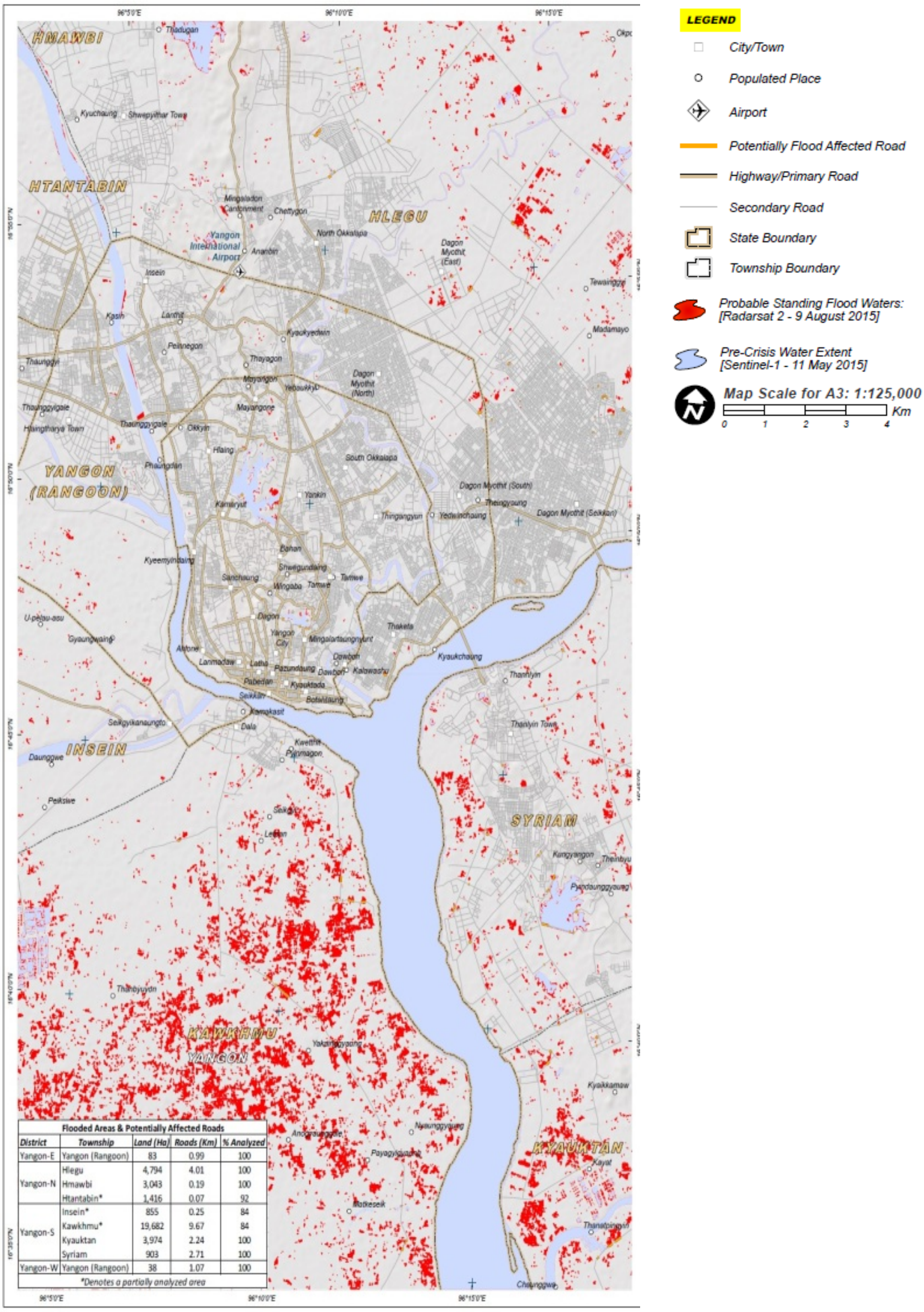
The high risk areas of flood disasters in Myanmar include:

- Central regions: Mandalay and its surroundings
- Ayeyarwadi River delta

Thus, it can be seen that the flood risk to the Yangon region is not very high in the hot-spots identified in Yangon region are given in **Figure 5.13**. As can be seen from the map, the flood risk is almost non-existent in the Insein region, where the power plant is located.

It was also found during the study that near the Ywama power plant, the west bank of the Hliang River is at a lower level, and thus in case of increase in water level in the river, overflow water inundates the western side. However, the low-lying area of neighbouring Sub-quarters 5 and 6 of Ywama gets inundated due to backflow of water through the water channels. This is a regular occurrence in the area and happens during high tides. The level of the plant was found to be much higher and thus there is no risk of flooding in the plant area. Since the operation of the plant, there has been no incidents of flooding within the plant area.

Ywama Power Plant is located on the (eastern) banks of River Hlaing, which is a tidal river and will have a direct impact on the water level in the river. As per the study, the water level rise predicted by 2050 (i.e. till the project duration) in Hlaing River is 56 cm and by 2080 river level is expected to rise by 121cm (Table 7.1). It was found that the present level difference between the plant and the river during high tide is about 3.8m, whereas the rise of water in Hlaing River due to sea level rise by 2080 is predicted to be 1.21m. Thus, there will be no risk of the plant getting submerged due to the rise in water level during the next 60 years. It was also found during the study that near the Ywama power plant, the west bank of the Hliang River (the opposite bank) is at a lower level, (this is a truth which remained in the past much before 100 years and will remain in future) and thus in case of increase in water level in the river, overflow water inundates the western side.



District	Township	Land (Ha)	Roads (Km)	% Analyzed
Yangon-E	Yangon (Rangoon)	83	0.99	100
Yangon-N	Hlegu	4,794	4.01	100
	Hmawbi	3,043	0.19	100
	Htantabin*	1,416	0.07	92
Yangon-S	Insein*	855	0.25	84
	Kawkhmu*	19,682	9.67	84
	Kyauktan	3,974	2.24	100
	Syriam	903	2.71	100
Yangon-W	Yangon (Rangoon)	38	1.07	100

*Denotes a partially analyzed area

Figure 5-13: Flood map of Yangon Region

5.5.2 Cyclone

Myanmar is located on the western edge of the Indochina Peninsula between latitudes 10° and 28° to the north and longitudes 92° and 101° to the east. The central part of the country is covered predominantly by the Ayeyarwady River, which runs into the Bay of Bengal while the mouth lies in the Ayeyarwady Delta. Myanmar stretches for 1,930km from the north to the south. The climate of the country is mostly tropical. The southern coastal area is characterized by the tropical monsoon; the central part is a savanna, while the mountainous terrain in the north is a temperate zone. The country has three seasons, a hot season (late February to early May), a rainy season (mid-May to mid-October), and winter season (late October to mid-February).

Heavy rains with thunder usually occur in the coastal region during the afternoons and late nights of April and May. On the other hand, instead of rain, furious dust storms and occasionally, tornadoes occur inland. The monthly rainfall of July exceeds 1,000 mm while the annual rainfall is more than 5,000 mm on the slopes of the mountains and coastal areas in the western region. Myanmar is exposed to meteorological hazards which include cyclones, storm surges, floods, landslides, droughts, and forest fires.The average annual frequency of tropical cyclones (cyclonic disturbances) in the Bay of Bengal is from five to nine. Normally, only two to four cyclones are formed. The monthly frequency of tropical cyclones in the Bay of Bengal peaks in November (the transition month between the southwest monsoon and the northeast monsoon).

Tropical cyclones developing during the monsoon months (July to September) are generally not so intense. Cyclones which make land fall in Myanmar are most prevalent in two peaks periods: April to May and October to November. In the last three decades, five major cyclones have hit Myanmar. However, none of the cyclones affected the Yangon region much (**Table 5.3**).

Table 5-3: Incidents of Cyclones in Myanmar

Years	Location	Cyclone Name	Dead	Victims
October, 2010	Kyaukpyu, Minbya, Munaug	Gili	45	260,049
May, 2008	Ngapadudaw, Labutta, Mawl	Nargis	138,373	2,420,000
April, 2006	Irrawaddy, Rakhine, Araka	Mara	37	60,106
May, 1994	Maungdaw, Buthidaung	Mandoryu	17	64,970
May, 1982	South West	Gaoua	11	36,000

Source: Natural Disaster Risk Assessment and Area Business Continuity Plan Formulation for Industrial Agglomerated Areas in the ASEAN Region

5.5.3 Earthquake

Geographically, a large part of Myanmar lies in the southern part of the Himalayas and on the eastern side of the Indian Ocean. Myanmar is earthquake-prone as it lies in one of the two main earthquake belts of the world, known as the Alpine-Himalayan Belt. 16 earthquakes with magnitudes 7.0 and over have occurred over the last 170 years since 1839**(Figure 5.10).**

The earthquakes that caused many casualties were the earthquake that occurred in Innwa in 1839 and the earthquake that occurred in Near Khyan in 1930. The earthquakes not only caused casualties, but also an economic impact on society. One death and USD 1 million (0.006% of GDP) in losses were recorded for the earthquake that occurred in Bagan in 1975. About 70 deaths and USD 4 million (0.004% of GDP) in losses were recorded for the earthquake occurred that in Tachilek in 2011.

Earthquakes in Myanmar have been mainly attributed to the following two plate activities:

- The continuous subduction of the northward-moving Indian Plate under the Burma Platelet, which is a part of the Eurasian Plate, and
- The northward movement of the Burma Platelet along the Sagain Fault from a spreading center in the Andaman Sea.

Four areas are designated to the Destructive Zone, namely, Bago-Phyu, Mandalay-Sagaing-Tagaung, Putao-Tanaing, and Kale-Homalin. Although the latter two have major earthquake hazards, their risk-level is low because they are sparsely populated. Important cities and towns in Zone IV (Severe: the probable maximum range of ground acceleration is 0.3 – 0.4 g) are Taungoo, Taungdwingyi, Bagan-Nyaung-U, Kyaukse, PyinOoLwin, Shwebo, Wuntho, Hkamti, Haka, Myitkyina, Taunggyi, and Kunglong.

Yangon is located at the boundary between Zone II and Zone III. The old and new satellite towns in the eastern area are in Zone III, and the old City is in Zone II.Till date, there has been no history of earthquake in Yangon region, although due to population increase in Yangon, the risk of damage from earthquake has increased over the period of time. Thus no risk of impact of earthquake on the proposed plant is foreseen.

5.6 PHYSICAL ENVIRONMENT

5.6.1 Climatology

The analysis of the meteorological aspects of the study area has been carried out on the basis of data collected from the nearest meteorological station at Kaba-Aye in Yangon. The period of analysis is for the period January 2018 to December 2018. The year may be broadly divided into four seasons:

- Winter season: December to February
- Pre-monsoon season: March to May
- Monsoon season: June to September
- Post-monsoon season: October to November

5.6.1.1 Rainfall

The Yangon region experiences high rainfall with the average annual rainfall of 3143mm. The highest rainfall was observed in the month of July at 805mm followed by 627mm in June. The highest daily rainfall of 153mm was experienced in October. The monthly break-up of rainfall for the calendar year 2018 is given in **Table 5.4**. The monthly mean values are presented in **Figure 5.14**.

Table 5-4: Monthly Variation of Rainfall at Yangon in mm (Jan-Dec 2018)

Aspects	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	0	0	0	42	259	627	805	578	472	229	70	61

Source: Meteorological and Hydrological Department, Yangon

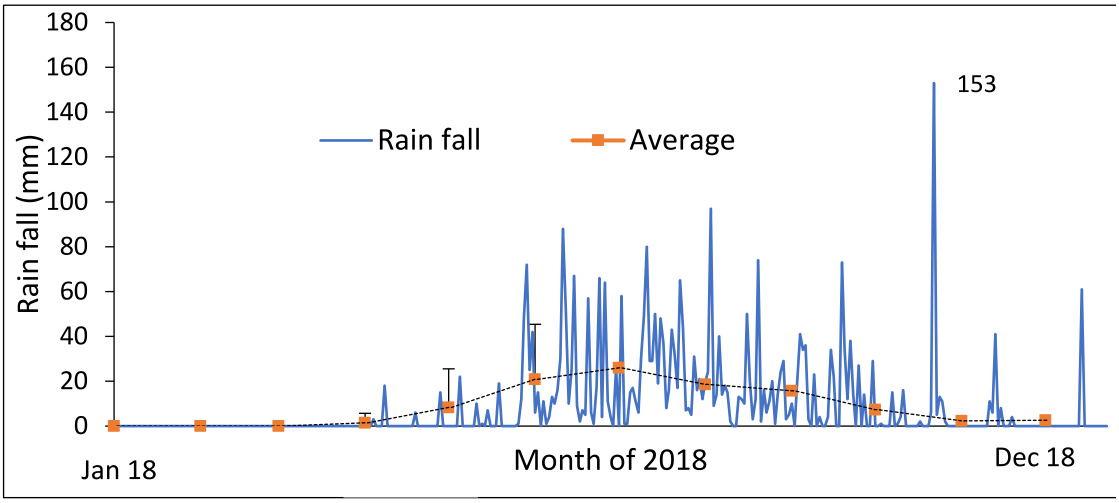


Figure 5-14: Monthly Rainfall at Yangon in mm

5.6.1.2 Relative Humidity

The relative humidity values at 06.30hr and 18.30hr are ranging from 36-83%. The monthly mean values are presented in **Table-5.5**.

Table 5-5: Monthly Variation of Relative Humidity at Yangon in % (Jan-Dec 2018)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
At 06.30hr												
Min	82	82.0	82.0	74.0	82.0	92.0	88.0	88.0	92.0	91.0	82.0	82.0
Max	96	100	100	100	100	100	100.	100	100	100	96.0	96.0
Avg	90	92.7	93.7	88.7	90.9	96.8	97.2	95.7	96.0	95.6	93.4	91.3
SD	3.5	3.9	3.8	5.4	4.9	2.7	2.6	2.5	2.1	2.2	3.7	3.9
At 18.30hr												
Min	47	39.0	38.0	42.0	56.0	59.0	84.0	84.0	71.0	65.0	67.0	44.0
Max	92	70	71.0	71.0	100.0	100	100.0	100.0	100	98.0	96.0	100.0
Avg	70	57	55.8	58.2	73	88.9	95.6	93.1	87.7	86.0	78.5	74.9
SD	9.8	8.1	8.8	8.0	13.5	9.9	3.7	5.3	7.1	6.5	8.8	10.2

Min =Minimum; Max = Maximum; Avg = Average; SD = Standard Deviation

Source: Meteorological and Hydrological Department, Yangon

In long-term analysis, the mean daily relative humidity of Yangon Region is high (about 100%) in the rainy season from June to September at both morning and evening measurements. However, the average relative humidity drops in other months around 90% in the morning and around 70% in the evening. The lowest relative humidity in Yangon Region is about 70% in February 18:30 measurements. The difference between morning and evening relative humidity is large (about 20%) in the period between January to April, but there is no difference in the period between June to September. The long-term monthly average for the mean daily relative humidity of Yangon Region at 06:30 hr. and 18:30 hr. is illustrated below in **Figure 5.15**.

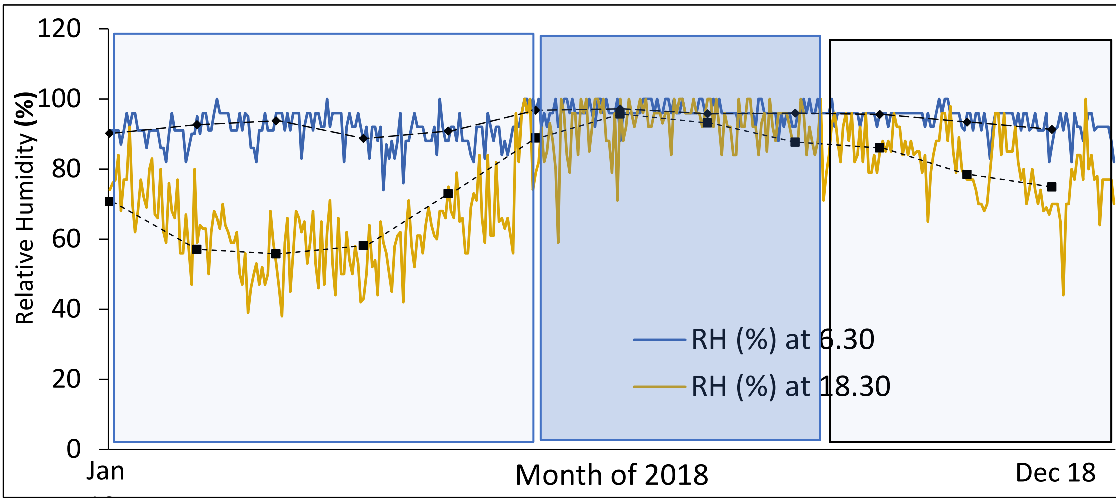


Figure 5-15: Monthly Relative Humidity in % at Yangon

5.6.1.3 Temperature

The data obtained from the Kaba-Aye weather station shows that the hottest months are April to July, with average temperatures between 30.0°C and 37.5°C. The lowest temperature is experienced in January with average of 17.3 °C.

In long-term analysis, the maximum mean daily temperature of Yangon Region is 37.5ºC (in April) and the minimum is 17.8ºC (in January). The long-term monthly average of mean daily maximum and minimum temperature of Yangon Region is shown in **Table 5.6** and **Figure 5.16**.

Table 5-6: Monthly Variation of Temperature at Yangon (Jan-Dec 2018)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Maximum Temperature (ºC)												
Min	29.2	31.5	35.0	32.8	26.2	26.9	27.0	27.0	26.2	27.0	32.0	31.6
Max	34.5	37.6	37.6	40.0	38.8	33.5	33.3	32.3	35.0	35.5	35.5	35.5
Avg	32.4	34.4	36.4	37.5	35.3	31.0	30.0	30.2	31.9	32.9	33.7	33.6
Sd	1.5	1.8	0.7	1.6	3.0	1.5	1.6	1.5	2.0	2.1	0.8	1.2
Daily Minimum Temperature (ºC)												
Min	11.0	12.0	17.3	20.2	20.2	20.4	20.2	20.0	19.5	18.8	15.0	17.4
Max	22.0	20.3	23.0	24.3	25.5	23.2	23.0	22.8	22.5	22.2	21.7	20.2
Avg	17.3	17.4	20.4	22.8	23.2	21.6	21.4	21.0	21.1	20.5	18.7	18.9
Sd	2.6	2.1	1.1	1.0	1.3	0.8	0.8	0.7	0.9	0.9	1.7	0.8

Min =Minimum; Max = Maximum; Avg = Average; Sd = Standard deviation
Source: Meteorological and Hydrological Department

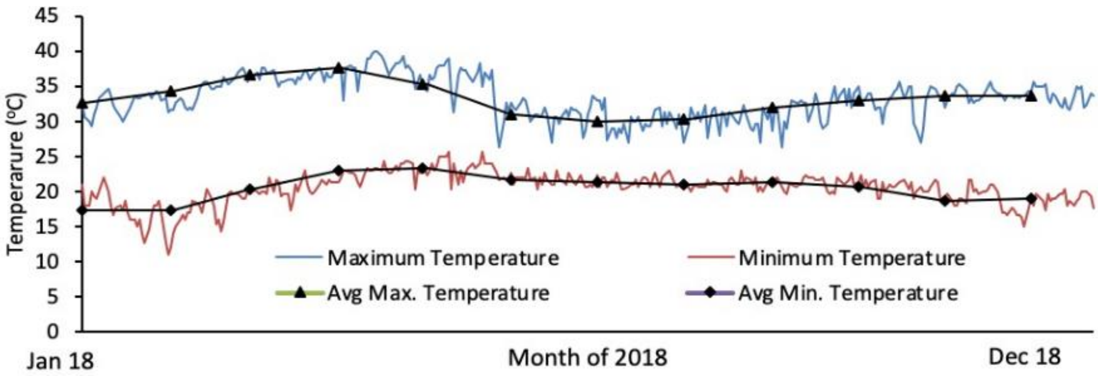


Figure 5-16: Monthly Temperature in°Cat Yangon

5.6.1.4 Wind Speed

Maximum monthly wind speed of Yangon Region is 5.8mph in the morning. Wind speed in Yangon Region is higher in the rainy season than the other period. Although cyclones come to the country at the beginning and ending of the rainy season, Yangon Region seldom experiences the effect of cyclone wind. The long-term monthly average for mean daily wind speed of Yangon Region is described in **Figure 5.17 & Table 5.7.**

Table 5-7:Monthly Variation of Wind Speed at Yangon in mph (Jan-Dec 2018)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
At 06.30 hr												
Min	1.2	1.2	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Max	2.3	2.3	1.2	4.6	4.6	5.8	3.5	2.3	3.5	5.8	2.3	2.3
Avg	1.3	1.2	1.1	1.7	1.7	2.0	1.5	1.6	1.7	1.5	1.4	1.5
SD	0.3	0.2	0.4	0.9	0.9	1.2	0.6	0.5	0.7	0.9	0.4	0.5
At 18.30 hr												
Min	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Max	4.6	3.5	3.5	4.6	4.6	5.8	5.8	3.5	4.6	2.3	2.3	3.5
Avg	1.4	1.6	2.0	2.1	2.3	2.3	2.2	2.1	2.0	1.6	1.9	1.8
SD	0.7	0.7	0.8	0.9	1.0	1.1	1.1	0.6	0.7	0.5	0.5	0.7

Min =Minimum; Max = Maximum; Avg = Average; Sd = Standard deviation

Source: Meteorological and Hydrological Department

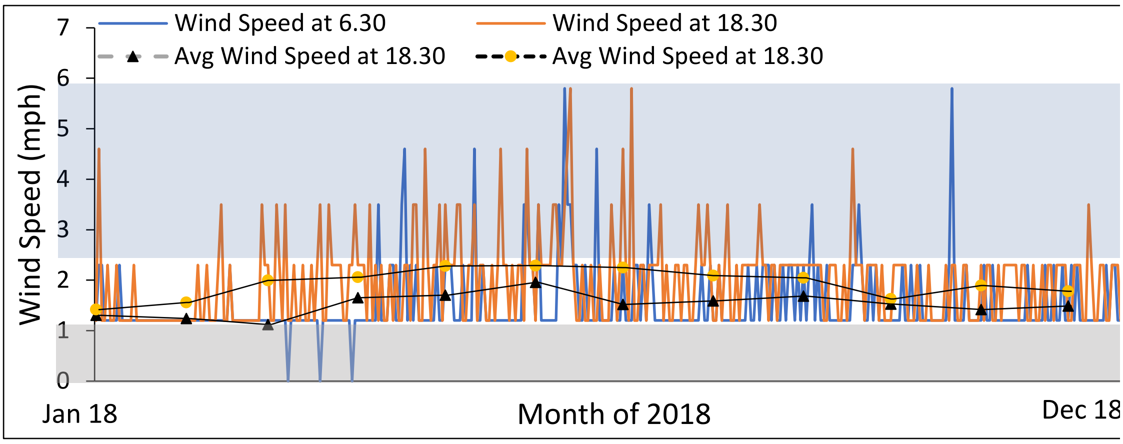


Figure 5-17: Monthly wind speed at Yangon in mph

5.6.1.5 Wind Direction

The predominant wind direction for the 2018 annual data was found to be from South followed by South-East. This shows that most of the time wind flows from the direction of the sea. (Refer wind-rose in **Figure 5.18**).

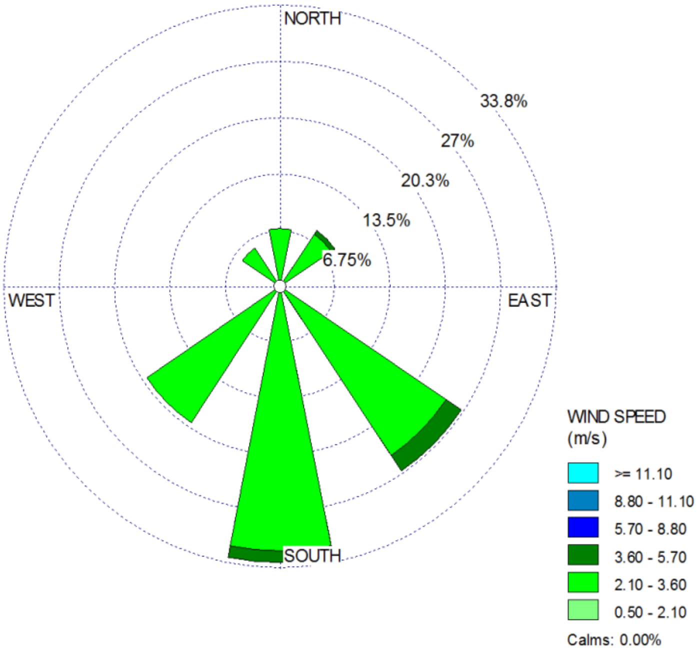


Figure 5-18: Wind Rose Diagram

5.6.2 Ambient Air Quality

The ambient air quality with respect to the study zone of 5.0km distance around the proposed project boundary forms the baseline information. The prime objective of the baseline air quality study was to assess the existing air quality of the area. This will also be useful for assessing the conformity to standards of the ambient air quality during the project operations.

Monitoring stations were established at four locations zone inside the power plant, one in the pre-dominant downwind direction, one inside an industrial area and one in the nearest thickly populated residential area. In addition to that, the data was validated from other secondary data available for the area. This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling.

5.6.2.1 Frequency and Parameter of Sampling

Ambient air quality monitoring was carried out at a frequency of two days per week at each location. The duration of sampling was 24 hourly continuous sampling per day. The baseline data of air was monitored for PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO.

5.6.2.2 Instruments used for Sampling

With a view to collect the samples, Envirotech make calibrated Respirable Dust Samplers (RDS-APM 460 BL) along with Gaseous attachment and Fine Particulate Matter (FPS APM 550) were used. The instruments are well capable of drawing air at a flow rate of 1 to 1.3 m^3/min with very little pressure drop for RDS and the impactor system of FPS is designed to operate at an air flow rate of 1m^3/hr. Filter papers (8” x 10” GF for PM_{10} and 46.2 diameter PTFE for $PM_{2.5}$) were used for the collection of PM_{10} and $PM_{2.5}$. SO_2 was collected by drawing air at a flow-rate of 0.5 litres per minute (lpm) through an absorbing solution i.e., Sodium Tetrachloro Mercurate (TCM) (West and Gaeke Method) and NO_2 was collected by drawing air at a flow rate of 0.4 lpm through the mixture of absorbing solutions i.e. sodium hydroxide and sodium arsenite (Jacobs and Hochheiser Method). Carbon Monoxide samples were collected on 8 hourly bases and analyzed by Non-Dispersive Infrared Spectroscopy.

5.6.2.3 Sampling and Analytical Techniques

The equipment used in air monitoring was equipped with timers, which automatically records the total duration of monitoring for which equipment was in operation. Based on this, total volume of gas sampled was calculated to arrive at concentrations of pollutants monitored. The concentrations of parameters were computed for the total duration of monitoring and for the total gas volume sampled excluding the time lapses due to power failures. The analytical techniques used for the analysis of both particulate and gaseous pollutants are given in **Table 5.8**.

Table 5-8: Ambient Air Quality Monitoring Techniques

Parameter	Analytical Technique	Technical Protocol
PM10	Respirable Dust Sampler (Gravimetric method)	IS-5182 (Part 23)
PM2.5	Fine Particulate Sampler (Cyclonic method)	Measurement of Ambient Air Pollutants, Volume-I
SO_2	West and Gaeke	IS-5182 (Part 2)
NO_2	Jacob and Hochheiser	IS-5182 (Part 6)
CO	Non-Dispersive Infra-Red Spectroscopy(NDIR)	

5.6.2.4 Selection of Sampling Locations

The selection of monitoring station was done on the basis of the following considerations:

- Meteorological conditions (wind direction and wind speed);
- Representativeness of regional background air quality for obtaining baseline status;
- Representative of likely affected area;
- Topography of the study area;
- Accessibility and availability of the infrastructure.

Keeping in view the above-mentioned points, four ambient air quality monitoring locations were selected. The location of human habitation and other sensitive areas within the study area were also considered for selection of ambient air quality monitoring locations. The Ambient Air Quality Monitoring locations have been shown in **Figure 5.19**. The relative direction and distance of these locations with respect to the plant site is given in **Table 5-9**.

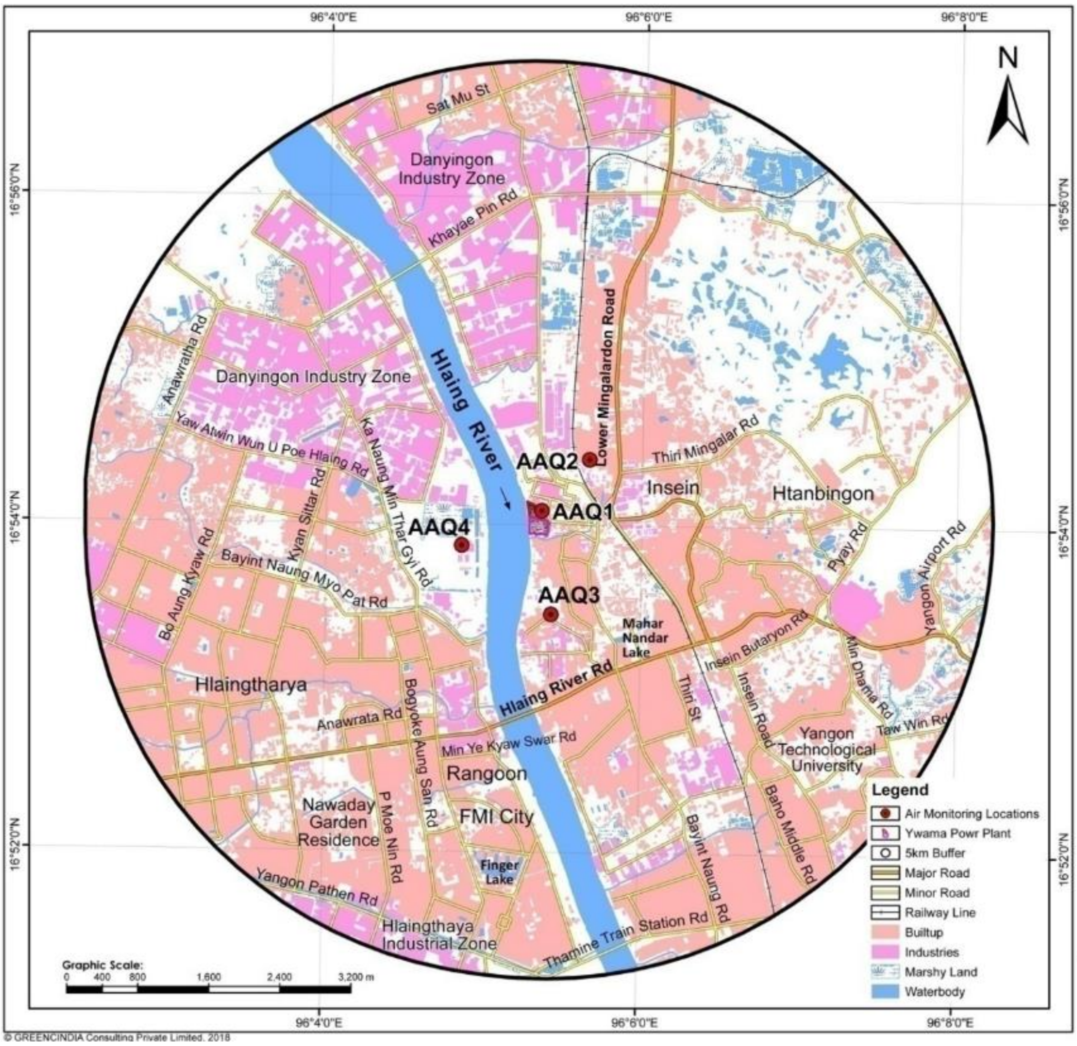


Figure 5-19: **AAQ Monitoring Locations**

Table 5-9: **Ambient Air Quality ("AAQ") Monitoring Stations**

Sl. No.	Location	Code	Distance from project site*	Direction
1	Project Site	AAQ1	-	-
2	Adjacent residential area	AAQ2	0.1km	NE
3	Insein Township	AAQ3	2.1km	S
4	Shwe Lin Ban Industrial Zone	AAQ4	1.2km	SW

*- Distance and direction are in respect of the center of the existing power plant and on the basis of aerial distance

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

5.6.2.5 Presentation of Primary Data - Baseline Air Quality

The 98th percentile, average, maximum and minimum values were computed from the observed raw data for all the AAQ monitoring stations. The summary of these results for each location during the Study period (November 2018) are presented in **Tables 5.10** to **5.15**.

Particulate Matter 10 (PM_{10}): The particulate matters sizes of up to 10µm in diameter are collectively referred to as PM_{10}. Hence respiratory health effects on people can be observed when they are exposed at elevated concentrations (Pope et al. 2002)[9]. The natural sources, anthropogenic sources including fuel combustion, incineration, domestic heating for households and fuel combustion for vehicles, as well as vehicle (tyres and brake) and road wear and tear, other types of anthropogenic dust in the study area give rise to PM_{10} concentration in the study area. The range of PM_{10} concentration in the study area varies from 83.4 -95.3 µg/m^3. The 98 percentile minimum value for PM_{10} is observed at AAQ2 as 84.7µg/m^3 with the maximum 98 percentile value observed at AAQ4, as 95.2µg/m^3 during the study period (**Table 5.10 & Figure 5.20**). The values at all the locations are higher than the Myanmar National Guideline value of 50µg/m^3 which can be attributed to industries on both side of the Hlaing River and vehicle pollution of near-by roads.

Table 5-10: Particulate Matter (PM10) in µg/m³

Station Code	Location	Min	Max	StdDev	98P	Mean
AAQ1	Project Site	88.1	89.6	0.7	89.6	89.0
AAQ2	Adjacent residential area	83.4	84.7	0.6	84.7	84.1
AAQ3	Insein Township	88.3	90.1	0.7	90.1	89.2
AAQ4	Shwe Lin Ban Industrial Zone	90.9	95.3	1.9	95.2	92.7

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

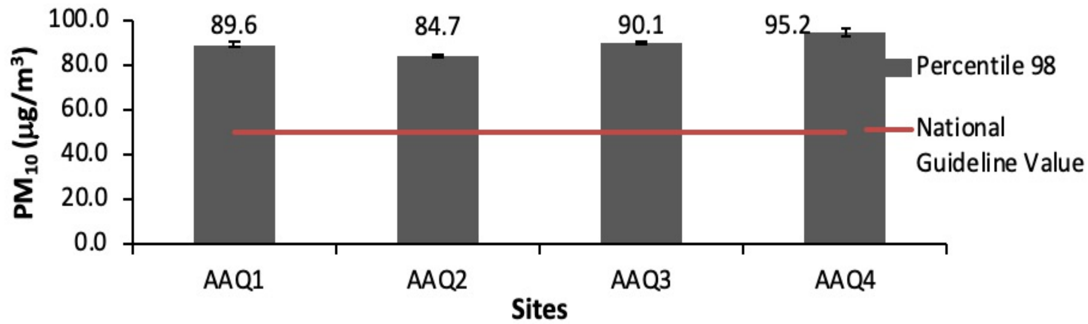


Figure 5-20: Graphical Representation of Particulate Matter 10 (PM_{10})

Particulate Matter 2.5 ($PM_{2.5}$):$PM_{2.5}$ constitutes mostly fine particles smaller than 2.5µ in diameter. Fine and ultrafine particles are formed by chemical reaction; nucleation, condensation, coagulation, evaporation of fog and cloud droplets, in which gases also dissolve and react (Seinfeld et al, 2004)[10]. Populations subjected to long-term exposure to particulate matter have a significantly higher cardiovascular incident and mortality rate. Short-term acute exposures subtly increase the rate of cardio-vascular events within days of a pollution spike[11]. The range of $PM_{2.5}$ concentration in the study area varied from 29.1-35.3µg/m^3. The 98 percentile minimum value for $PM_{2.5}$ was observed at AAQ3, as 30.7µg/m^3 with the maximum 98 percentile value observed at AAQ1, as 35.3µg/m^3 during the study period (**Table 5.11 & Figure 5.21**). For this parameter also

9Pope, C. A., Burnett, R. T., Thun, M. J., Calle, E. E., Krewski, D., Ito, K., et al. (2002). Lung cancer, cardio-pulmonary mortality and long term exposure to fine particulate air pollution, Journal of the American Medical Association, 287

10Seinfeld JH, Carmichael G et al (2004), ACE-Asia: Regional Climate and Atmospheric Chemical Effects of Asian Dust and Pollution. Bull Am Met Soc 85:367–380

11Franco A. and Diaz A.R., 2009, The Future Challenges for "Clean Coal Technologies" Joining efficiency increase and pollutant emission control. Energy 34, 348–354, the concentrations were found to be higher than the Myanmar National Guideline value of 25µg/m^3. This is due to the presence of industries and heavy traffic in the study area.

Table 5-11: Particulate Matter (PM2.5) in µg/m³

Station Code	Location	Min	Max	StdDev	98P	Mean
AAQ1	Project Site	32.2	35.3	1.3	35.3	34.1
AAQ2	Adjacent residential area	30.3	31.4	0.5	31.4	30.8
AAQ3	Insein Township	29.1	30.7	0.8	30.7	30.0
AAQ4	Shwe Lin Ban Industrial Zone	33.3	34.2	0.4	34.2	33.8

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

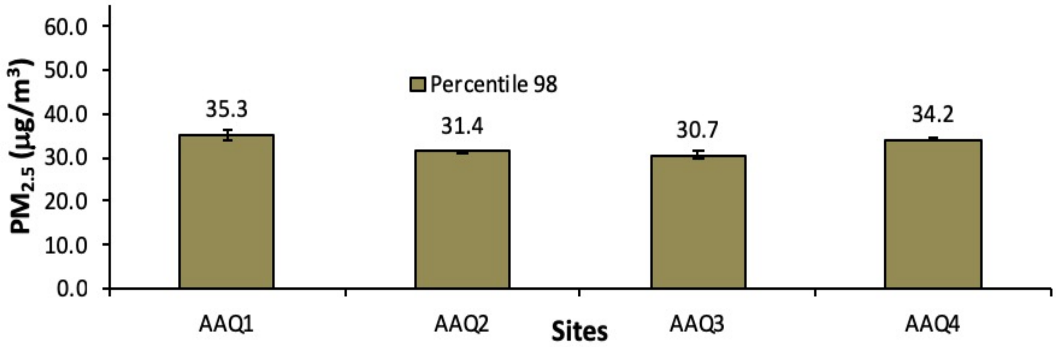


Figure 5-21: Graphical Representation of Particulate Matter 2.5 ($PM_{2.5}$)

Sulphur Dioxide (SO_2): The source of SO_2 in the study area is mainly from burning fuels containing sulfur or emissions from coal combustion depending on the Sulphur content in the coal. Other anthropogenic sources are emissions from domestic burning and vehicles (Seinfed, J.L. and Pandis. (1998)[12]. Exposure to sulphur dioxide in the ambient air has been associated with reduced lung function, increased incidence of respiratory symptoms and diseases, irritation of the eyes, nose and throat. Sulphur dioxide reacts with other substances in the atmosphere to form sulfate aerosols (USEPA, 1982)[13]. Since most sulphate aerosols are part of $PM_{2.5}$, they may have an important role in the health impacts associated with fine particulates (WHO, 1979)[14].

The minimum value of SO_2in the study area was 12.2±1.5µg/m^3 in Insein Township while maximum value was 16.8±0.5µg/m^{3}at Shwe Lin Ban Industrial Zone. The 98 percentile minimum value for $SO_2$was observed to be 13.2µg/m^{3}at AAQ2and the maximum value observed at AAQ4 was 16.8µg/m^3 during the study period (**Table 5.12& Figure 5.22**). Thus the SO_2 concentrations in all the locations were found to be below the National Guideline value of 20µg/m^3.

12Seinfed ,J.L., and Pandis, (1998). Atmospheric chemistry and physics from Air Pollution to climate change ;John Wiley and sons: New York ,pp 74 –75,1056 –1057.

13USEPA (United States Environmental Protection Agency). 1982. Air Quality Criteria for Particulate Matter and Sulfur Oxides. EPA-600/8-82-029, December, Research Triangle Park, N.C.

14WHO (World Health Organization) 1979, "Sulfur Oxides and Suspended Particulate Matter," Environmental Health Criteria Geneva

Table 5-12: Sulphur dioxide (SO_2) in µg/m³

Station Code	Location	Min	Max	StdDev	98P	Mean
AAQ1	Project Site	13.3	15.4	0.9	15.4	14.5
AAQ2	Adjacent residential area	12.6	13.2	0.3	13.2	12.9
AAQ3	Insein Township	12.2	15.8	1.5	15.7	14.1
AAQ4	Shwe Lin Ban Industrial Zone	15.7	16.8	0.5	16.8	16.3

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

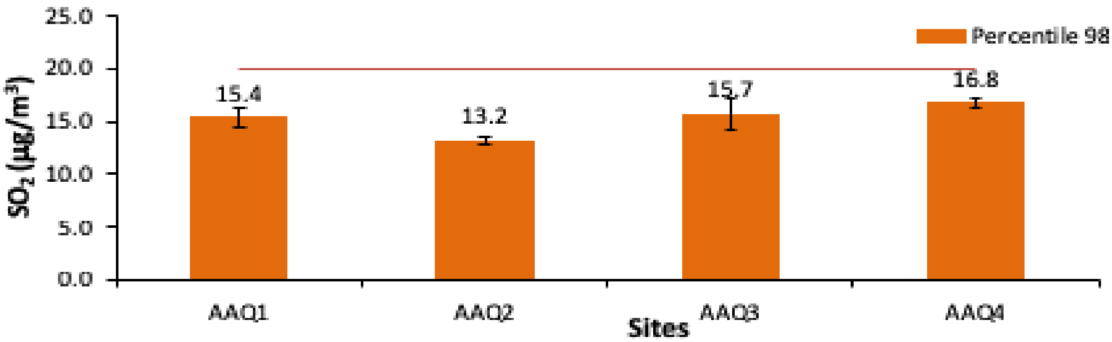


Figure 5-22: Graphical Representation of Sulphur dioxide (SO_2)

Nitrogen Dioxide (NO_2): Nitrogen dioxide (NO_2) in the ambient air consists primarily of nitric oxide (NO) and nitrogen dioxide (NO_2). These two forms of gaseous nitrogen oxides are significant pollutants of the lower atmosphere. The primary sources of NO_2 are motor vehicles, electric utilities, and residential sources that burn fuels. NO_2 is one of the main ingredients involved in the formation of ground level ozone, which can trigger serious respiratory problems. It reacts to form nitrate particles, acid aerosols, as well as NO_2, which also cause respiratory problems (NAPAP 1991)[15].

The minimum value of NO_2 in the study area was found to be 15.6±0.9µg/m³ in the residential area adjacent to the plant while maximum value was25.5±1.0µg/m³. The 98 percentile minimum value for NO_2 is observed at AAQ2, as 17.6µg/m³ with the maximum value observed at AAQ4, as 25.4µg/m³ during the study period (**Table 5.13& Figure 5.23**). The values were found to be much less than the stipulated value of 40µg/m³.

Table 5-13:Nitrogen Dioxide (NO_2) in µg/m³

Station Code	Location	Min	Max	StdDev	98P	Mean
AAQ1	Project Site	18.7	19.7	0.5	19.7	19.2
AAQ2	Adjacent residential area	15.6	17.7	0.9	17.6	16.6
AAQ3	Insein Township	19.1	19.7	0.3	19.7	19.4
AAQ4	Shwe Lin Ban Industrial Zone	23.3	25.5	1.0	25.4	24.1

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

15NAPAP (National Acid Precipitation Assessment Program, Various years, 1987–91, Washington, D.C:Government Printing Office.

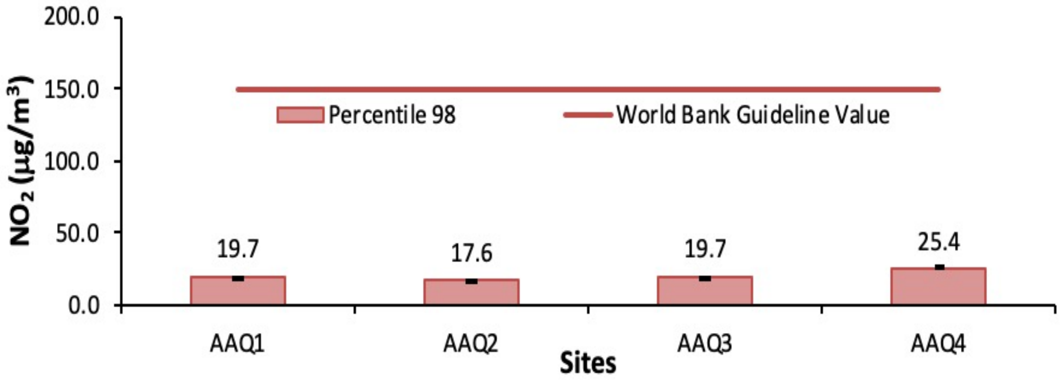


Figure 5-23: **Graphical Representation of Nitrogen Dioxide (NO_2)**

Carbon Monoxide: Carbon monoxide (CO), a colorless, odorless, tasteless and toxic air pollutant, is produced in the incomplete combustion of carbon-containing fuels, such as gasoline, natural gas, oil, coal, and wood. The 98 percentile minimum value for CO is observed at AAQ2, as 0.77mg/m^3 with the maximum value observed at AAQ5, as 1.39mg/m^3 during the study period (**Table 5.14 & Figure 5.24**).

Table 5-14:**Carbon Monoxide (CO) in mg/m³**

Station Code	Location	Min	Max	StdDev	98P	Mean
AAQ1	Project Site	1.00	1.10	0.05	1.10	1.06
AAQ2	Adjacent residential area	0.69	0.77	0.04	0.77	0.74
AAQ3	Insein Township	0.85	0.98	0.06	0.97	0.90
AAQ4	Shwe Lin Ban Industrial Zone	1.20	1.40	0.08	1.39	1.30

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

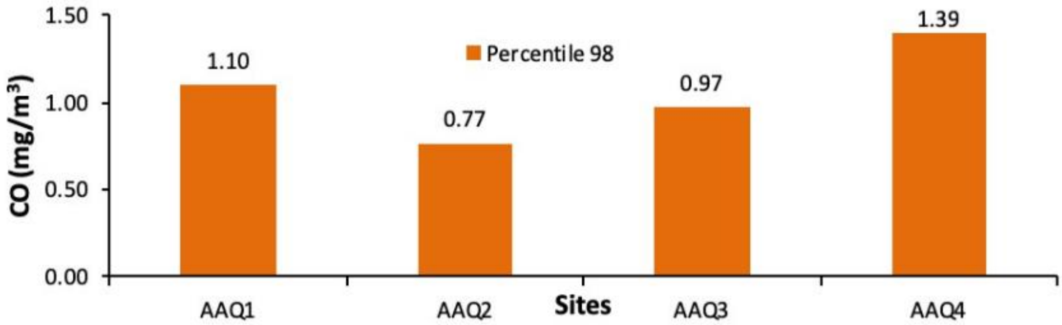


Figure 5-24: **Graphical Representation of Carbon Monoxide (CO)**

Table 5-15: **Consolidated Values of AAQ (98 percentile)**

Station Code	Location	Direction	Distance (in km)	µg/m³				mg/m³
				PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO
AAQ1	Project Site	-	-	89.6	35.3	15.4	19.7	1.10
AAQ2	Adjacent residential area	NE	100m	84.7	31.4	13.2	17.6	0.77
AAQ3	Insein Township	S	2.1km	90.1	30.7	15.7	19.7	0.97
AAQ4	Shwe Lin Ban Industrial Zone	SW	1.2km	95.2	34.2	16.8	25.4	1.39

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

Table 5-16: Correlation Matrix of AAQ Parameters (98 percentile)

	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO
PM_{10}	1.000				
$PM_{2.5}$	0.486	1.000			
SO_2	0.972	0.438	1.000		
NO_2	0.951	0.480	0.852	1.000	
CO	0.967	0.673	0.907	0.956	1.000

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad, India

From the above analysis of the data, it infers that the baseline concentrations in the study area are within the permissible limits except PM_{10}. However, the high concentration can be attributed to the presence of the power plants, activities in the industrial zone and dusty open terrain and high traffic density in the study area. The correlations between different parameters show positive relation with each other (**Tables 5.17& 5.16**).

Table 5-17: Ambient Air Quality Standards (mg/m^3) of Myanmar, Other Countries and WHO

Item	Average Period	Myanmar	Japan	Thailand	Vietnam	WHO
SO_2	10 mins	0.5	-	-	-	0.5
	1 hour	-	0.26	0.78	0.35	-
	24 hours	0.02	0.10	0.3	0.125	0.125 (InterimTarget-1) 0.05 (InterimTarget-2) 0.02 (Guideline)
	1 year	-	-	0.1	0.05	-
NO_2	1 hour	0.2	-	0.32	0.2	0.2
	24 hours	-	0.07-0.11	-	0.1	-
	1 year	0.04	-	0.057	0.04	0.04
CO	1 hour	-	-	36.3	30	-
	8 hours	-	22.5	-	10	-
	24 hours	-	11.3	10.26	-	-
PM_{10}	1 hour	-	0.2	-	-	-
	24 hours	0.05	0.1	0.12	0.15	0.15 (InterimTarget-1) 0.10 (InterimTarget-2) 0.075 (InterimTarget-3)
	1 year	0.02	-	0.05	0.05	0.07 (InterimTarget-1) 0.05 (InterimTarget-2) 0.03 (InterimTarget-3)
$PM_{2.5}$	24 hours	0.025	0.035	0.05	0.05	0.075 (InterimTarget-1) 0.05 (Interim Target-2) 0.0375 (Interim Target-3) 0.025 (Guideline)

Item	Average Period	Myanmar	Japan	Thailand	Vietnam	WHO
	1 year	0.01	0.015	0.025	0.025	0.035 (InterimTarget-1) 0.025 (InterimTarget-2) 0.015 (InterimTarget-3)

Source: Myanmar: National Environmental Quality (Emission) Guidelines (December, 2015).
Japan: National Air Quality Standard in Japan (Circular No.25, 1973, originally), Ministry of Environment, Japan
Thailand: Notifications of National Environmental Board No.10, B.E 2538 (1995), No. 24, B.E. 2547 (2004),No. 28, B.E 2550
(2007),No. 33, B.E 2552 (2009),No. 36, B.E 2553 (2010) under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992).
Vietnam: National Technical Regulation on Ambient Air Quality (QCVN 05:2013/BTNMT), Ministry of Science and Technology in Vietnam.
WHO: WHO Air Quality Guidelines 2005.

5.6.3 Noise Level Measurement

The main objective of noise monitoring in the study area is to establish the baseline noise levels and assess the impact of the total noise expected to be generated by the construction and operation of the plant.

5.6.3.1 Identification of Sampling Locations

A preliminary reconnaissance survey has been undertaken to identify the major noise generating sources in the area. Noise at different noise generating sources has been identified based on the residential, commercial and industrial activities in the area. The monitoring locations are given in **Table 5.18** and **Figures 5.25**& **5.26**.

Table 5-18:Ambient Noise Quality Monitoring Stations

Code	Location	Distance*	Direction*
N1	Project Site	-	-
N2	Residential area in North	100m	NE
N3	Insein	1.1km	S
N4	West Bank of Hlaingriver	1.0km	SW

*- Distance & direction are in respect of the center of the existing power plant and on the basis of aerial distance

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

Figure 5-25: Noise Monitoring Location at Project Site

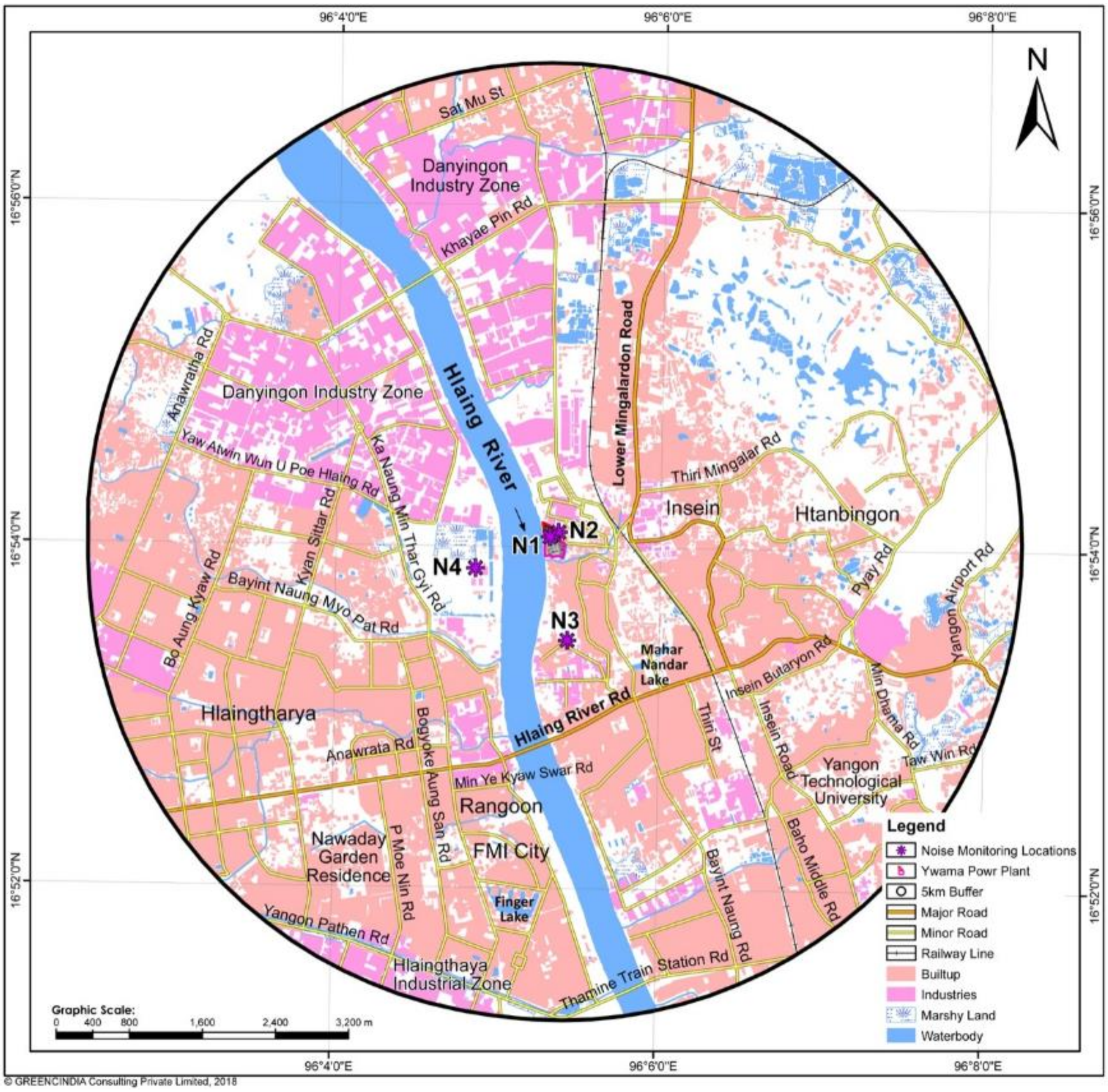


Figure 5-26: Noise Monitoring Locations in Study Area

5.6.3.2 Frequency & Parameters of Sampling

Noise levels were recorded at an interval of 60 minutes during the day and night times to compute the day equivalent, night equivalent and day-night equivalent level. The noise level was monitored once during the study period at each monitoring location. The noise level is recorded in dB(A). The important parameters measured are L_{eq}, L_{day}, and L_{night}.

Leq: Noise monitoring equipment's provide the facility for measurement of Leq directly. However, Leq can also be calculated using the following equation:

$$L_{eq}\ \textbf{(hourly)} = L_{50} + (L_{10} - L_{90})^2/60$$

Where,

L_{90}:(Ninety Percentile Exceeding Level) is the level of sound, which exceeds 90% of the total time of measurement.

L_{eq}: This represents L_{eq} of whole day including night. Leq is calculated as logarithmic average using the hourly L_{eq} for whole 24 hrs in a day.

	L_{day}: This represents Leq of day-time. L_{day} is calculated as logarithmic average using the hourly Leq's for day time hours from 6.00 A.M to 10.00 P.M **L_{night}:** This represents Leq of night-time. L_{night} is calculated as logarithmic average using the hourly Leq's for night-time hours from 10.00 PM to 6.00 A.M.

5.6.3.3 Instruments used for Sampling

Envirotech make automatic Sound Level Meter (SLM)100was used for measuring the noise levels. This instrument measures Sound Pressure Level (SPL), maximum sound pressure level (max) and equivalent continuous noise level (L_{eq}).

5.6.3.4 Presentation of Results

The statistical analysis is done for measured noise levels at 4 locations. The parameters are analyzed for L_{10}, L_{50}, L_{90}, Leq, L_{day}, L_{night}, and L_{dn}. The statistical analysis results monitored during the study period (i.e. November, 2018) are given in Table 5.18& Figure 5.24.

Day time Noise Levels (L_{day}): The noise value (Leq) recorded inside the premises of the plant near to the administrative building was found to be around 96.0 dB(A), while those near to the residential building next to the plant was found to be 76.5dB(A). The noise at the adjoining residential block was found to be very high and much above the prescribed limit given by NEQ Guidelines of 55 dB(A) for residential areas. Even the noise level inside the plant was higher than the 70dB(A) prescribed for industrial areas. The noise level in the other residential areas about 1km from the plant was found to have normal noise level below the prescribed standards.

Night time Noise Levels (L_{night}): A similar trend was found during the night-time also. The night time noise levels (L_{eq}) ranged between 65.4dB(A) to 90.5dB(A) near the plant. Again, the levels near the plant was higher than the prescribed standards of 70dB(A). The noise level in other locations further from the plant had noise levels within stipulated norms.

Table 5-19: Noise Levels [dB(A)] In Study Area

Location	Distance*	Direction*	Day			Night		
			L_{Max}	L_{Min}	L_{eq}	L_{Max}	L_{Min}	L_{eq}
N1	-	-	98.4	91.1	96.0	93.3	88.2	90.5
N2	100m	NE	79.0	72.7	76.5	68.2	60.2	65.4
N3	1.1km	S	55.8	50.9	53.4	49.8	40.1	43.5
N4	1.0km	SW	58.5	51.9	55.4	52.3	47.4	50.0
Noise Level Set in NEQG								
Receptor			**Daytime (7:00-22:00)**			**Nighttime (22:00-7:00)**		
Residential, institutional, educational			55			45		
Industrial, commercial			70			70		

*- Distance & direction are in respect of the center of the existing power plant and on the basis of aerial distance
Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

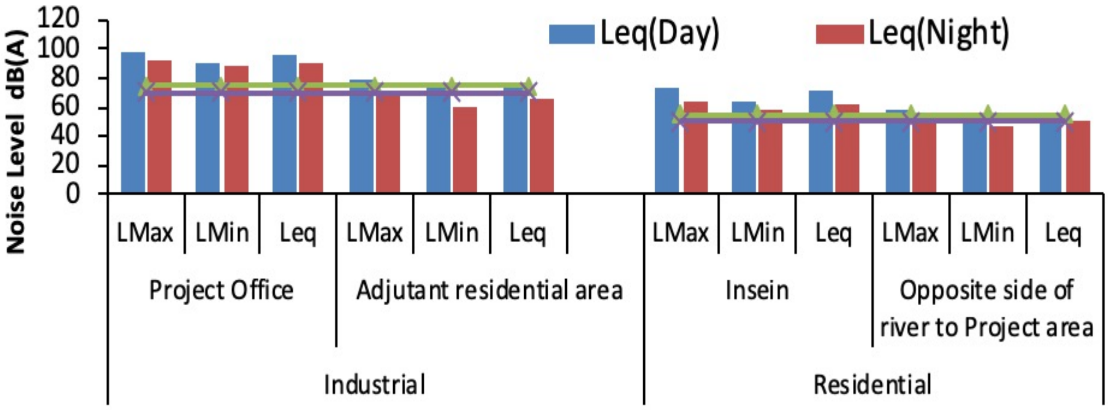


Figure 5-27: Noise levels in the Day and Night time

Thus, it can be concluded that the major concern is the high noise level at the residential area adjacent to the plant, where the sound pressure level was found to be high for 24-hour exposure. Thus, during selection of machines and designing for the new plant, attention has to be given to means of reduction of the noise level outside the plant boundary.

5.6.4 Traffic Volume

Traffic studies have been conducted to know the prevailing traffic volumes on major roads in the study area. This study was conducted to find out the feasibility of transportation of machineries from the port to the plant. Thus all locations chosen were on the route from the port to the plant.

The variations of traffic densities depend upon the working days and time as there would be variations in day and night times. In order to assess the prevailing traffic volumes on the roads, the survey was conducted during normal working days of the week by avoiding local holidays or abnormal situations to reflect the true picture of the traffic densities.

The survey items for traffic volume survey are number of vehicles, types of vehicles, and direction of vehicle movement when vehicles pass through the survey point. Survey locations were identified along the route from port to the plant as well as in front of the plant. The details of the location are given in **Table 5.20** and depicted in **Figure 5.28**.

Table 5-20: Traffic Survey Locations

Sl No	Area	Code	Coordinates
1	Strand Rd, Near Port, Opposite to AYA bank	T1	16^{0}46'57.67" N; 96^{0}07'38.14" E
2	BayintNaung Rd, Near BayintNaung Bridge	T2	16^{0}52'36.30" N; 96^{0}06'03.38" E
3	BayintNaung Rd, Near Ywama power plant	T3	16^{0}53'50.10" N; 96^{0}05'42.24" E

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

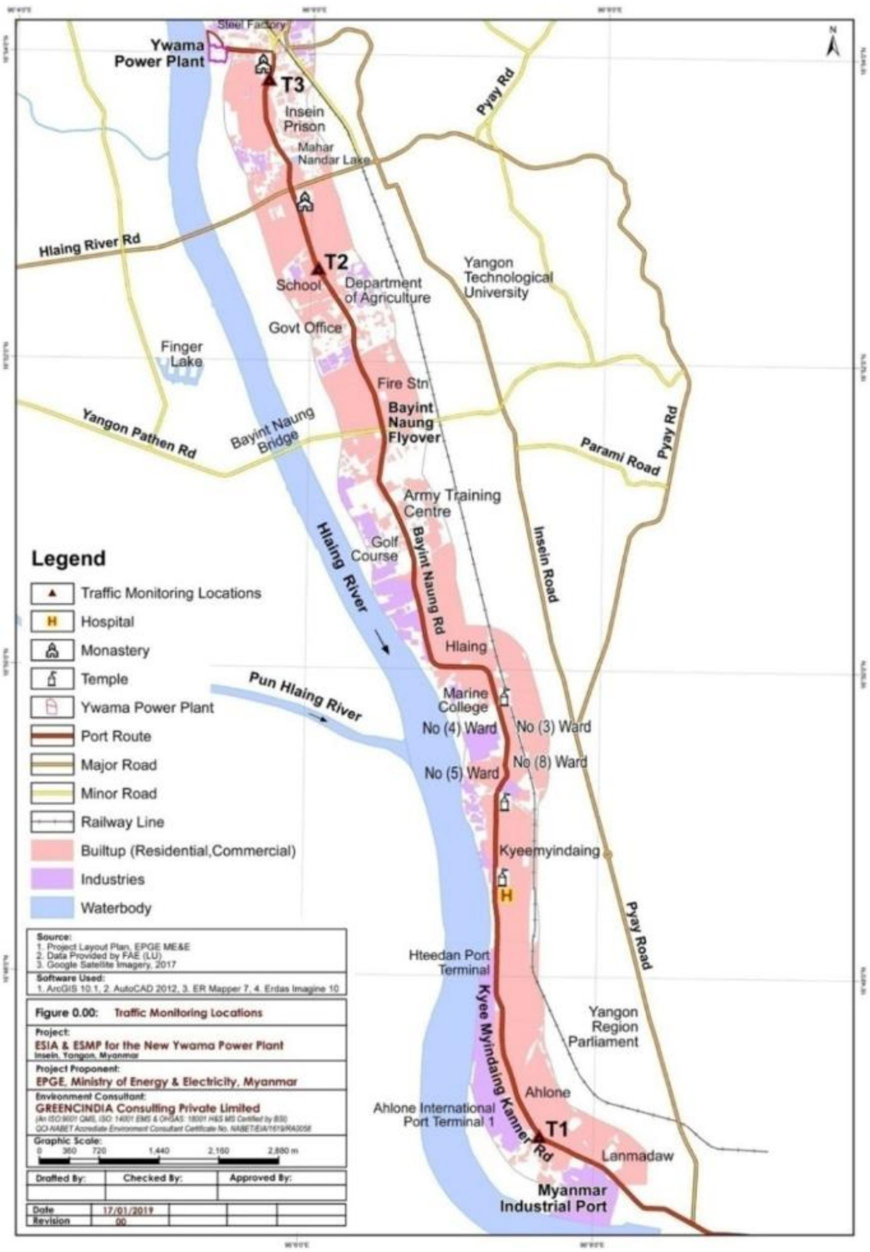


Figure 5-28: **Traffic Volume Count Locations in Study Area**

The 24-hour vehicle traffic survey was conducted for a day. Manual direct observation and recording using tally counters were conducted to count the number of vehicles moving in each direction (e.g., from plant to Port and back). Type of vehicles was also recorded concurrently. All vehicles were classified into four types as detailed in **Table 5.21**. Hourly quantities of each type of vehicle recorded by the tally counters were summarized (**Figure 5.29**).

Table 5-21: **Classification of Vehicles**

Sl. No.	Classification	Description
1	2-wheeler	Motorbike, Motorbike with side-car
2	Cars	Hatchbacks, Sedans, SUVs
3	Vans	Goods vans, passenger vans (below 2 tons)
4	Heavy vehicles	Mini-buses, large buses, two axle trucks

Sl. No.	Classification	Description
5	Multi axle Vehicles	Multi axle trucks and trailers

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

Figure 5-29: Traffic Volume Survey in Study Area

As can be seen from **Table 5.22**, the classified traffic volume count shows that there is heavy traffic in T1 as compared to the other two locations. It was found that there is more volume of heavy goods vehicles near the plant site than the down-town area. It was also observed that there is a major increase in the heavy goods vehicle during night and also simultaneous decrease in light vehicle volume. Overall it can be concluded that the road has enough capacity for movement of over-sized vehicles required for transportation of plant machineries.

Table 5-22: Classified Traffic Volume Count in Study Area

Code	Location	Direction	Car	Van	Two-axle Heavy	Multi-Axle Truck	2-wheeler
T1	Strand Rd, Near Port, Opposite to AYA bank	Towards Port	11,880	2,750	5,904	321	0
		Towards Plant	12,996	864	6,744	416	0
Total			**24,876**	**3,614**	**12,648**	**737**	**0**
T2	BayintNaung Rd, Near BayintNaung Bridge	Towards Port	6,490	672	2,644	576	0
		Towards Plant	7,408	1,632	3,744	1,296	0
		Total	**13,898**	**2,304**	**6,388**	**1,872**	**0**
T3	BayintNaung Rd, Near Ywama Power Plant	Towards Port	2,160	1,008	2,712	1,536	1225
		Towards Plant	3,708	1,435	2,376	1,823	812
		Total	**5,868**	**2,443**	**5,088**	**3,359**	**2,037**

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

5.6.5 Water Quality

Selected water quality parameters of surface and ground water resources within 5 km radius of the study area has been studied for assessing the water environment and evaluate anticipated impact of the project. Understanding the water quality is essential in preparation of environmental impact assessment and to identify critical issues with a view to suggest appropriate mitigation measures for implementation. The purpose of this study is to:

- Assess the water quality characteristics for critical parameters;
- Evaluate the impacts on agricultural productivity, habitat conditions, recreational resources and aesthetics in the vicinity; and
- Predict impact on water quality by this project and related activities.

The information required has been collected through primary surveys and secondary sources.

Ground-water data will be collected in three locations, viz at plant site and two at nearest residential area. The samples will be analyzed by a laboratory for a wide range of parameters including major ions, metals, physical parameters and cyanide. Field parameters such as temperature and pH will also be measured. Groundwater modeling will be undertaken to understand the flow directions within the geologic formations and assess potential impacts from project activities.

Surface water monitoring will be done at three location which will include upstream and down-stream of the Hliang River from the plant. The process will include laboratory analysis for various parameters including nutrients, major ions and total dissolved solids and will include parameters field measurements such as temperature and dissolved oxygen.

- **Physico-chemical Parameters -** pH, odour, colour, temperature, and conductivity, TDS, alkalinity, hardness and turbidity, COD, Na^+, K^+, NO_3^-, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Phenolic compounds, Cyanide, Aluminum, Arsenic, Cadmium, Chromium, Iron, Copper, Lead, Manganese, Zinc and Mercury etc.
- **Biological Parameters -** DO, BOD and Total Coliform

5.6.5.1 Method and Water Collection Techniques

Water samples were taken horizontal water sampler and collected in sterilized sample containers. Sampling was conducted strictly in accordance with recognized standard procedures. The parameters such as pH, temperature, dissolved oxygen ("DO"), and electrical conductivity ("EC"), were measured at each site concurrently with the sample collection. All samples were kept in iced boxes and transported to laboratories and stored at 2-4°C. Detailed description of field equipment and containers used for water sampling and preservation method are described in **Table 5.23**.

Table 5-23: Techniques for Data Collection-Water

Sl. No.	Parameter	Test Method
1	pH Value	IS: 3025 (Pt 11) 1983 RA 2017
2	Color	IS: 3025 (Pt 4) 1983 RA 2017
3	Conductivity	IS: 3025 (Pt 14) 1983 RA 2017
4	Turbidity	IS: 3025 (Pt 10) 1984 RA 2017
5	Total Dissolve solids	IS: 3025 (Pt 16) 1984 RA 2017
6	Total alkalinity as $CaCO_3$	IS: 3025 (Pt 23) 1986 RA 2014
7	Total Hardness (as $CaCO_3$)	IS: 3025 (Pt 21) 2009 RA 2014
8	Calcium (as Ca)	IS: 3025 (Pt 40) 1991 RA 2014
9	Magnesium (as Mg++)	APHA 23rd edition, 3500 Mg B

Sl. No.	Parameter	Test Method
10	Chloride (as Cl)	IS: 3025 (Pt 32) 1988 RA 2014
11	Fluoride (as F)	APHA 23rd edition, 4500F (D)
12	Sulphate (as SO_4)	IS: 3025 (Pt 24) 1986 RA 2014
13	Iron (as Fe)	APHA 23rd edition, 3111
14	Copper (as Cu)	APHA 23rd edition, 3111
15	Nitrate (as NO_3)	IS: 3025 (Pt 34) 1988 R 2014
16	Manganese (as Mn)	APHA 23rd edition, 3111
17	Phenolic compound (as C_6H_5OH)	IS: 3025 (Pt 45)
18	Sodium (as Na)	IS: 3025 (Pt 45)
19	Potassium (as K)	IS: 3025 (Pt 45)
20	Total nitrogen (as N)	IS: 3025 (Pt 34) 1988 R 2014
21	Ammonia (as N)	IS: 3025 (Pt 34) 1988 R 2014
22	Zinc (as Zn)	APHA 23rd edition, 3111
23	Cadmium (as Cd)	APHA 23rd edition, 3111
24	Cyanide (as CN)	IS: 3025 (Pt 27) 1986 R 2014
25	Lead (as Pb)	APHA 23rd edition, 3111
26	Mercury (as Hg)	APHA 23rd edition, 3111
27	Arsenic (as As)	APHA 23rd edition, 3111
28	Total Chromium (as Cr)	APHA 23rd edition, 3111
29	Oil & Grease	IS: 3025 (Pt 39)
30	Dissolve Oxygen	APHA 23rd edition, 4500 - O
31	BOD (at 27°C for 3 days)	IS: 3025 (Pt 44) 1993 R 2014
32	Chemical Oxygen Demand	IS: 3025 (Pt 58) 2006 R 2017
33	Total coliform	IS: 1622-2003 R 2009

5.6.5.2 Selection of Sampling Locations

The sampling was taken for surface water quality from major surface water bodies and underground water samples were taken from the hand-pumps of the adjoining settlements. A total of 10 samples were taken (3 for ground water, 1 for waste water & 6 for surface water). Surface water sample was collected from project site, upstream and downstream at both high and low tide. The water quality sampling locations are described in **Table 5.24**and depicted in **Figure 5.30**.**Figure 5.31** shows sample collection done by the project team.

Table 5-24: Water Sampling Locations in Study Area

Code	Name of Location	Source	Distance*	Direction*
SW1	Hliang River at Project Site (low tide)	River	-	-
SW1a	Hliang River at Project Site (high tide)	River	-	-
SW2	Hliang River Upstream (low tide)	River	4.5 km	NW
SW2a	Hliang River Upstream (high tide)	River		
SW3	Hliang River Downstream (low tide)	River	2.1 km	S
SW3a	Hliang River Downstream (high tide)	River		
GW1	Project Site	Bore well	-	-
GW2	Adjutant Residential Area	Hand pump	0.4 km	SE
GW3	Insein	Hand pump	2.5 km	SE

*- Distance & direction are in respect of nearest project site and on the basis of aerial distance

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

- **SW-1:** SW-1 is located on Hliang River at Project Site. The water sample was collected during the low tide. The River flows from northeast to southwest and joins the Yangon River at its end. The surrounding area of the sampling point is flat and industrial and residential area. The width of the river is about 460m.
- **SW-1a:** SW-1a is located as same site as SW-1 on Hliang River at Project Site. The water sample was collected during the high tide.
- **SW-2:** SW-2 is located on upstream of Hliang River form Project Site. This site located upstream of the river at the north-east end of the industrial zone. The water sample was collected during the low tide. The River flows from northeast to southwest and joins the Yangon River at its end. The surrounding area of the sampling point is flat and industrial and residential area. The width of the river is about 591m.
- **SW-2a:** SW-2a is located as same site as SW-2 on Hliang River at Project Site. The water sample was collected during the high tide.
- **SW-3:** SW-3 is located on downstream of Hliang River form Project Site. This site located downstream of the river at the south-west end part of the industrial zone. The water sample was collected during the low tide. The River flows from northeast to southwest and joins the Yangon River at its end. The surrounding area of the sampling point is flat and industrial and residential area. The width of the river is about 440m.
- **SW-3a:** SW-3a is located as same site as SW-3 on Hliang River at Project Site. The water sample was collected during the high tide.
- **GW-1:** Sample was taken from one bore well located in project site. The water sample is highly transparent.
- **GW-2:** Sample was taken from one tube well located in adjutant residential area. The depth of the tube well is about 30m. Water from the well is utilized for washing, cooking, and planting. The water sample is highly transparent.
- **GW-3:** Sample was taken from one tube well located in Insein Township. The depth of the tube well is about 50m. Water from the well is utilized for washing, cooking, and planting. The water sample is highly transparent.

Currently, there is no ambient water quality standard in Myanmar. In consideration of the above situation, the target value ofthe water quality for the Project is set in reference of the ambient quality standards in South-east Asia (e.g. Indonesia, Thailand and Vietnam) and Japan as shown in **Table 5-25**. For analysis, standards of Thailand have been taken.

Table 5-25: Ground Water Quality Standard of World Health Organization (WHO)

Sl. No.	Characteristics	Highest desirable	Maximum permissible	Unit
1	Turbidity (J.T.U)	5.0	25.0	NTU
2	Colour (Pt-scale)	5.0	50.0	
3	Taste and Odour	nothing	disagreeable	
4	pH	7.0 - 8.5	6.5-9.2	
5	Total solids	500	1500	mg/l
6	Total hardness	100	500	mg/l
7	Chlorides	200	600	mg/l
8	Sulphates (as SO_4)	200	400	mg/l
9	Fluorides (as F)	1.0	1.5	
10	Nitrates (as NO_3)	45	45	
11	Calcium (as Ca)	75	200	mg/l

12	Magnesium	30	150	mg/l
13	Iron (as Fe)	0.1	1.0	mg/l
14	Manganese (as Mn)	0.05	0.5	mg/l
15	Copper	0.05	1.0	mg/l
16	Zinc	5.0	15.0	mg/l
17	Arsenic	0.05	0.05	
18	Chromium (as Cr^{+6})	-	0.01	
19	Lead	-	0.10	
20	Mercury	-	0.001	mg/l

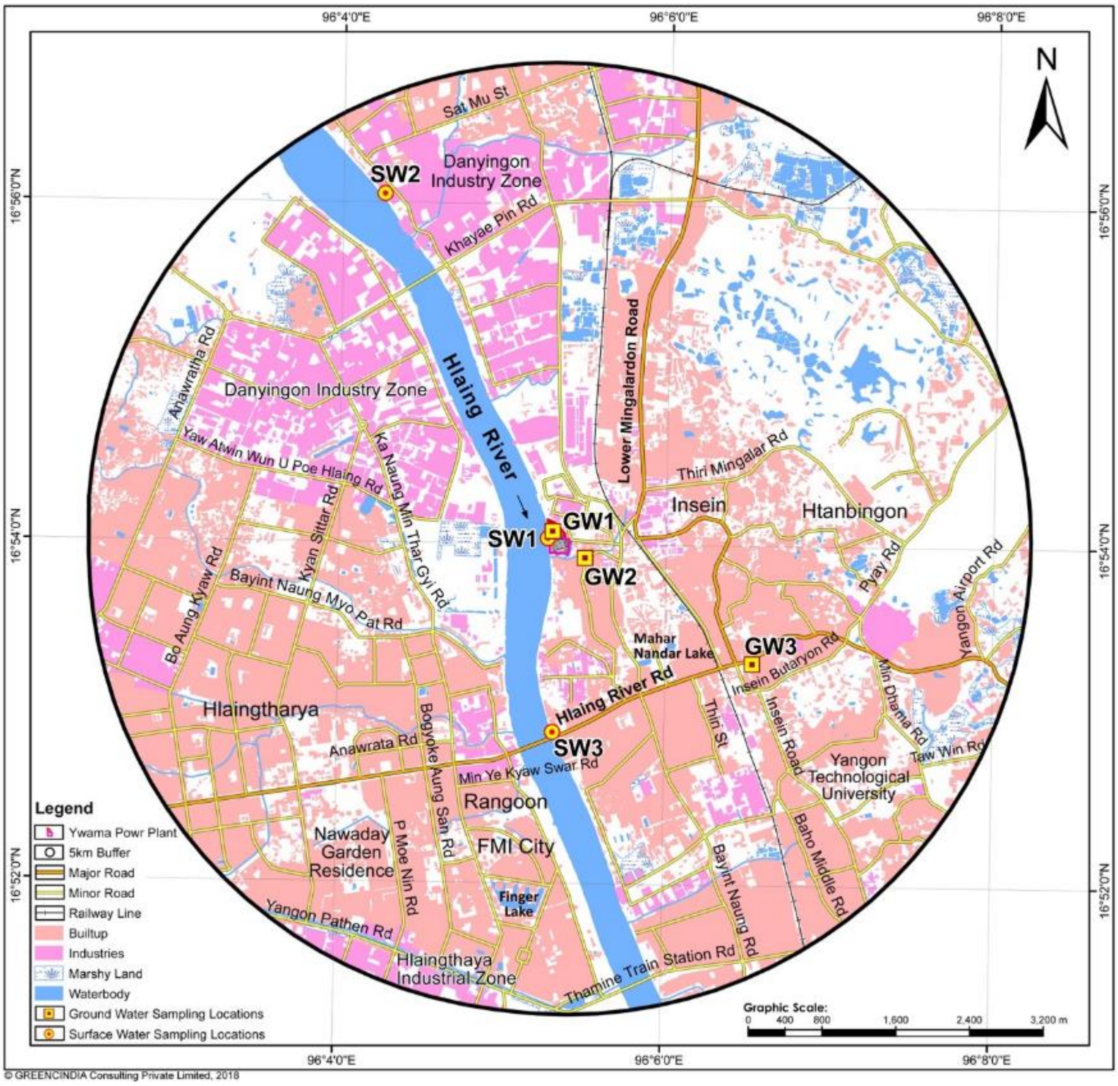


Figure 5-30: Water Sampling Locations in Study Area


Figure 5-31: Water Sample Collection in Study Area

5.6.5.3 Surface Water Quality

Primary Data: The analysis results indicate that pH is found to be 6.5 to 6.8, which is well within the specified standard 6.5-8.5. pH values shows within the environmental standard (5.5-9.0). Since there is no official standard for surface water quality in Myanmar and the Reference did not cover quantitative target levels for surface water in its scope, the reference standards for surface water quality related parameters, which the Project proponent surveyed, were taken from countries of the Association of Southeast Asian Nations (ASEAN) countries near Myanmar such as Vietnam and Thailand. The TDS was observed at 986 to 1012mg/l. It is found that water quality of Hlaing River deteriorates due to the pollution from the tributary streams which received waste-water from adjacent industrial zones and new satellite town. The range of Iron value in water samples was observer 0.18-0.33 mg/l which is within the limits of Vietnam surface water quality standard 1.5 mg/l. Dissolved oxygen (DO) was observed to be 5.7 to 7.4mg/l. Environmental standard of DO for the both Vietnam and Thailand is>4 mg/l. Surface water sample from Hliang River upstream and downstream shows higher than the standard which supports the healthy environmental condition for aquatic faunal community. Environmental standard concentrations of Biological Oxygen Demand (BOD) are 15 mg/l and 2 mg/l of Vietnam and Thailand respectively. Surface water sample from Hliang River ranged between 1.8-2.4 mg/l. It shows BOD of this river remains within the limits in respect to Vietnam environmental standard but in SW2 (2.4 mg/l) and SW2a (2.2 mg/l) sites have higher concentration than Thailand environmental standard. Chemical Oxygen Demand (COD) concentration observed between 14-20 mg/l shows within the limits of Vietnam standard (30 mg/l).The chlorides and sulphates were found to be 402 to 436mg/l and 22 to 31mg/l respectively. Bacteriological studies reveal total coil form 5 MPN/100ml (Table 5.26).

Table 5-26: Surface Water Quality in Study Area

Parameters, Units	Sampling Sites						Environmental Standard	
	SW1	SW1a	SW2	SW2a	SW3	SW3a	Vietnam	Thailand
pH Value	6.67	6.71	6.84	6.89	6.37	6.58	5.5-9.0	5.5-9.0
Color, hazen	<5	<5	<5	<5	<5	<5	-	-
Conductivity, µS/cm	1627	1635	1637	1641	1605	1625	-	-
Turbidity, NTU	3	5	7	8	4	6	-	-
Total Dissolve solids, mg/l	995	1001	1006	1012	986	998	-	-

Parameters, Units	Sampling Sites						Environmental Standard	
	SW1	SW1a	SW2	SW2a	SW3	SW3a	Vietnam	Thailand
Total alkalinity, mg/l	152	159	161	167	145	154	-	-
Total Hardness, mg/l	396	407	407	413	381	397	-	-
Calcium (as Ca), mg/l	70	74	75	78	67	71	-	-
Magnesium (as Mg++), mg/l	53	57	58	61	49	53	-	-
Chloride (as Cl) , mg/l	428	432	436	402	417	424	-	-
Fluoride (as F), mg/l	0.8	1.03	1.2	1.3	0.6	0.7	-	-
Sulphate (as SO_4), mg/l	26	27	29	31	22	25	-	-
Iron (as Fe), mg/l	0.22	0.25	0.31	0.33	0.18	0.2	1.5	-
Copper (as Cu), mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.5	0.1
Nitrate (as NO_3), mg/l	0.11	0.14	0.15	0.17	0.1	0.12	10	5
Manganese (as Mn), mg/l	10.6	11.1	11.4	11.9	10.3	11.2	-	1.0
Phenolic compound, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-
Sodium (as Na), mg/l	167	171	173	176	155	163	-	-
Potassium (as K), mg/l	18	29	22	25	17	19	-	-
Total nitrogen (as N), mg/l	2.4	2.7	2.8	2.9	2.1	2.4	-	-
Ammonia (as N), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	0.5
Zinc (as Zn),mg/l	0.13	0.16	0.15	0.18	0.12	0.14	1.5	1.0
Cadmium (as Cd), mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.001	0.005
Cyanide (as CN), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.02	-
Lead (as Pb), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.05
Mercury (as Hg), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002
Arsenic (as As), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Total Chromium (as Cr), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.04 (Cr(VI))	0.05 (Cr(VI))
Oil & Grease, mg/l	<1	<1	<1	<1	<1	<1	0.1	-
Dissolve Oxygen, mg/l	6.9	7.3	5.7	6.2	7.1	7.4	>4	>4
BOD, mg/l	2	1.8	2.4	2.2	1.9	1.6	15	2.0
COD, mg/l	16	19	17	20	14	15	30	-
Total coliform, MPN/100ml	<2	<2	<2	<2	<2	<2	7.5×10^3	2.0×10^4

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad
Surface Water Quality Standard (QCVN 08:2008/BTNMT), Vietnam B1: Standard for Irrigation Purpose
Surface Water Standards 2009 Thailand Class 3: Standard for Agriculture Purpose
EIA Report for the Thilawa SEZ Zone A Development Project

BOD, COD and DO: DO is the oxygen present in a dissolved form in water. Under equilibrium conditions there is a relationship between the amount of dissolved oxygen and the partial pressure of oxygen in the atmosphere. Oxygen is one of the principal limiting factors in aquatic respiration and metabolic reactions and as such, it is a significant water quality constituent that may limit production under aquaculture conditions. Low DO concentrations indicate eutrophication and biological overloading in aquaculture systems. Biochemical Oxygen Demand (BOD) is concerned with the amount of oxygen consumed by microorganisms to decompose the organic matters under aerobic conditions while Chemical Oxygen Demand (COD) relates the oxygen requirement to oxidize all organic materials both biologically available and inert organic matter into carbon dioxide and water. Usually, there is a hydrological relation between DO, BOD and COD which can affect the total amount of organic (TOC) and inorganic carbon (IC) in an ecosystem

Secondary Data: The secondary data observation of Hlaing River shows the pH value varies between 6.83 and 7.82. At present condition the value of pH varies within 6.37 to 6.84. In both conditions the water pH value meets the aquaculture conditions. It shows that the dissolved oxygen concentrations (5.6-7.6mg/l) have some lower value in dry season for upstream and downstream conditions. The dissolved oxygen concentrations also do not shows any crucial alteration for present condition (5.7-7.3mg/l). According to secondary date observation Biological oxygen demand in Hlaing River is varied between 1.68 to 4.2mg/l. The COD value in past conditions shows some higher value**(Table 5.27).**

Table 5-27: Surface Water Quality in Study Area (Secondary data)

Sl. No.	Sample Site	Temp ºC		pH		DO mg/l		BOD mg/l		COD mg/l	
		Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
1	Hlaing River upstream	28	25	6.83	7.72	7.3	6.2	2.4	1.68	45	32
2	HlaingRiverdownstream	27	25	6.9	7.82	7.6	5.6	4.2	2.28	64	48

Source: Ph.D thesis Investigation on the effect of waste water disposal on aquatic environment of Haling TharyarIndustrial zone"

5.6.5.4 Ground Water Quality

As mentioned above, ground water samples were collected from 3 locations and the sources were bore wells. The physical and chemical analysis of the water samples collected is given in **Table 5.28**.

Table 5-28: Ground Water Quality in Study Area

Parameters	Units	GW1	GW2	GW3	National Standards	
					Highest desirable	Maximum permissible
pH Value	_	8.17	8.31	8.22	7.0 - 8.5	6.5-9.2
Color	hazen	<5	<5	<5	5.0	50.0
Conductivity	µS/cm	254	262	257	-	-
Turbidity	NTU	32	35	34	5.0	25.0
Total Dissolve solids	mg/l	153	166	159	500	1500
Total alkalinity as $CaCO_3$	mg/l	84	91	87		
Total Hardness (as $CaCO_3$)	mg/l	96	106	98	100	500
Calcium (as Ca)	mg/l	22	26	21	75	200
Magnesium (as Mg++)	mg/l	9.8	10.7	10.1	30	150
Chloride (as Cl)	mg/l	28	31	30	200	600
Fluoride (as F)	mg/l	0.6	0.7	0.9	1.0	1.5
Sulphate(as SO_4)	mg/l	9	11	9.9	200	400
Iron (as Fe)	mg/l	5.4	5.8	5.6	0.1	1.0

Parameters	Units	GW1	GW2	GW3	National Standards	
					Highest desirable	Maximum permissible
Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	0.05	1.0
Nitrate (as NO_3)	mg/l	0.11	0.13	0.11	45	45
Manganese (as Mn)	mg/l	3.4	3.8	3.6	0.05	0.5
Phenolic compound (as C_6H_5OH)	mg/l	<0.001	<0.001	<0.001	-	-
Sodium (as Na)	mg/l	16	18	15	-	-
Potassium (as K)	mg/l	1.5	1.7	1.4	-	-
Total nitrogen (as N)	mg/l	0.9	1.1	1.02		
Ammonia (as N)	mg/l	<0.05	<0.05	<0.05		
Zinc (as Zn)	mg/l	0.05	0.03	0.06	5.0	15.0
Cadmium (as Cd)	mg/l	<0.003	<0.003	<0.003	-	-
Cynide (as CN)	mg/l	<0.05	<0.05	<0.05	-	-
Lead (as Pb)	mg/l	<0.01	<0.01	<0.01	-	0.10
Mercury (as Hg)	mg/l	<0.001	<0.001	<0.001	-	0.001
Arsenic (as As)	mg/l	<0.01	<0.01	<0.01	0.05	0.05
Total Chromium (as Cr)	mg/l	<0.05	<0.05	<0.05	-	0.01
Oil & Grease	mg/l	<1	<1	<1	-	-

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

pH: This parameter generally indicates the acid or alkaline nature of any solution and usually does not bear any direct impact on consumers. The pH value of all the samples does not exceed the maximum permissible limit (6.5-8.5) and were found to be ranging from 8.17 to 8.31.

Alkalinity: Alkaline nature of the samples is generally attributed to the presence of carbonates and bi-carbonates. Though alkalinity if not harmful to human health, its presence in the water imparts unpleasant taste. Alkalinity of water is due to the presence of bicarbonate, carbonate and strong bases. The maximum alkalinity value was found to be 91 mg/l and the minimum alkalinity of 84 mg/l.

Total Dissolved Solids: Minimum TDS value of 153 mg/l and maximum value of 166 mg/l was encountered. The values of TDS remain within the highest desirable limits 500 mg/l.

Chlorides: The chloride value (28-31 mg/l) of all the samples confirmed the desirable limit of 250 mg/l. Chloride in Groundwater gains its entry from various sources such as agricultural activities, industrial activities, geological formation, domestic water contamination and seawater intrusion in the study area. The observations show that the chloride value limits within the highest desirable limits 200 mg/l.

Sulphate: Sulphate content in the ground water sample ranges from 9-11 mg/l. Sulphate is a naturally occurring element found in groundwater. All the samples were found below the highest desirable limits 200 mg/l.

Fluoride: Fluoride content (0. 6 - 0.9 mg/l) is found within desirable limit (1.0 - 1.5 mg/l).

Zinc: Zinc content (0.03-0.06 mg/l) in the water samples were found to be within the desirable limit (i.e. 5 mg/l).

Iron: Iron content in all sampling locations was found to be higher than the desired permissible limit maximum permissible limit (1.5 mg/l).

Other Parameters: Other parameters like heavy metals were found below detection level

5.6.6 Soil Type & Characteristics

It is essential to determine the potentials of soil in the area to identify the current status of soil quality and also to predict the impacts that may arise due to the project. Accordingly, a study for assessment of the baseline soil quality has been carried out in the region. The soil quality of the study area has been assessed by collecting samples from 3 different locations. Details of soil sampling locations are presented in **Table 5.29** and shown in **Figure 5.32**.

Table 5-29: **Methodology for Sample Collection & Analysis**

Sl. No.	Code	Location	Distance	Direction
1	S1	Project Site	-	-
2	S2	Lay down area	0.23 km	SE
3	S3	Opposite side of river to Project area	0.8 km	W

*- Distance & direction are in respect of nearest project site and on the basis of aerial distance

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

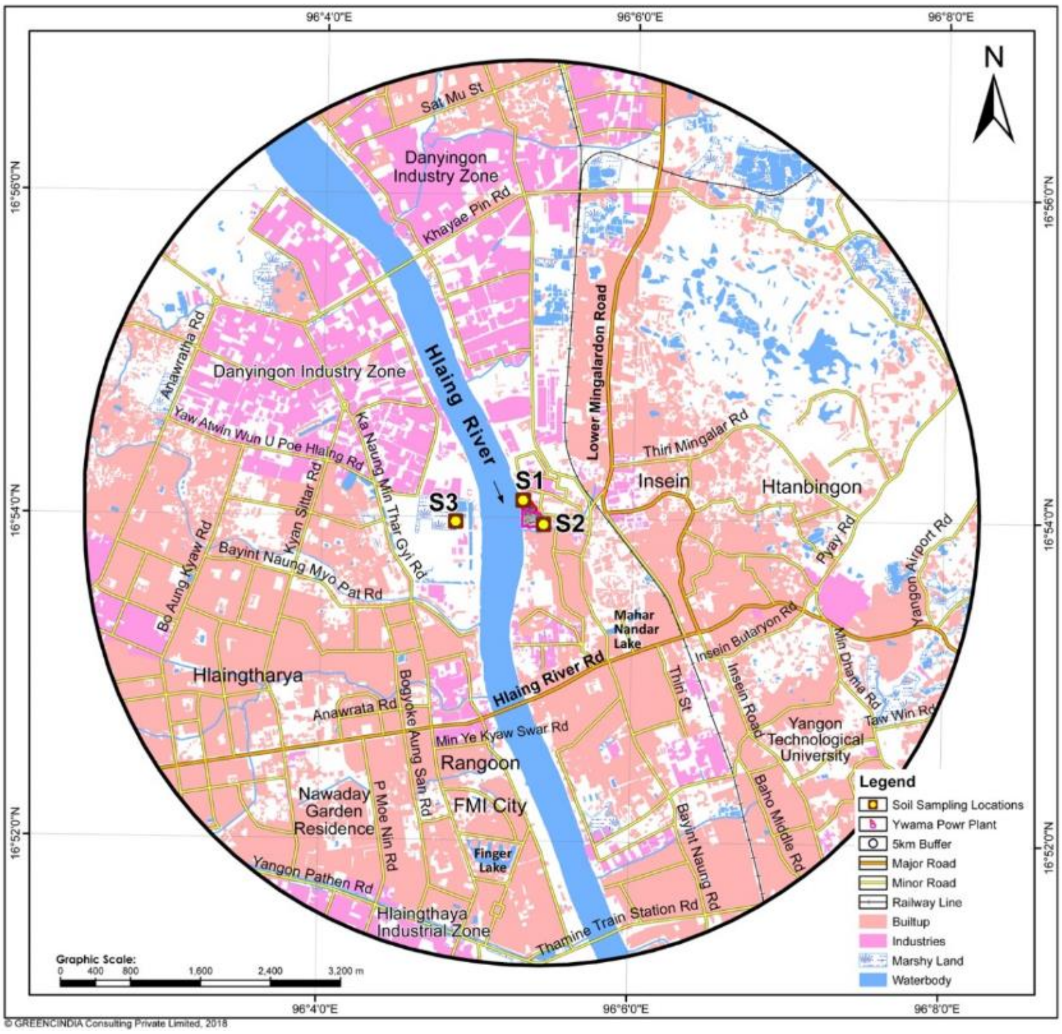


Figure 5-32: Soil Sampling Locations in Study Area

5.6.6.1 Methodology

The physical parameter and chemical parameter will be determined. The soil samples were collected by random grid method of 10m x 10m grid by ramming a core-cutter into the soil up to a depth of 90cm. Composite samples has been collected from each grid, by mixing of 3 sub-samples and reducing the weight to approximately 500gm by conning and quartering method. The samples will be packed in polyethylene bags and assigned a number. The collected samples were air dried at room temperature in the laboratory and lightly crushed with mortar-pastle and passed through 2 mm sieve. The soil samples will be analyzed for the physico-chemical properties by standard procedure as presented in **Table 5.30 and Figure 5.33**.

Table 5-30: Analytical Technique for Soil Sample

Sl. No.	Parameters	Analytical Method
1	Colour	-
2	Texture	Soil chemical analysis by M.L. Jackson
3	Sand >0.2 mm Dia	Soil chemical analysis by M.L. Jackson
4	Silt , 0.02 to 0.2 mm Dia	

Sl. No.	Parameters	Analytical Method
5	Clay <0.0002 mm Dia	
6	pH (at 25 C)(1:2 suspension)	IS 2720 Part -26: 1987 (RA 2016)
7	Elec. Conductivity (at 25°C)(1:2.5 suspension)	IS 14767 : 2000 (RA 2016)
8	Moisture	IS 2720 Part -2: 1987 (RA 2016)
9	Infiltration rate	Soil chemical analysis by M.L. Jackson
10	Bulk Density	Soil chemical analysis by M.L. Jackson
11	Porosity	Soil chemical analysis by M.L. Jackson
12	Organic Carbon	IS 2720 Part -26: 1972 (RA 2015)
13	Organic matter	IS 2720 Part -26: 1972 (RA 2015)
14	Cadmium	IS 2720 Part -24: 1976 (R 2015)
15	Total chromium	Soil chemical analysis by M.L. Jackson
16	Lead	Soil chemical analysis by M.L. Jackson
17	Manganese	Soil chemical analysis by M.L. Jackson
18	Mercury	Soil chemical analysis by M.L. Jackson
19	Nitrogen as N	Soil chemical analysis by M.L. Jackson
20	Phosphorous	Soil chemical analysis by M.L. Jackson
21	Potassium as K	Soil chemical analysis by M.L. Jackson

Assessment of soil quality is an important aspect with reference to tree plantations, percolation of water, ground water impact etc. The soil quality of the study area has been assessed by collecting samples from 3 different locations.

Random soil samples were collected by Auger up to depth of 15cm and homogenized samples were then sent to the laboratory for analysis. The physical and chemical characteristics of the soil of the study area have been assessed by analyzing various parameters as per the methods described in "Soil Chemical Analysis" (M.L. Jackson, 1967).

Figure 5-33: Soil Sampling Location in Study Area

The soil quality as analyzed from the collected samples is given in **Table 5.31**.

Table 5-31: Soil Characteristics of the Study Area

Sl. No.	Parameters, Units	S1	S2	S3	Vietnam	Thailand
1	Colour	Black	Black	Black	-	-

Sl. No.	Parameters, Units	S1	S2	S3	Vietnam	Thailand
2	Texture	Sandy Clay loam	Sandy Clay loam	Sandy Clay loam	-	-
3	Sand >0.2 mm Dia, %	55.2	56.8	58.6	-	-
4	Silt , 0.02 to 0.2 mm Dia , %	23.4	21.1	21.1	-	-
6	Clay <0.0002 mm Dia, %	21.4	22.1	21.3	-	-
7	pH (at 25°C) (1:2 suspension	7.71	7.38	7.54	-	-
8	Elec. Conductivity (at 25°C) (1:2.5 suspension), µS/ cm	212	204	213	-	-
9	Moisture, %	53	48	51	-	-
10	Infiltration rate, Inch/hours	0.45	0.41	0.47	-	-
11	Bulk Density,gm/ cc	1.25	1.09	1.16	-	-
12	Porosity, %	30.8	31.5	33.2	-	-
13	Organic Carbon, %	1.52	0.98	1.03	-	-
14	Organic matter, %	2.62	1.68	1.74	-	-
15	Cadmium, mg/ Kg	<0.2	<0.2	<0.2	2	37
16	Total chromium, mg/ Kg	<0.2	<0.2	<0.2	200	-
17	Lead, mg/ Kg	10.7	11.4	12.7	70	400
18	Manganese, mg/ Kg	106	51	62	-	1800
19	Mercury, mg/ Kg	<0.1	<0.1	<0.1	-	23
20	Nitrogen as N, Kg/ ha	204	194	198	-	-
21	Phosphorous, Kg/ ha	13.1	12.4	13.8	-	-
22	Potassium as K, Kg/ ha	156	156	172	-	-

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

Soil Quality Standard for Other Purposes, 2004, Thailand

Regulation for Implementing the Law on Soil Contamination Countermeasures” QCVN 03:2008/BTNMT, Vietnam. It is applied as “farm land”.

5.6.6.2 PhysicalCharacteristics

Grain Size Distribution: Texture indicates relative proportion of various sizes of primary soil particles such as sand, silt and clay present in the soil. Based on their quantities present in the soil sample and using the textural classification diagram. The textural classes of 3 soil samples are sandy clay loam (mod fine texture).

Bulk Density: In case of bulk density total soil space (space occupied by solid and pore spaces combined) are taken in to consideration. Thus, bulk density is defined as the mass (weight) of a unit volume of a dry soil. This volume would, off course include both solids and pores. Soil texture, soil structure and organic matter content are the factors influencing the bulk density of a soil. Bulk density, besides being an interesting and significant physical characteristic, is very important as a basis for certain computations.

The Bulk density of the three-soil sample under consideration ranges between 1.09 to 1.25 gm/cc, and confirms the finer texture of the soils of the area under study.

Porosity: The pore space of a soil is the space occupied by air and water and is expressed as percent pore space. The amount of this pore space is determined by structural conditions, that is by inter- related influence of texture, compactness and aggregation. Porosity is also related to aeration and retention and movement of water in the soil. The porosity of three soil samples was inferred from textural analysis and is moderate in accordance to the texture of soil, and considered good for air and water movement in the soil for crops..

5.6.6.3 Chemical Characteristics

Soil Reaction (pH): The nutritional importance of pH is illustrated, thus hydrogen ion concentration has influence not only on, solubility of nutrients, but also upon facility with which these nutrients are absorbed by plants, even already in soil solution for e.g. Fe, Mn and Zn become less available as pH rises from 4.5 to 7. At pH 6.5 to7.0 utilization of nitrate and ammonia nitrogen becomes more available. In case of phosphorus it becomes less available to plant as pH increases above 8.5, due to its fixation in exchange complex of soil. For the three-soil sample under consideration the pH ranges between 7.38 and 7.71 indicating soils are slight to moderately alkaline.

Electrical Conductivity (EC): The salt content of the soils is estimated by EC measurements, and is useful to designate soils as normal or sodic (saline). Electrical conductivity is expressed as μmhos/cm at 25^0C, μsmhos/ cm or mmhos /cm or sm/cm. The EC of three soil samples range between 204 to 213 μS/cm and are below the limits to be called as saline and hence the soils are normal for crop growth.

Organic Carbon / Organic Matter (%): Although accounting for only a small part of the total soil mass in mineral soils, organic matter influences physical, chemical, and biological activities in the soil. Organic matter in the soil is plant and animal residue which serves as a reserve for many essential nutrients, especially nitrogen. Determination of organic matter helps to estimate the nitrogen which will be released by bacterial activity for the next season depending on the conditions, soil aeration, pH, type of organic material, and other factors. The three soil samples under consideration contain 0.98 to 1.52% organic carbon; OM is calculated from organic carbon estimation. As per crop requirements the soils are very less to less in organic matter contentandwill require addition of organic matter, by way of compost application.

Available Nitrogen (N): Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis. Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops. The available nitrogen in the three samples in question, as per analysis ranges between 194 to 204 kg/ha showing very low to good nitrogen content for crop growth.

Available Phosphorus (P): Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis. Involved in the formation of all oils, sugars, starches, etc, helps with the transformation of solar energy into chemical energy; proper plant maturation; withstanding stress, effects rapid growth, encourages blooming and root growth. The phosphorus content of soil of three samples ranges between 12.4 to 13.8 kg/ha.

Available Potassium (K): Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium. K helps in the building of protein, photosynthesis, fruit quality and reduction of diseases. The potassium content of three soil samples ranges between 156 to 172 kg/ha.

Chromium (Cr): Chromium mobility depends on absorption characteristics of the soil, including clay content, iron oxide content, and the amount of organic matter present. Chromium can be transported by surface runoff to surface waters in its soluble or precipitated form. Soluble and un-adsorbed chromium complexes can leach from soil into groundwater. The leachability of Cr (VI) increases as soil pH increases. Most of Cr released into natural waters is particle associated, however, and is ultimately deposited into the sediment. In the three samples the chromium ranges in <0.2 mg/kg. Environmental Standard concentration of Cr as per Soil Quality Standard, 2004, Thailand is 300 mg/kg.

Lead (Pb): Typical mean Pb concentration for surface soils worldwide averages 32 mg/kg and ranges from 10 to 67 mg/kg. The most serious source of exposure to soil lead is through direct ingestion of contaminated soil or dust. In general, plants do not absorb or accumulate lead. However, in soils testing high in lead, it is possible for some lead to be taken up. Studies have shown that lead does not readily accumulate in the fruiting parts of vegetable and fruit crops (e.g., corn, beans, squash, tomatoes, strawberries, and apples). Higher concentrations are more likely to be found in leafy vegetables (e.g., lettuce) and on the surface of root crops (e.g., carrots). Since plants do not take up large quantities of soil lead, the lead levels in soil considered safe for plants will be much higher than soil lead levels where eating of soil is a concern (pica). Generally, it has been considered safe to use garden produce grown in soils with total lead levels less than 300 ppm. The risk of lead poisoning through the food chain increases as the soil lead level rises above this concentration. Even at soil levels above 300 ppm, most of the risk is from lead contaminated soil or dust deposits on the plants rather than from uptake of lead by the plant. Environmental Standard concentration of Pb as per Soil Quality Standard, 2004, Thailand is 400 mg/kg while in Vietnam it is 70 mg/kg (QCVN 03: 2008/BTNMT). In three samples the Lead ranges between 10.7 and 12.7 mg/kg.

Mercury (Hg): Absorption to soils, sediments, and humic materials is an important mechanism for the removal of Hg from solution. Absorption is pH dependent and increases as pH increases. Mercury may also be removed from solution by co-precipitation with sulphides. Under anaerobic conditions, both organic and inorganic forms of Hg may be converted to alkylated forms by microbial activity, such as by sulfur-reducing bacteria. Elemental mercury may also be formed under anaerobic conditions by demethylation of methyl mercury, or by reduction of Hg (II). Acidic conditions (pH < 4) also favor the formation of methyl mercury, whereas higher pH values favour precipitation of HgS(s). Soil Quality Standard, 2004, Thailand, shows the Hg concentration 23 mg/kg. In the three samples the mercury content is < 0.1mg/kg.

Some more detailed soil sampling at the plant site after demolition will be required in the contact for the civil work contractor.

5.7 ECOLOGICAL ENVIRONMENT

5.7.1 Habitats in the Study Area

Ecological evaluation aims at developing and applying methodologies to assess the relevance of an area for nature conservation. As such, it is to support the assessment of the impact of a proposed development by providing guidance on how to describe the ecological features within the area affected, how to value them, and how to predict the value losses caused by the development. The evaluation of the ecological significance of an area can be undertaken from different perspectives and consequently with different objectives. One of such perspectives focuses on the conservation of the biological diversity or biodiversity.

Most of the background data needs to be acquired from the governmental agencies or the scientific literature. This information is typically complemented by field visit, site surveys and sample collection. The description of the actual ecological assessment provided by the ecological baseline study serves to set a reference for the subsequent impact analysis. Moreover, it helps decision makers and EIA reviewers to become familiar with the environmental features and the needs of the study area and project site**(Figure 5.34).**

5.7.2 Methodology

The detailed study of the area was undertaken with the project site as its center. The different techniques used for the survey are given below:

- Generation of primary data by undertaking systematic ecological studies in the study area;
- Primary data collection for flora through random sampling method for trees, shrubs and herbs from the selected locations to know the vegetation cover qualitatively;
- Sourcing secondary data with respect to the study area from published literature

Figure 5-34: Tree Enumeration in Project Area

5.7.3 Terrestrial Ecology

The enumeration of trees presents within the plant site, which will be cut, was conducted. All these trees are old and is in existence since before the plant was established. The types, girth size and canopy cover of the trees were studied. Secondary data was used to understand the bio-diversity of the surrounding areas. The biological environment described includes the description of forests areas and protected areas.

5.7.3.1 Floral Diversity in Project Site

The detailed list of trees which were found in the study and cross-checked with the secondary list available at the Forest Department is given in **Table 5.32**.

Table 5-32: Floral Diversity in Project Site

SlNo	Common name	Scientific name	TrunkDiameter(ft)	Number
1	Cycas	*Cycasrevolita*	2.5	1
2	Casuarina	*Casuarinaequisetifolia*	2.1-2.7	4
3	Banyan	*Ficusbenghalensis*	5.1-27	2
4	Coconut	*Cocosnucifera*	4.3	7
5	Jack fruit	*Artocarpusheterophyllus*	3.1 -2.6	2
6	Vander	*Terminaliacatappa*	3.1	1
7	Mango	Mangiferaindica	1.1-9.7	11
			Total	**28**

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

As can be seen from the above table majority of the affected trees are mango (*Mangiferaindica)*. The other dominant species include vandar (*Terminaliacatappa*) and Jackfruit (*Artocarpusheterophyllus*). There were also clumps of banana trees in the whole area. The details survey are provided in **Annex 5.1**.

5.7.3.2 Floral Diversity in 500-m Radius

Survey was also conducted of trees present within 500m radius around the plant site. In this area also, the dominant species were Mango (*Mangiferaindica),* Vandar *(Terminaliacatappa),* Jackfruit *(Artocarpusheterophyllus)* and Coconut (*Cocosnucifera).* The details are provided in **Table 5.33**.

Table 5-33: Floral Diversity in 500m around Project Site

Sl no	Common name	Scientific name	TrunkDiameter(ft)	Number
1	Vandar	*Terminaliacatappa*	1.0-6.1	17
2	Coconut	*Cocosnucifera*	3.2-6.4	10
3	Mango	*Mangiferaindica*	1.7-6.7	40
4	Moth	*Bombaxciiba*	0.11-6	7
5	Star flower	*Trientail borealis*	2.0	1
6	Golden Rain Tree	*Cassia fistula*	1.4	1
7	Rain Tree	*Samaneasaman*	2.3	1
8	Lemon	*Citrus limon*	1.3-5.1	2
9	Jack fruit	*Artocarpusheterophyllus*	0.9-4.1	10
10	Nut	*Areca nut*	1.5	2
11	Tarmari	*Tarmarindusindica*	1-3.8	3
12	Padauk	*Pterocarpusdalbergioides*	4.1	1

Source: Greencindia Consulting Private Limited, NCR, Ghaziabad

5.7.3.3 Biodiversity in Study Area (Secondary Data)

As the project site is located in an urban area with heavy population density, the floral and faunal diversity is limited. There are some clusters of trees and planned plantations. Natural habitats are not present in the study area. There are also only domesticated animals in the area. However, there are fishes in the Hlaing River which show diversity. The secondary sources used for the ecological study is from latest EIA studies[16] of the area and lists of flora and fauna from Government Departments

In the Yangon Area, the vegetation cover consists of a mosaic of semi-evergreen, moist mixed decidous, lower mixed decidous, and swamp/mangrove forests. Common trees include *Aporosa sp., Pteropermum semiagittatum, Eugenia magacarpa, Rauvolfia ophiorrhizoides, Microcas paniculata, Markhamia stipulata* and *Casia sp., Eupatorium sp,. Miliusa roxburgghana, Connarus monocarpus* and *Jasminum sessiliflorum*. A total of 143 floral species have been identified in the greater Yangon area.

A total of 380 animal and plant species have been recorded in the Greater Yangon area during 2015. The total flora and fauna species reported in the Greater Yangon region is given in **Table 5.32**.

Table 5-34: Flora & Fauna Groups in Greater Yangon Area

Taxonomical Groups	No of Species
Mammal	8
Birds	129
Reptiles	12
Amphibian	6
Fish	34
Invertebrate	48
Plant	143
Total	**380**

Source: Environmental Impact Assessment for Industrial Area Of Zone B, Myanmar Japan Thilawa Development Ltd, May 2016

5.7.3.4 Fauna in the Area

Mammals: A total of eight mammal species were recorded during the survey periods. Recorded species were checked with the IUCN Red List of Threatened Species 2015-4 Version 3.1. All species were classified as LC.

Reptilian and Amphibian Species: There were a total of 18 reptilian and amphibian species recorded in the survey area during the survey periods. The Garden Lizard (*Calotesversicolor*) was observed in the mixed vegetation with scattered trees area. Among the recorded species, the Paddy Frog (*Fejervaryalimnocharis*) was found as a very common species. Recorded species were checked with the IUCN Red List of Threatened Species 2015-4 Version 3.1. Most of the species were classified as NE and

16 Environmental Impact Assessment For Industrial Area Of Zone B, Myanmar Japan Thilawa Development Ltd, May 2016;
Initial Environment Examination for Renovation of Sub-stations, JICA, November 2014

LC. One species, *Ophiophagushannah* (King Cobra), was considered as Vulnerable (VU).

Birds: A total of 129 bird species were recorded in the Yangon area. The bird species common in this area are Black Drongo (Dicrurusmacrocercus), Spotted Dove (Spilopeliachinensis), Barn Swallow (Hirundorustica), and Common Myna (Acridotherestristis). One species, White-throated Babbler (Turdoidesgularis), was reported as Myanmar endemic species. During the study period, some bird species were seen in all kinds of habitat showing their capability for wide distribution. Such commonly distributed species comprised insect eaters and some omnivores that have alternative food choices such as insects, flowers, seeds, and fruits.

Fish: A total of 34 fish species were recorded during the Yangon area. The fishes are important for the ecosystem of the canal and rice field water bodies. It inhabits shallow inland wetlands including lakes, rivers, swamps and reservoirs. The fish species such as Giant Snakehead (Channamarulius), Ceylon Snakehead (Channaorientalis), Gangeticmystus (Mystuscavasius), and Chola barb (Puntiuschola) were found as very common species in the project area. Recorded species were checked with the IUCN Red List of Threatened Species 2015- 4 Version 3.1. Most of the species were classified as NE and LC. There were three species classified as NT, including Ompokbimaculatus (Indian Butterfish), Oreochromismossambicus (Mozambique Tilapia), and Wallagoattu (Wallago).

5.7.3.5 Threatened Species

A total of 3 animal species and 2 plant species have been recorded as threatened species among the 380 recorded species in the Yangon Region. Indian flap shell Turtle (Lissemyspaunctata) freshwater species are exploited for local consumption and export. King Cobra, (*Ophiophagushannah*) became an endangered species mainly due to habitat loss and human activities. Habitat is mostly observed in bamboos, reeds and near the mangroves. These threatened species are however not found in the project site.

5.8 SOCIO-ECONOMIC ENVIRONMENT

5.8.1 Profile of Insein Township

The proposed project is located in Insein Township. Insein Township is located in northern Yangon and it is composed of 21 wards with a total population of 305,283. Its area is 35km borderingShwepyitha Township in the north, Hlaingthaya Township in the west, Mingaladon Township in the east and Mayangon Township in the south. It is well known by its highest Buddha image (KyautDawKyi Pagoda) which is a sculpture with marble stone. The universities are located in this township, such as Christian Dammha University, Myanmar Dammha University, Yangon Technology University. YwamaPariyatti Buddhist University which locates in the north ward at InseinYwama is a well- known University. Kayin ethnic traditional events are celebrating in this township annually.

The proportion of productive working population between 15 to 64 years of age in Insein Township is 72.9 percent, which is higher than the proportion of children aged 14 and below together with the proportion of the elderly aged 65. It means thatthe fewer proportions of children and elderly reduce the dependency of those age groups on the working age population.Compared to Union level, there is higher percentage of working age group 15-64 population in Insein Township.

Compared with other townships in Yangon Region, Insein has the high proportion of households with improved sanitation facilities. Some 93.9 per cent of the households have improved sanitation facilities [flush toilet (5.4 percent), water seal (improved pit latrine) (88.5 percent)].

5.8.2 Profile of Ywama West

Among the 21 Quarters in Insein Township, Ywama (West) is located next to the proposed Ywama Power Plant. The number of households in the locality is 6,752 with a total population of 30,704.The sex ratio is 106.2, which includes 14,889 males and 15,815females.TheYwama West is the nearest settlement to the plant and thus may have certain impact due to the operation of the plant.

5.8.3 Social Characteristics

Ethnicity: As the area under study is an urban area, there is a mixed urban population that does not have collective or ancestral attachment to this area. According to township municipal data, the breakdown is 88% Bamar, 8% Kayin and 1.2% Rakhine.Other ethnic groups in the area includeKachin, Kayah and Chin.[17] A very small portion of people with South Asian origin also reside in this area. It was found that the residents of this area settled about 25 years back with the rapid urbanization of Yangon. More people settled in this area about 10-years back with the development of industrial areas nearby.

Gender Profile: The sex ratio of the area was found to be dominated by female with a figure of 52.46% while 47.54% were males.

5.8.4 Economic Profile

It was found that most of the people in this area are employed in industries located in the vicinity. There are major industrial zones in the area with small and middle scale industries. The GDP growth rate was found to be healthy and in 2014-15, it was 9.9% for Insein. The employment rate among the adult population was found to be 93.2%.

Per Capita Income: There has been a significant increase in the per capita income in the Insein region from 1,717,979 Kyats in 2012-13 to 2,408,398 Kyats. This is due to rapid industrialization of the area. There are 3 industrial zones located in the study area leading to easy availability of employment in the area.

Industries in the Area: As mentioned earlier, the study area islocated predominantly in an industrial area, with small scale and medium scale industries located in it. It was found that the existing population of the study area is dependent on these industries for livelihood. Many people have also migrated from outside areas and settled in Ywama sub-quarters 5 & 6 for employment.

17Insein Township General Administrative Office

Table 5-35: Types of Industries in Study Area

Sl No	Type of Industries	Industrial Zones		
		Shwe Li Ban	ShwePyiThar Zone 4	ShwePyiThar Zone 3
1	Bags	7	2	3
2	Car Accessories	11	7	3
3	Food Processing	28	13	36
4	Beverage/Water Units	5	3	4
5	Bicycle	1	0	-
6	Garments/Accessories	85	11	17
7	Light Engineering/Fabrication	21	2	6
8	Plastic Accessories/Products	14	4	5
9	Construction Materials	5	6	6
10	Paper Processing	6	1	-
11	Ice Factory	8	1	1
12	Shoe Factories	8	1	-
13	Furniture`	-	2	3
14	Steel Mill	-	-	2

5.8.5 Health Status

The common diseases prevalent in the area are malaria, diarrhoea, tuberculosis, dysentery and cirrhosis of liver. In the area under reference, the incidence of disease is high due to unsanitary living conditions, stagnant water, open defecation practice, non-disposal of municipal solid waste, etc. The medical facilities in these areas are also not well developed and people have to travel to other parts of the city for availing proper health care services.

5.8.6 Infrastructure in Study Area

The infrastructure of Insein and Ywama townships has been considered for the purpose of evaluating the facilities available in the area.

5.8.6.1 Transportation

The road network in the area is very well developed with public transport facilities. The main roads in the area includes Pyay Road, Insein Road, Baho Road, Hlaing River Road, BayintNuang Road, Lower Mingalardor Road, ShwePyiThar Bridge Road, etc. All these roads connect the area to other parts of Yangon City. There are public transports such as buses, taxis, pick-up vans available for transportation. There are a total of 173 buses catering to this area. Railway transport is also available in the area with two railways, Yangon Circular Railways and Yangon-Pyay railway serving the area. There are 13 functional railway stations in the study area.

5.8.6.2 Health Care Facilities

As the project area is an urban area, there is no problem related to health infrastructure. There are 4 government hospitals and 4 private hospitals available in the area as well as private clinics. The main hospitals are Insein General Hospital (300 bedded), Myanma Railway Hospital (50 bedded), AungTsun TB Hospital (100 bedded) and Kaung Hospital

(50 bedded). As per records of Insein Township General Administrative Office, there are 173 registered doctors in the area.

5.8.6.3 Communication

As the study area is an urban area, all modern technologies associated with communication is available. As in other urban areas, the importance of traditional communication means such as the post and telegraph offices are diminishing. It was found that there is one post office and one telegraph office in the area, which caters to a population of 254,975. As per records there are 58,000 mobile phones registered in the area.

5.8.6.4 Energy Status

There are two power lines from the national grid feeding this area, with sub-stations at Ywama and Insein. The average total power consumption is 250356655 KW which is supplied through 341 transformers.

5.8.6.5 Education Facilities

There are 33 primary schools, 10 middle schools, 5 high schools in the area which are managed by the government. In addition to that there are three monasteries, which also impart education. Other than this, there are private schools which cater to a particular section of the population.

5.8.6.6 Water Supply

Currently the Water Supply System is managed by the Yangon City Development Committee (Municipality of Yangon) by pumping with the Gyobyu Pipelines and pumping it into the different wards within the City. Water is accessed by the people from taps and in some cases from bore-wells. All the residential areas near to the project site extract ground water for domestic use. Only the colonies have water from municipal supply.

5.8.7 Cultural Resources

There are some structures of archaeological importance in the area. However they are more than 2km away from the plant site. They are as given below.

Table 5-36: List of Archaeological Structures

Sr. No.	Archaeological Structures	Location	Constructed Year
1	Su Paung Yon Office Complex	Insein	1902
2	Central Prison	Insein	1900
3	Criminal Investigation Department (CID)	Insein	1900
4	Locomotive Workshop	Insein	1877
5	Yangon Golf Club	Insein	1908

There are also religious structures present in the area, which includes 114 monasteries, 53 churches, 6 mosques and 14 Hindu Temples. The nearest religious structure is the Ywama Monastery, located within 500m of the project site.

Chapter-6

Environment & Social Impact Assessment

Environment & Social Impact Assessment explains the description and prediction of the potential impacts of the proposed development including the methodology used for the impact's identification for environmental, biological and socio-economic parameters.

6 ENVIRONMENT & SOCIAL IMPACT ASSESSMENT

6.1 INTRODUCTION

The anticipated environmental and social impacts from the Ywama Power Plant may be beneficial or adverse, short or long term, temporary or permanent, direct or indirect and local or regional. Adverse environmental impacts include such impacts which can lead harm to living resources, atmosphere, damage to human health, birds and animal, vegetation, land and water resources, hindrance to activities in place, harm of quality for use, reduction of amenities, damage to cultural and heritage resources, damage to physical structures, etc. Environmental risk is also evaluated based on its likelihood and significance for each identified potential environmental and social impact due to proposed activities in the area.

This section analyses the potential environmental and social impacts due to the Project. The term Environmental Impact means both environmental and social impacts. The project involves setting a new plant within an existing plant premises by dismantling of a few old units and structures and their safe disposal; construction of new foundations and structures at the same location; erecting the new plant and machineries; commissioning the new plant; operating and maintaining the new plant and ultimately dismantling the plant, machinery and structures and their safe disposal after the working life of plant comes to an end. Therefore, the Project activities can be divided in 4 distinct stages of the Project life cycle:

- Dismantling of existing plant, machinery and structures and their safe disposal (Pre-construction Phase; PC);
- Dismantling of existing foundations; site preparation; construction of new foundations and structures; and erection of the Plant, machinery and structures (Construction Phase; C);
- Commissioning, Operation and maintenance of the Plant (Operation Phase; OP)and
- Dismantling of plant, machinery and structures and their disposal(Decommissioning Phase; D)

6.2 IDENTIFICATION & CATEGORIZATION OF IMPACTS

For the proposed project, the impacts assessment will be carried out in the following three steps:

- **Step 1:** Identification of interface between project activities and environmental & social receptors
- **Step 2:** Identification of potential environmental impacts
- **Step 3:** Prediction of significant environmental impacts quantitatively and qualitatively by models and their mitigation.

In **Step 1**, based on the project description and environmental baseline conditions, a detailed matrix of activities and environmental receptors are prepared. Based on project activities and baseline environment conditions at and around the power plant site,it is determined whether an interface exists between project activity and an environmental receptor.

In **Step 2**, on the basis of interface identified in Step 1, potential environmental impacts due to the power plant activities are identified. The environmental impacts may be beneficial or adverse, direct or indirect, reversible or irreversible and short-term or long-term. An impact level is rated as "low", "medium" or "high". The impact rating is based on two parameters, i.e. "severity of environmental impacts" and "likelihood of occurrence of the environmental impacts". This is identified as per the criteria given in **Table 6.1**.

Table 6-1:Impact Assessment Rating Matrix

Impact	Criteria	Description
A. Nature of Impact		
A-1 Pollution		
Air Quality (both ambient and work zone)	Significant	**Applicable to PC, C, OP & D** **PM_{10}:** If incremental value of particulate matter (PM_{10}) is **greater than 25% of the standard** **$PM_{2.5}$:** If incremental value of particulate matter ($PM_{2.5}$) is **greater than 25% of the Standard** **Gases:** If incremental value of any of the gases is **greater than 10% of the Standard**
	Insignificant	**Applicable to PC, C, OP & D** **PM_{10}:** If incremental value of particulate matter (PM_{10}) is **greater than 5% & less than 25%of the Standard** **$PM_{2.5}$:** If incremental value of particulate matter ($PM_{2.5}$) is **greater than 5% & less than 25%of the Standard** **Gases:** If incremental value of any of the gases is **greater than 5% & less than 10% of the Standard**
	Negligible	**Applicable to PC, C, OP & D** **PM_{10}:** If incremental value of particulate matter (PM_{10}) is **less than 5% of the Standard** **$PM_{2.5}$:** If incremental value of particulate matter ($PM_{2.5}$) is **less than 5%of the Standard** **Gases:** If incremental value of any of the gases is **less than 5 % of the Standard**
Water Quality[2]	Significant	**PC& C:** Discharge of waste water without any treatment. **OP:** Discharge of Process effluent and accidental spills without any treatment and Blow down from cooling tower with incremental temperature (Δt) **more than 3^{0}C of ambient river water temperature** into Hlaing river. **D:** Discharge of waste water and residual sludge from waste-water treatment works and accidental spills in to Hlaing river without treatment.
	Insignificant	**PC & C:**Discharge of waste water with treatment but with **turbidity greater than 5% &less than 25% of Standard** (5NTU) **and TSS greater than 5% &less than 25% of Standard** (50mg/l). **OP:** Discharge of Process effluent with treatment and Blow down from cooling tower with incremental temperature (Δt) **less than 3^{0}C of ambient river water temperature** into Hlaing river **and discharged at shore**.

Impact	Criteria	Description
		D: Discharge of waste water and residual sludge from waste-water treatment works and incidents of spills into Hlaing river with treatment.
	Negligible	**PC & C:** Discharge of waste water with treatment and with **turbidity less than 5% of Standard** (5NTU) **and TSS less than 5% of Standard** (50mg/l). **OP:** Discharge of Process effluent with treatment and Blow down from cooling tower with incremental temperature (Δt) **less than 3^0 of ambient river water temperature**. Into Hlaing river away from the shore through submarine pipeline. **D:** No discharge of waste water and residual sludge from waste-water treatment works and incidents of spills into Hlaing river.
Noise[3]	Significant	**Applicable to PC, C, OP & D** Predicted Noise levels at nearest residential buildings due to all sources within plant **greater than 55dB(A).**
	Insignificant	**Applicable to PC, C, OP & D** Predicted Noise levels at nearest residential buildings due to all sources within plant **greater than 45dB(A)& less than 55dB(A).**
	Negligible	**Applicable to PC, C, OP & D** Predicted Noise levels at boundary due to all sources within plant **less than 45dB (A).**
Soil & Ground Water[4] Contamination	Significant	**PC, C, and OP& D:** The storage tanks of fuels/chemicals not properly maintained causing spills leading to soil & ground water contamination and without spill clean-up procedures.
	Insignificant	**PC, C, and OP& D:** The storage tanks of fuels/chemicals properly maintained and stored within a bunded area of 110% of their storage capacity and spill clean-up procedures to avoid spills leading to soil & ground water contamination but without emergency pumps
	Negligible	**PC, C, and OP& D:** The storage tanks of fuels/chemicals properly maintained and stored within a bunded area of 110% of their storage capacity with emergency pumps and spill clean-up procedures avoiding spills leading to **no soil contamination and no groundwater contamination.**
Solid Waste	Significant	**PC& D:** If 100% of the scrap for units to be dismantled at PC stage and Decommissioning stage and C&D waste at PC stage and Decommissioning stage is disposed without reuse and recycling. **C:** If100% of construction waste and MSW dumped outside the project site & lay-down area. **OP:** If 100% of un-segregated municipal waste is disposed outside.
	Insignificant	**PC& D:** If part of scrap for units to be dismantled at PC stage and Decommissioning stage and full C&D waste at

Impact	Criteria	Description
		PC stage and Decommissioning stage is utilized by reuse and recycling and balance disposed off to authorized agencies. **C**: If100% of construction waste of and MSW is disposed outside the project site & lay-down area to authorized agencies. **OP**: If waste is segregated at site and is disposed to local body.
	Negligible	**PC& D:** If100% of the scrap for units to be dismantled at PC stage and Decommissioning stage and C&D waste at PC stage and Decommissioning stage is utilized by reuse and recycling. **C**: If100% of construction waste is disposed outside the project site & lay-down area to authorized agencies and 100%biodegradable portion MSW is treated inside to generate manure. **OP**: If waste is segregated at site and bio-degradable portion of waste is treated in Organic Waste Convertors for use as manure and non-biodegradable portion of waste is disposed off to authorized agencies.
Hazardous Waste	Significant	**PC**: Removal, dismantling & transportation of pipes with asbestos without PPE, mask & gloves and storage in open area **C&D:**No proper collection, storage & disposal facilities for spent oil.
	Insignificant	**PC**: Removal, Dismantling & Transportation of pipes with asbestos with PPE, mask & gloves and storage in open area **C&D**: Proper collection & storage facilities for spent oil.
	Negligible	**PC:** Removal, Dismantling & Transportation of pipes with asbestos with PPE, mask & gloves and storage in covered area **C&D**: Proper collection, storage & disposal facilities for spent oil.
A-2Natural Environment		
Flora/Fauna & Ecosystem	Significant	**PC&C**: If all natural trees and planted trees identified are removed from project site and lay-down area and the land is cleared of all vegetation to make space for plant.
	Insignificant	**PC&C**: If natural trees and planted trees at the boundary of project site and lay-down area are notcut to survive as a green belt to reduce spread of dust and noise.
	Negligible	**PC&C**: If all natural trees are prevented from being removed from project site and lay down area.
A-3 Social Environment		
Living and Livelihood	Significant	**PC, C& D:** If noon-site facility for stay, crèche, water supply, health & Sanitation ***is provided*** to any of the construction workers during working hours and **no** off-site

Impact	Criteria	Description
		facility for stay, crèche, water supply, health & Sanitation for their families during non-working hours.
	Insignificant	**PC, C& D:** If on-site facility for stay, crèche, water supply, health & Sanitation ***is provided*** to 100% construction workers only during working hours and **no** off-site facility for stay, crèche, water supply, health & Sanitation for their families during non-working hours.
	Negligible	**PC, C&D:** If on-site facility for stay, crèche, water supply, health & Sanitation ***is provided*** to 100% construction workers for stay during working and off site facility **is also provided** for stay, crèche, water supply, health &Sanitationfor their families during non-working hours
Existing Road Traffic Condition and Services	Significant	**PC, C& D:** Road Traffic due to heavy construction vehicles, Heavy Earth Moving Machines during day & night time
	Insignificant	**PC, C& D:** Road Traffic due to heavy construction vehicles, Heavy Earth Moving Machines during night time
	Negligible	**PC, C& D: River** Transportation of dismantled equipment, construction materials, heavy construction vehicles, Heavy Earth Moving Machines through Hlaing River
A-4Health and Safety		
Occupational Health &Safety	Significant	**PC, C, OP& D:** Workers and Non-workers irrespective of age and authorization without PPEs of approved make like helmet, gloves, safety shoes & safety glasses
	Insignificant	**PC, C, OP & D:** Workers without authorization with PPEs like helmet, gloves, safety shoes & safety glasses
	Negligible	**PC, C, OP & D:** Restricted movement of only authorized Workers with PPEs like helmet, gloves, safety shoes & safety glasses
B. Duration of Impact	Short Term	Impacts of PC and D which shall be confined to a stipulated time during pre-construction (PC and D Phase- <6months)
	Medium Term	Impacts of C which shall be confined to a stipulated time during Construction Phase **(Start to end of construction) [<32months]**
	Long Term	Impacts of OP which shall continue till the end of project life **(up to 30 years)**
C. Impacted Area	Project Site	Impact within the project boundary
	Vicinity	Impacts within 500m radius of Project Site
	Localized	Impacts within 500m to 2km radius of Project Site
	Area Level	Impacts beyond 2km radius
D. Likelihood of Occurrence	Unlikely	Not likely to occur during Pre-Construction, Construction, Operation Phase or Decommissioning phases. The likelihood of these impacts occurring is slight

Impact	Criteria	Description
	Low	May occur once or twice annually in operation phase or daily during pre-construction, construction and decommissioning phase (for 6months or a year). The likelihood of these impacts occurring is possible
	Medium	May occur at regular intervals in Operation Phase or daily during construction phase **(up to 32 months)** The likelihood of these impacts occurring is probable
	High	Daily during operation phase **(up to30 years)** The likelihood is that this impact will definitely occur
E. Severity of Impact	High	Very severe change to the affected system(s) or party(ies)
	Medium	Severe impacts on the affected system(s) or party(ies)
	Low	Moderate impacts on the affected system(s) or party(ies)
	Slight	Slight impacts on the affected system(s) or party(ies)
F. Significance of Impact	Major	Defined as significant; amenable to mitigation; must be mitigated if cost effectively possible. A very serious impact which may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects, or very beneficial effects.
	Moderate	Defined as insignificant; amenable to mitigation; should be mitigated where practicable A serious impact, if not mitigated, may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects.
	Minor	Defined as detectable but not significant An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.
	Negligible	Defined as magnitude of change comparable to natural variation Acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment.

Note:1-National Environmental Quality (Emission) Guidelines 2015, Myanmar,
2-Water Quality Assessment & Protection, Water Resources & Environment, Technical Note D-1, The World Bank Washington DC, March 2003,
3-;4-Feasibility Study for Ywama CCP, Tractabel Engineering, Belgium

PC: Pre-construction; **C:** Construction; **OP:** Operation; **D:** Decommissioning

In **Step 3**, all the potential environmental impacts as identified in Step 2 are summarized and are identified qualitatively, and a qualitative evaluation is carried out. An impact level is rated as “low”, medium” or “high”. The impact rating is finally based on two major parameters, i.e. “severity of environmental impacts” and “likelihood of occurrence of the environmental impacts”.

- **Severity of Environmental Impact**: The severity of an environmental impact is a function of a range of considerations including impact magnitude, impact duration, impact extent, compliance of prescribed legal framework and the characteristics of the receptors/ resources; and
- **Likelihood of Occurrence of Environmental Impact**: How likely is the impact (this is particularly an important consideration in the evaluation of unplanned/accidental events).

The significance of each environmental impact is determined by assessing the impact’s Severity against the Likelihood of the environmental impact occurring. This is summarized in the Environmental Impact Significance Assessment Matrix in **Table 6.2**.

Table 6-2: Environmental Impact Identification Rating Matrix

Impact Severity	Likelihood of Occurrence			
	Unlikely (not likely to occur during project lifetime)	**Low Likelihood (may occur once or twice during project lifetime)**	**Medium Likelihood (e.g. may occur every few years)**	**High Likelihood (routine, happens several times a year)**
Slight	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact
Low	Negligible Impact	Negligible Impact	Minor Impact	Minor Impact
Medium	Negligible Impact	Minor Impact	Moderate Impact	Moderate Impact
High	Minor Impact	Moderate Impact	Major Impact	Major Impact

Notes:

Negligible Impact: Defined as magnitude of change comparable to natural variation;
Minor Impact: Defined as detectable but not significant;
Moderate Impact: Defined as insignificant; amenable to mitigation; should be mitigated where practicable;
Major Impact: Defined as significant; amenable to mitigation; must be mitigated if cost effective.

6.3 ENVIRONMENTAL IMPACT

Any project brings with itself both positive and negative impacts. The need of the hour is to increase the positive impacts and mitigate or offset the negative impacts. The project under consideration will also have both the types of impacts. Not only the local population will benefit but also the whole nation will benefit from the project.

As regards benefit to Nation, it is already mentioned that the industry in Myanmar suffers as the grid suffers frequent load shedding for several reasons. Without implementation of new power projects and considering the power demand increase (11%), the current problems will grow. To remedy to the above issues, the following actions should be taken.

- Reinforce the transmission system with a new 500 kV line connecting North and South of Myanmar (expected COD in 2022) in order to improve the hydro power distribution across the country;

- Build new hydro plants;
- Increase the natural gas supply capacity via new LNG plants and install new efficient gas fired power plants

Keeping in mind the availability of natural gas in Myanmar and gas line to the Ywama plant from Yadana off-shore gas fields, installation of the 250-300MW CCGT at the Ywama plant is needed for both reducing the gap between power supply and demand as well as for economic development of the country.

As regards local business, the local business communities engaged in trade and commerce will be benefited. On the other hand, people living in abject poverty are expected to marginally gain in terms of greater number of employment days. As the labour demand grows, a general wage increase is expected. The socio-economic enhancement on account of these positive changes is anticipated both in core as well as buffer area. Daily wage labours, mostly in and around project site, have been observed during site visit and tried to consult them. Consultation with the labours highlights that the proposed Thermal Power Project will support their employment during construction period and helps them tackle the seasonal unemployment in the area. The project activities are expected to enhance economic activities in the area which will benefit the overall economic development of the area by way of meeting energy demands. Income generating opportunities will also grow in the area on account of creation of new job opportunities. The job opportunities in non-agricultural sector are likely to increase. The installation of proposed project is expected to further increase the prospects by bringing in some direct and indirect employment opportunities.

6.3.1 Impact on Air Quality

6.3.1.1 Identification of Sensitive Receptors

The proposed power plant is located in an urban area and thus is surrounded by densely populated residential areas of Insein Township on the Eastern and Southern part. In the East of plant boundary, almost adjacent, there are some residential flats owned by the company. Other sensitive areas include Ywama Monastery about 500m away. There are also seven buildings of historical and archaeological importance in Insein as notified by Yangon City Development Committee but is more than 5-km from the plant. The impact on air quality due to the plant operation on the densely populated residential areas may be a matter of concern and has to be mitigated in a planned manner. The sensitive receptors within 0.5 km and 5-km of the project site are given in **Figure 6.1** and **6.2** respectively.

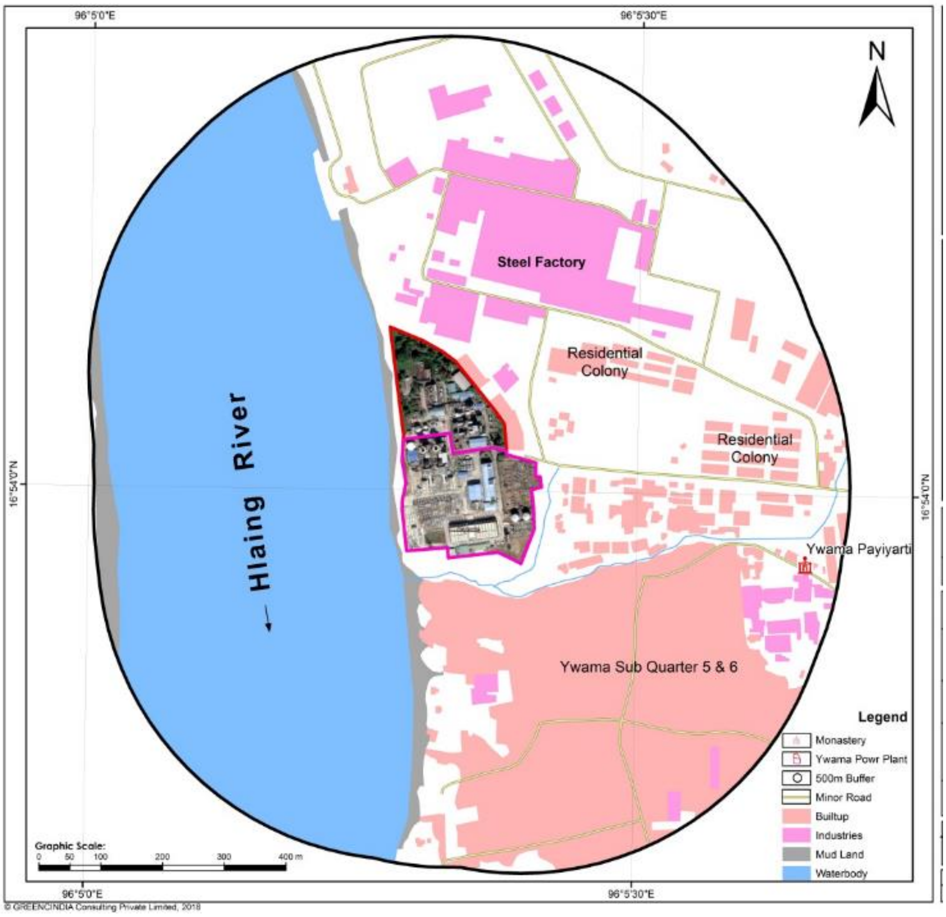


Figure 6-1:Plant and 500m surrounding

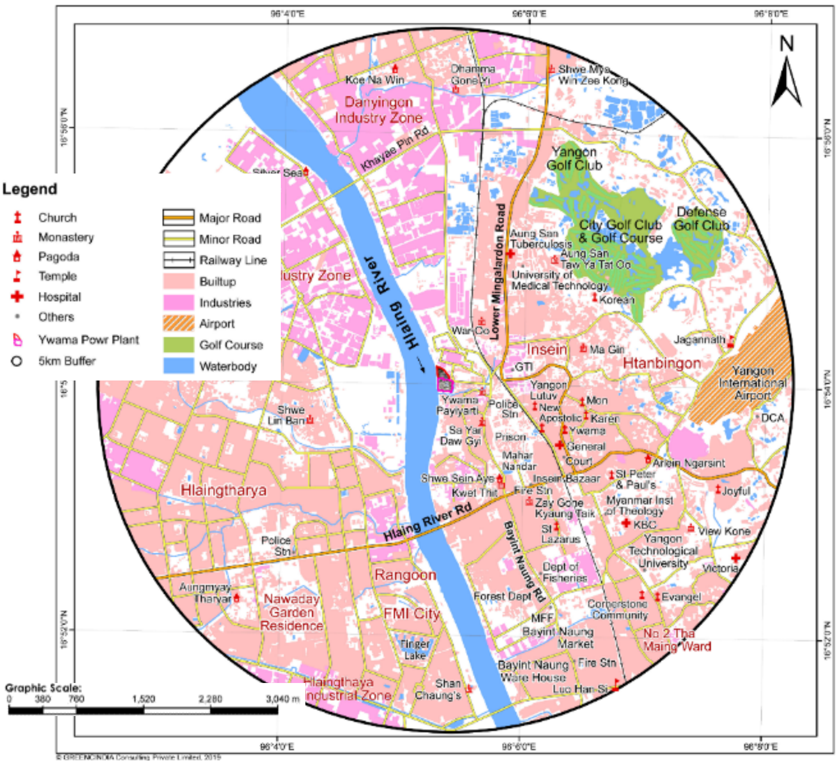


Figure 6-2:Sensitive Receptors within 5km of the Project site

For predicting the impacts quantitatively, wherever possible, air quality modeling was performed for simple and combined cycle modes of the Project for the utilization of natural gas. For running in simple mode, only by-pass stack is considered whereas for running in combined mode, only the stack after WHRB is considered. The results have been compared with the host country standards; WBG General EHS Guidelines on Environmental Air Emissions and Ambient Air Quality. The WBG's General EHS Guidelines on Environmental Air Emissions and Ambient Air Quality suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same air shed. In other words, it is recommended that the GLCs of the pollutants generated by a Project do not exceed 25 percent of the applicable air quality standards. If the model indicates crossing 25% limit, suitable mitigation measures has to be implemented.

6.3.1.2 Myanmar Power Sector and Greenhouse Gas Emission

Most of Myanmar's electricity (74.7%) is produced by hydro-electricity. The rest is from fossil fuels, with gas as the main fuel (20.5%) followed by coal and oil. In 2017, Myanmar had an installed electricity generation capacity of about 5.0GW. The country plans to achieve 100% electrification by 2030. The country is targeting 12% of all electricity to be generated from renewable sources by 2025.

Myanmar has abundant energy resources, particularly hydropower and natural gas. Coal plants tend to have relatively low thermal efficiency compared to plants using combined-cycle technology fueled by natural gas. Although there is some variation across individual plants, in general a coal plant consumes more energy than a combined-cycle natural gas plant to produce the same amount of electricity. Also, coal's carbon content per unit of energy is nearly twice that of natural gas. Considering both the higher thermal efficiency of generators and lower carbon content of fuels, electricity generation using natural gas emits roughly 40% of the carbon dioxide that would be emitted from a coal-fired unit producing the same amount of electricity.

Despite being a relatively low greenhouse gas (GHG) emitter and being a net GHG sink, Myanmar wishes to undertake a series of actions to demonstrate its commitment to climate change mitigation and highlight options for adaptation. Therefore, in accordance with relevant decisions of the Conference of the Parties to the Convention, Myanmar has presented its enhanced mitigation actions, policies, strategies and adaptive efforts on climate change in Myanmar's Intended Nationally Determined Contribution-IND C, and wishes to contribute to making the Paris Conference agreement negotiation a great success in August, 2015.

In effect, the country is extremely vulnerable to the negative effects of climate change. In 2015, for the third consecutive year, Myanmar was ranked globally by studies, as the second most vulnerable country in the world to extreme weather events over the last 20 years. Tropical Cyclone Nargis caused the loss of 138,000 lives in 2008 and devastated of infrastructure, causing long-term adverse socio-economic impacts. Myanmar is now developing its National Climate Change Strategy and associated action plans. These will present a vision for achieving climate resilient, low-carbon, resource efficient and inclusive development as a contribution to sustainable development. As such, whereas

GHG emission from the project is considered as insignificant, the project fulfills the objective of meeting the highest fuel mix for thermal power generation in the country by natural gas. The impact is therefore, insignificant.

6.3.1.3 Impact in Pre-Construction Phase

The pre-construction phase, hereinafter referred as PC stage, of this project will involve de-commissioning and dismantling of three plants, one of which will be re-installed at Hlawga Power Plant, while the other two will be completely dismantled and sold as scrap. In place of these, two units of a combined cycle gas turbine plant of about 250 MW to 300 MW will be installed.

The dismantling process consists of mechanical, hydraulic and electrical unbolting, cutting or disconnecting and lead to use of mobile crane of adequate capacity and boom height. Significant particulate or gaseous emission is not expected from these activities.However, some gaseous emissions and noise will take place during use of trucks used for transporting the dismantled machineries and scraps. Also, as the initial storage before packaging or disposal will be done in the lay-down area identified close to residential areas, there is a risk of minor fugitive dust emissions from lay down areas. Only a small part of 300 construction work-force will be exposed to PM_{10} at the dismantling and lay-down area, limits of which will be as per ACGIH TLV-TWA[18] for 8 hours exposure. These values are known as Threshold Limit Value-Time-Weighted Average (TLV-TWA)-the time-weighted average concentration for a conventional 8-hour work day and a 40-hour workweek, to which it is believed that nearly all workers maybe repeatedly exposed, day after day, without adverse effect. The TLV for nuisance particulates, the standards are as follows:

- Inhalable: 10 mg/m^3
- Respirable: 3 mg/m^3

Particle size less than 10 micron size is considered as Respirable dust. The nearest sensitive areas will also be exposed to PM_{10} and gases from transport vehicles, which will be compared with ambient air quality standards of Myanmar and WB.

As mentioned above, the main concern during the PC phase is fugitive emission from the lay down area and transportation of dismantled plant and machinery which are not having dustiness. For the project, the activities envisaged to lead to dust generation are:

- Emission from wind erosion of exposed surfaces in lay-down area.
- Emission from scrapping of top soil in lay-down area

Emission of dust from transportation of demolition wastes on paved roads has not been considered as all transportation will be done through paved roads with covered trucks. Gaseous emissions from transport vehicles will be insignificant as all vehicles will meet vehicular emission limits of Myanmar.

Table 6-3: Impact Rating for Air during 'PC' Phase

[18] American Conference of Governmental Industrial Hygienists (ACGIH) stipulated Threshold Limit Value

Environmental Impact Rating	Criteria	Reason
A. Nature of Impact	Negligible	**Number of workers at site will be 300.** • Fugitive dust will be only restricted to the operation area and no fugitive dust is expected in the residential areas as this phase will not involve excavation or any civil work. Activities will be restricted to dismantling of machineries and other equipments.
B. Duration of Impact	Short term	This impact is only for 6 months due to dismantling activities on project site. The impact will be reversible and end with the pre-construction phase
C. Impacted Area	Vicinity	The impacted area will be within boundary of the plant and the lay-down area
D. Likelihood of Occurrence	High	Daily for the period of 6 months
E. Severity of Impact	Low	There will be negligible effect on human health but may have dust deposition on tree leaves/vegetation on the southern side of the site
F. Significance of Impact	**Minor**	**Detectable impact but no significance to human health or ecology**

As the duration of the pre-construction activity will be short term and impact localized and reversible, the significance of impact will be minor.

6.3.1.4 Impact in Construction Phase

The construction of the project will last for about 32 months till COD. From references of Project Management for large CCGT, it is expected that a peak workforce of 750 to 800 will be needed at site. Site formation and leveling works will be required within the Project site and will be started from the stage as left by contractors after dismantling. Excavation, pile driving, foundation casting, backfilling and stockpiling of materials will be carried out and there will be potential to cause fugitive dust impact. The excavated materials suitable for backfilling will be temporarily stock-piled onsite. Construction equipment (electric and diesel-powered) will be operating in different areas of the entire work site area. Materials handling, trucks movements within the work sites, wind erosion of the open uncovered areas are the potential sources of fugitive dust emissions. Construction dust arising from the dust generating activities and air emissions from construction vehicles and non-road machinery within the construction site boundary are the key concerns during construction of the Project. About 800 workforces will be exposed to PM_{10} at construction site as well as lay-down area, limits of which will be as per ACGIH TLV-TWA for 8 hours exposure. The nearest sensitive areas will also be exposed to PM_{10} and gases, which will be compared with ambient air quality standards of Myanmar and WB.

The key activities which may potentially cause air quality impacts are listed below:

- Site clearing activities;
- Ground excavation;
- Pile driving, backfilling and stockpiling of materials

- Transportation of construction materials to site
- Handling and mixing of cement
- Site clearance, site formation and levelling involving excavation and backfilling; and
- Construction of sub-structure and super-structure of the main power plant facilities including infrastructure and buildings.

6.3.1.4.1 Site Clearing

The land left after dismantling will be mostly paved with abandoned foundations left from dismantled plants. The first activity will be to clear this land of any obstructions.

Site preparation in readiness for construction work may require some vegetation clearance and top soil removal from the northern part of the site. As most of area left after dismantling will be paved, removing paved areas and existing portion of foundations of dismantled plants will have to be done; followed by ground leveling and compaction. It is recommended that only the required area should be broken to minimize waste generation and handling. The paved areas may be judiciously used without damaging it, wherever possible. These activities will open up some ground to wind action and thus potentially resulting in dust generation. This is because of the following:

- Vegetation clearance will directly expose the ground to agents of erosion;
- Stripping off of broken concrete material and soil will loosen aggregates increasing their dustiness thus making them easily susceptible to wind action;
- Removal of tree stumps and roots will weaken soil bounding and thus can easily be blown by wind

6.3.1.4.2 Piling, Foundation and Excavation

From the Civil Engineering Specification of FS of Engineering Consultant, it is noted that piling and sheet piling technique will be followed in the project's civil engineering activities. Sheet piling for dewatering or trenching shall be steel or wood if temporary and removed upon completion of construction. Only steel piling shall be used if piling is to be left in place after construction.

Sheet Piles is mostly used to provide lateral support. Usually, they resist lateral pressure from loose soil, the flow of water, etc. They are usually used for cofferdams, trench sheeting, shore protection, etc. They are not used for providing vertical support to the structure. They are usually used to serve the following purpose-

- Construction of retaining walls.
- Protection from river bank erosion.
- Retain the loose soil around foundation trenches.
- For isolation of foundation from adjacent soils.
- For confinement of soil and thus increase the bearing capacity of the soil.

The foundation of all buildings, structures, pipe supports, duct banks, cable trenches, manholes, tanks, and equipments shall be of reinforced concrete supported on piles. The foundation component of the Generation Building shall be reinforced concrete slab and beam on concrete piles or reinforced concrete mat on pile. The foundation of the Central Control Building shall be designed as a reinforced concrete supported on piles. The foundations of miscellaneous buildings and structure shall be designed as a reinforced concrete supported on piles. The foundation component for the stacks shall be reinforced concrete foundation supported on piles.

It is mentioned that the pile capacities shall be determined by geotechnical investigation. The pile sizes and length shall be determined during the detailed geotechnical analysis. As such, quantum of earth to be removed and backfilled is not readily available. It is presumed that piles will cause the soil to be displaced vertically as they are driven to the ground. To assess this, references were taken from other past projects and it was assumed that a total of about 18000 m^3 of soil will be displaced and will be used for leveling inside the plant.

6.3.1.4.3 Delivery of Construction Materials to Site

Construction materials such as building blocks, cement, sand, steel bars, ballast will be bulky and thus will require to be delivered on site by a fleet of trucks driving in and out of the construction site. During this exercise dust is likely to be generated from the following activities:

- Handling of sand, cement and ballast which are dusty
- Ballast could contain loose dust particles
- Site clearing of area of holding ballast, building blocks and sand will expose the site to wind action
- Handling and mixing of Cement

6.3.1.4.4 Estimation of Pollution

As the project site is adjacent to residential areas on the east and south, care is to be taken to ensure that the fugitive emission does not cause too much inconvenience to the areas. The decision to whether transport heavy machineries from Yangon Port to the Project site by trucks and trailers or by the river is yet to be decided but river transport is recommended. The emissions will cause increase in GLC of PM_{10} from site clearance and gases from combustion of fuels in construction machineries. Whereas emission of fugitive dust is taken from US AP 42, the same for gaseous emission is taken from Environmental Protection Agency, 2004, *Exhaust and Crankcase Emission Factors for Non-road Engine Modeling—Compression-Ignition*, Washington. About 800 workforces will be exposed to emissions which are limited by ACGIH TLV-TWA.

Model Used: For calculating increase in ambient air quality level from construction activities, dispersion models has been used. In this case, USEPA approved AERMOD Cloud 5 Software has been used for predicting the incremental GLC of particulate matter and gases in the study area as well as the project site. This is an air dispersion-modeling package, which seamlessly incorporates the popular USEPA Models, ISCST3 and AERMOD into one interface without any modifications to the models. For this project, AERMOD interface has been applied along with AIRMET to generate surface and upper air data from the hourly monitored primary data at site for 30 days. These models are used extensively to assess pollution concentration and deposition from a wide variety of sources. Area source algorithm has been considered in this case with emission units calculated as g/s for emission from exposed surfaces in lay-down area and converting to g/s/m^2.

Meteorological Data: In order to conduct a refined air dispersion modeling project using the AERMOD short-term air quality dispersion model, it is necessary to process the meteorological data representative of the study area being modeled. The collected meteorological data collected during October 2018 has been converted into ASCI format and incorporated in the model.

As mentioned above, the main concern during the construction phase is fugitive emission from the construction site and transportation of waste and raw materials. For the project, the activities envisaged to lead to dust generation are:

- Emission during drilling of concrete;
- Emission due to removal of debris by scrapper;
- Emission from truck unloading for crushed stones;
- Emission from truck loading of demolition wastes and concrete debris; and
- Emission from exposed surfaces

Emission from transportation of construction materials, demolition wastes and concrete debris on unpaved roads have not been considered as all transportation will be done through RCC roads with covered trucks and preferably through river route.

Area Source Input Data: USEPA AP-42 Section 13.2.3, Miscellaneous Sources, Heavy Construction Operations, provides information on TSP emission factors was used to assess particulate emissions from construction. For gases, US EPA has published standards for emission factors in 'Exhaust Emission Factors for Non-road Engine Modeling - Compression-Ignition, EPA'. From this, the emissions of PM10 and gases in g/s/m^2 is calculated and put in the AERMOD dispersion model

Table 6-4: Emission for gases from construction equipment

Equipment	Number of equipment	Engine power HP	Emission Factors (g/bhp.h)	
			NO_2	PM
Automobile	2	136.3	0.30	0.01
Pick-up 4x2	4	136.5	0.30	0.01
Jeep 4x4	2	253	8.38	0.41
Truck Mixer	1	360	8.38	0.41
Concrete Mixing Plant	1	148	0.30	0.01
Concrete Vibrator	2	1.1	10.00	1.00
Truck Tractor	1	500	8.38	0.41
Generator	4	312	8.38	0.41
Rough Terrain Crane	3	240	8.38	0.41
Man lift– 33 m	1	75	6.90	0.72
Man lift– 43 m	2	74	6.90	0.72
Steel Bar Bending Machine	2	7.4	10.00	1.00
Steel Bar Cutting Machine	2	5.4	10.00	1.00

Ref. Exhaust Emission Factors for Non-road Engine Modeling - Compression-Ignition, EPA

Table 6-5: Calculated Emissions

Equipment	Emission (g/s/m²)			
	NO_2		PM	
	g/s	g/s/m²	g/s	g/s/m²
Automobile	0.01	5.83376E-08	0.0004	5.83376E-08
Pick-up 4x2	0.01	5.84232E-08	0.0004	5.84232E-08
Jeep 4x4	0.59	1.08286E-07	0.0007	1.08286E-07
Truck Mixer	0.84	1.54083E-07	0.0010	1.54083E-07
Concrete Mixing Plant	0.01	6.33453E-08	0.0004	6.33453E-08
Concrete Vibrator	0.00	4.7081E-10	0.0000	4.7081E-10
Truck Tractor	1.16	2.14004E-07	0.0014	2.14004E-07
Generator	0.73	1.33539E-07	0.0009	1.33539E-07
Rough Terrain Crane	0.56	1.02722E-07	0.0007	1.02722E-07
Man lift– 33 m	0.14	3.21007E-08	0.0002	3.21007E-08
Man lift– 43 m	0.14	3.16727E-08	0.0002	3.16727E-08
Steel Bar Bending machine	0.02	3.16727E-09	0.0000	3.16727E-09
Steel Bar Cutting machine	0.02	2.31125E-09	0.0000	2.31125E-09

Oxides of Nitrogen

The Nitrogen Oxides (NO_X) Emissions operations have been calculated from emission factors obtained from USEPA AP-42 and running AERMOD Area Source model. For gaseous exposure to plant workers during construction phase, the air quality standard as defined by ACGIH has been considered. From Table 6.6, it is observed that the maximum 24 hours incremental ground level concentration (GLC) of NO_X will occur within the project site and will be about 21.3µg/m³. When added with background concentration, this will be about 41.0µg/m³. The maximum GLC will be restricted within the plant site and the workers will be exposed to it. However the resultant GLC is within the prescribed standard and will not have any adverse impact on the workers.

Table 6.6:Comparison of Ambient Air Quality Standards for NO_X for 'C' case

Sl. No	Location	Direction	Distance(Km)	Averaging period (Hr)	Background Concentration (µg/m³)	Incremental concentration (µg/m³)	Total (µg/m³)
1	AAQ1	-	-	24	19.7	21.3	41.0
2	AAQ2	NE	0.1	24	17.6	3.1	20.7
3	AAQ3	S	2.1	24	19.7	0.1	19.8
4	AAQ4	SW	1.2	24	25.4	0.7	26.1

The incremental GLC in the other locations were found to be maximum of 3.1µg/m³just outside the plant boundary, which will not create any significant impact on the population residing in the nearby colonies. Thus, as the duration of construction activity will be short-term and localized, and will have no major impact on human health, the significance of impact will be minor.

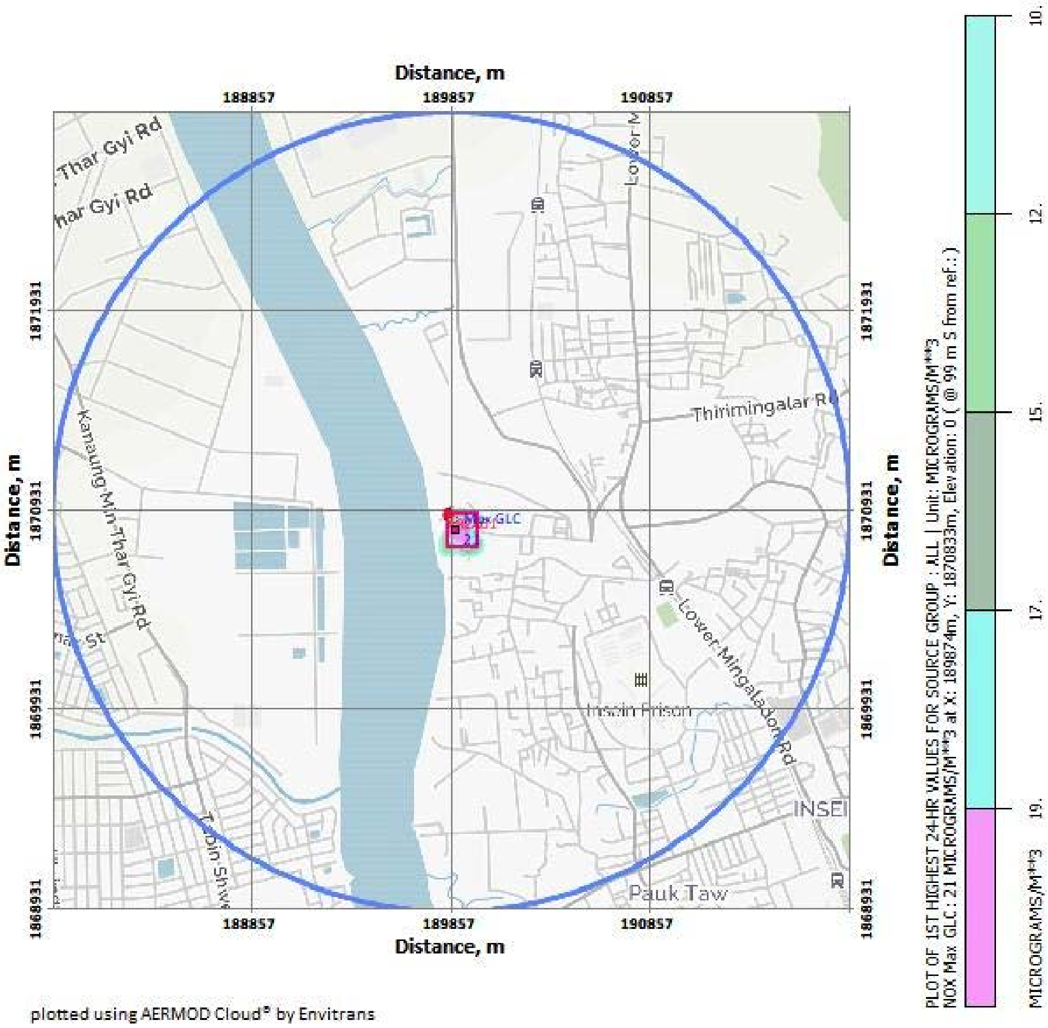


Figure 6-3: Isopleth showing GLC of NO_2 during Construction

Dust Emission

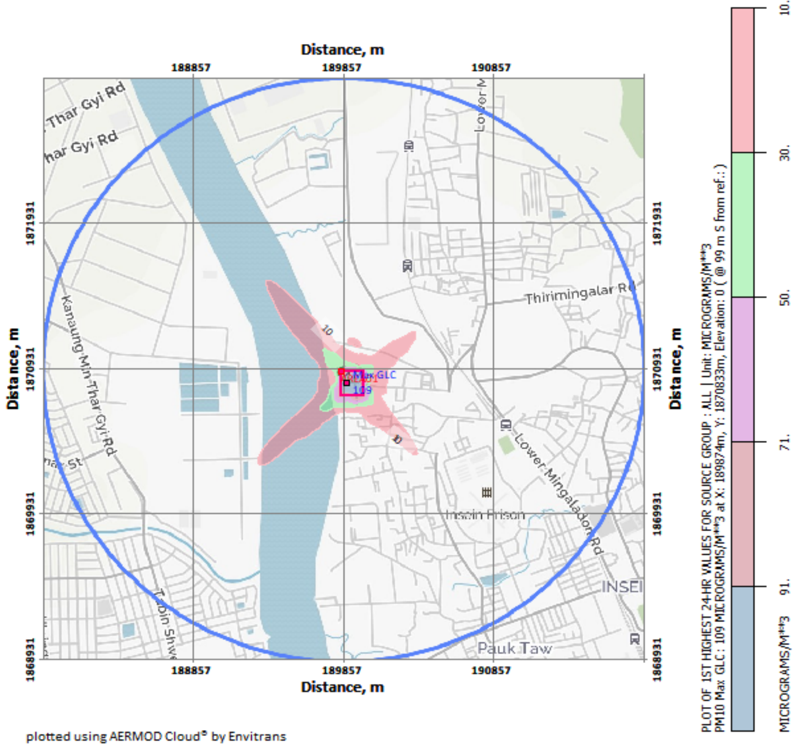
The dust emission from construction operations has been calculated from emission factors obtained from USEPA AP-42 and running AERMOD Area Source model. The results are as follows:

Table 6-6: Comparison of Ambient Air Quality Standards for PM_{10} for 'C' case

(All units in µg/m³)

Location	Averaging period (Hr)	Background Concentration (µg/m³)	Incremental concentration (µg/m³)	Resultant Concentration (µg/m³)
Within plant boundary	24	89.6	118	207.6

For dust exposure to plant workers during construction phase, the air quality standard as defined by ACGIH has been considered. From Table 6.7, it is observed that the maximum 24 hours incremental ground level concentration (GLC) of PM_{10} will occur within the project site and will be about 118µg/m³. When added with background concentration, this will be about 207.6µg/m³. As such, within the construction site, the incremental concentration of PM10 is less than 5% of the ACGIH TLV limit of 3 mg/m³.



Isopleth showing GLC for PM-10 of Pre-Construction & Construction Phase

Table 6-7: Comparison of Ambient Air Quality Standards for PM10 for 'C' case

Sl. No	Location	Direction	Distance(Km)	Averaging period (Hr)	Background Concentration (µg/m³)	Incremental concentration (µg/m³)	Total (µg/m³)
1	AAQ1	-	-	24	89.6	118	207.6
2	AAQ2	NE	0.1	24	84.7	17.0	101.7
3	AAQ3	S	2.1	24	90.1	0.7	90.8
4	AAQ4	SW	1.2	24	95.2	6.0	101.2

The incremental GLC in the other locations were found to be maximum of 17.0 µg/m³ just outside the plant boundary, which will not create any significant impact on the population residing in the nearby colonies.

Thus, as the duration of construction activity will be short-term and localized, and will have no major impact on human health, the significance of impact will be minor (**Table 6.8**).

Table 6-8: Impact Rating for Air during 'C' Phase

Environmental Impact Rating	Criteria	Reason
A. Nature of Impact	Negligible	**Number of workers at site will be 300.** • Fugitive dust concentration at site will be about 109 µg/m³ (less than 5% of ACGIH TLV) • Fugitive dust concentration in nearest residential colony be about 10 to 15 µg/m³ (less than 5% of host country/world bank AAQS

Environmental Impact Rating	Criteria	Reason
B. Duration of Impact	Short term	This impact is only for 32 months due to dismantling activities on project site. The impact will be reversible and end with the pre-construction phase
C. Impacted Area	Vicinity	The impacted area will be within project boundary.
D. Likelihood of Occurrence	High	Daily for the period of 6 months
E. Severity of Impact	Low	There will be no effect on human health but may have dust deposition on tree leaves/vegetation on the southern side
F. Significance of Impact	**Moderate**	**Detectable impact but no significance to human health or ecology**

As the duration of the construction activity will be medium term and impact localized and reversible, the significance of impact will be moderate.

6.3.1.5 Impact in Operation Phase

The main source of pollution from the project is air pollution. Air pollutant of concern from a gas-fired CCGT plant is nitrogen dioxide (NO_2) whilst emissions of particulate matters (PM_{10} and $PM_{2.5}$) are likely to be minimal. The amount of CO_2 produced when fuel is burnt is a function of the carbon content of the fuel. The heat content, or the amount of energy produced when a fuel is burned, is mainly determined by the carbon (C) and hydrogen (H) content of the fuel. Heat is produced when C and H combine with oxygen (O) during combustion. Natural gas is primarily methane (CH_4), which has higher energy content relative to other fuels, and thus, it has a relatively lower CO_2-to-energy content. Current natural gas powered electricity generation has a carbon footprint around half that of coal (~500gCO_2eq/kWh), because gas has a lower carbon content than coal.

6.3.1.5.1 Nitrogen Oxides (NOx) Emissions

Burning of fossil fuels at high temperature (above1600°C) generally produces two forms of nitrogen oxides-nitric oxide (NO) and nitrogen dioxides (NO_2); commonly referred to as nitrogen oxides (NOx). Since the gas turbine intakes excess air to the tune of 127% more than required for combustion, and if a fully premixed burner (dry low NOx burner DLN) is used there will be low NOx since the combustion temperature is much less in the case of such a turbine. The proportion of NOx and NO_2 varies depending on the combustion technology, and in the case of gas turbines, approximately 90 percent of the nitrogen oxides is present as NO with the remaining being NO_2. Once the NO enters the atmosphere, it reacts with oxygen in the air and oxidizes to NO_2 with passage of time.

6.3.1.5.2 Air Quality Prediction

Input Details: The assessment of the potential impact of the emissions from the operation of the power plant, when firing on natural gas, are in accordance with the relevant limit values outlined in the Draft BAT Guidance Note on Best Available Techniques for the Energy Sector (Large Combustion Plant Sector) Final Draft EPA February 2008, the IPPC reference document on BAT for Large Combustion Plants (July 2006) and the Large Combustion Plant (LCP) Directive (2001/80/EC).

As already informed the plant is an already operational one and there will be upgraded in capacity by de-commissioning of some old inefficient low capacity units and replacing them with new efficient high capacity units. With this, there will be increase in production and consequent increase in emissions of NOx. With increase in emissions, there will be increase in ground level concentration of NO_2. The same is described as follows:

Emission Sources: The following data was used to accurately determine the likely impact of the emissions from the stack on nearby receptors locations:

There are a total of 17 stacks consisting of 12 stacks of IPP, 2 stacks of GTs and 3 stacks of units to be dismantled (3 GTs +1 ST) in the existing plant. The last 3 stacks will be removed and in their place, 2 stacks of new CCGT Units will be added. Thus there will be total of 17-3+2=16 stacks in the expanded plant in After installation of proposed plants, increased emission is expected. The input details for the modeling are given in **Table 6.9**.

Table 6-9: Input Details for NO_2 emission

	Units	Existing Stacks						Proposed new stacks	
	IPP GE	**Mitsubishi Simple Cycle M701 D**		**Hitachi H25 CCGT**	**John Brown Simple Cycle Power Plant**			**150 MW CCGT**	**150 MW CCGT**
Stack No	1 to 12	13	14	15	16		17	18	19
	Status	To remain		To be removed				To be added	
Stack Height in m	16	33	33	30	17		17	40	40
Rounding off diameter in m	1.50	5.00	5.00	1.50	1.50		1.50	5.00	5.00
NO_2 emission rate in g/s	54.178 (total)	10.836	10.836	3.612	2.167		2.167	16.253	16.253
Temperature in K	823	823	823	823	823		823	374	374

Multiple point source algorithms were used for gas turbine stacks. The 12 stacks of the gas engine are very near to each other. Therefore, they are considered as multiple stacks with same co-ordinates for the emission calculation. These 17 existing stacks and 16 final stacks after expansion are located at various co-ordinates inside the plant. Therefore, multi-source emission modeling is performed with different stacks configurations and emission parameters in each case. NO_2 is the predominant pollution from the plant. Hence, all air quality calculations are done for NO_2. The maximum emission rate of NO_2 has been considered as 40 mg/Nm^3 which is then converted into g/s for each of the stacks.

The 24 hours averaging time existing baseline values of ground level concentration (GLC) of NO_2 was monitored at various stations for November month of 2019, which are getting contributions from Ywama Plant as well as other sources nearby emitting NO_2. To get a theoretical pristine baseline value without Ywama Plant, the contribution of Ywama existing Plant at these stations were calculated theoretically by using AERMOD Multipoint Source algorithm and deducted from existing baseline values. The ultimate additional contribution by expanded plant at these stations were then calculated using the same software by adding the incremental GLC of expanded plant at each monitored station with their pristine baseline value The emission and predicted GLC results are given in **Table 6-10**.

Table 6-10:Share of Ywama Plant on Baseline of NO_2 GLC at various points (µg/m³)

Sl. No.	Monitored Stations	Distance from plant center	Direction from plant center	Present Baseline GLC	Predicted Contribution by Ywama existing Plant	Pristine Baseline GLC without Ywama Plant	Predicted Contribution by Ywama expanded Plant	Future Base Line GLC with expanded Ywama Plant	% increase in GLC after expansion	% of WB NO_2 Standard met
				A	B	C=A-B	D	E=C+D		
Units		KM		µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	%	%
1	AAQ1	-	-	19.7	-	19.7	0.01	19.71	0.05	13.14
2	AAQ2	0.1	NE	17.6	0.09	17.51	0.01	17.51	0.06	11.67
3	AAQ3	2.1	S	19.7	0.32	19.38	0.61	19.99	3.15	13.32
4	AAQ4	1.2	SW	25.4	0.02	25.38	0.07	25.45	0.28	16.93
WB 24 hours avg. time standard of NO_2				150						

As maximum GLC may not occur at selected stations, another modeling was done to calculate maximum GLC of NO_2 by existing plant and expanded plant and their occurrence location as given in **Table 6.11**. From this percentage of WB GLC Standard met by proposed plant at the location of maximum GLC is also determined.

Table 6-11: Maximum GLC of NO_2 by Existing plant and Expanded Plant

Sl. No.	Maximum GLC by existing plant	Maximum GLC by expanded plant	Distance and direction from plant center
1	10.96	14.24	NW

6.3.1.5.3 Modeling Results

The graphical representation of results is given in Figures 6.3 and 6.4 for GLC values for existing plant and proposed plant respectively. It is observed that maximum GLC of NO_2 will not occur in residential areas but on the Hlaing River and exiting industrial areas due to predominant wind blowing towards the river.

From the 24 hours averaging time baseline ground level concentration, it was found that the present value of NO_2 with other industries located near the plant was around 25.4µg/m³at Shwe Lin Ban Industrial Zone, which is only 1.6 % of the prescribed standard of World Bank which is 150µg/m³ for 24 hours averaging time. After the plant is expanded, the GLC at this location will be 0.07µg/m³ which is only 0.28% of the prescribed standard of World Bank.

It can be seen that the proposed plant will generate 2.5 times electricity output from the existing plant and with an increase of only about 4 µg/m³ of NO_2. Thus there will be reduction in GHG emissions per unit of output.

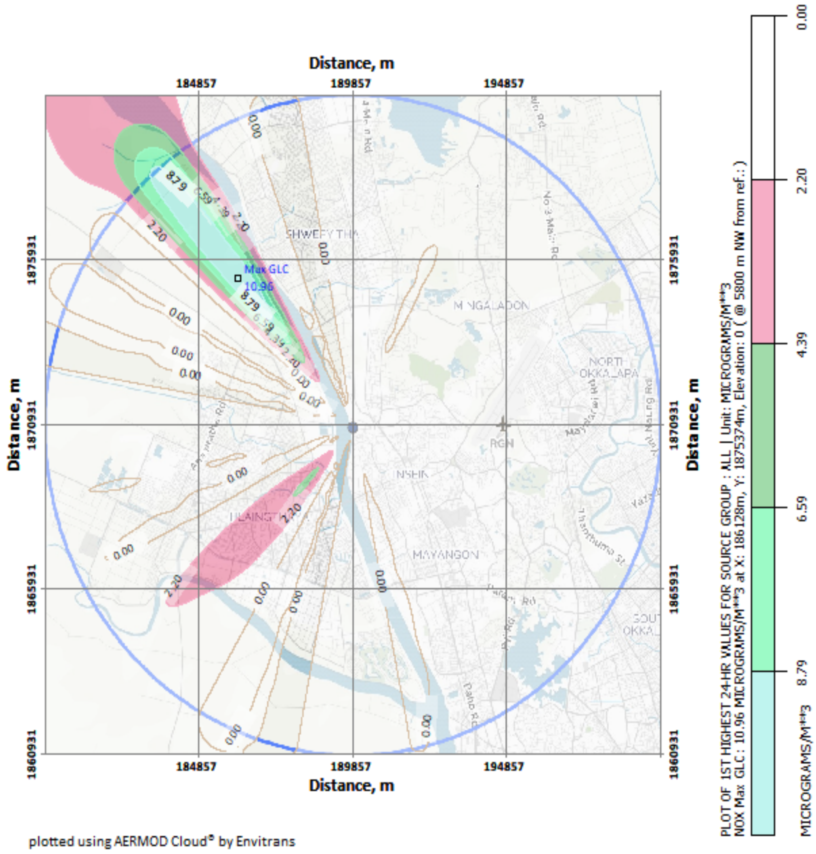


Figure 6-4: Isopleth showing NO_2 GLC of Existing Plant Operation Phase

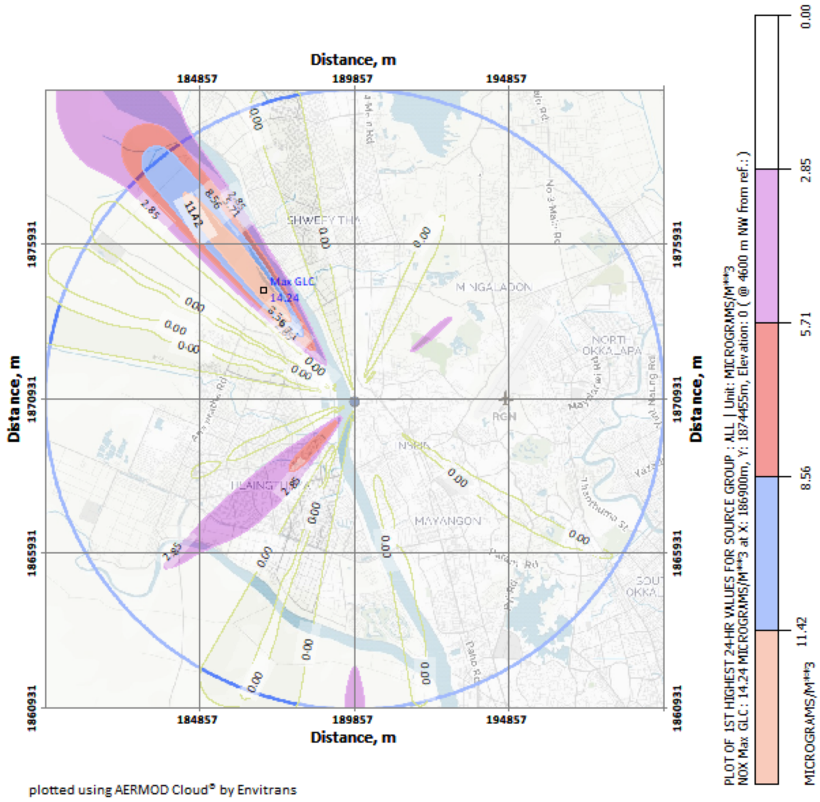


Figure 6-5: Isopleth showing NO_2 Ground Level Concentration of Proposed Plant

Emission factor input from USEPA-42 13.2.3

Aspects	Emission factor	Unit	kg/year	Control Efficiency
Site Preparation – Bulldozing	3.75E-13	kg/mg	6.27302E-08	50%
Site Preparation – Scrapers Removing Topsoil	9.07E-09	kg/mg	0.001517535	75%*
Site Preparation – Grading	2.72E-10	kg/mg	4.5527E-05	50%
Wind Erosion on Exposed Surfaces	0.38	ton/acre/yr	-	50%
Site Preparation – Truck Unloading	3.08E-13	kg/mg	3.86973E-08	50%

Note: This emission factor is for TSP, 50 percent reduction for watering and additional 50 percent reduction converting from TSP to PM_{10}

The modeling was done for PM10 concentration increase with the proposed construction site, i.e., the proposed 300 MW CCGT expansion. The modeling result shows an incremental GLC of about 109µg/m^3 at a distance of 50m in the SSE direction(Figure 6.2). Thus, the resultant GLC during construction phase will be about 198.6µg/m3. However, the concentration will be mainly confined within the plant boundary and thus will not affect any receptors such as the residential areas. The impact on the residential areas will be limited to about 10-15µg/m^3. Thus, the impact on air quality during construction will be minor.

Table 6-12: Impact Rating for Air during 'OP' Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Negligible	• Incremental 24 hrs. avg. Ground Level Concentration due to Gaseous Emission from plant (NO_2) will be about 0.01 µg/m^3 at nearest residential colony, which when added to baseline, will be 17.51 µg/m^3. • There will be no process emission of dust from plant operation and transport movement on paved roads causing fugitive dust emissions. • There will be no process emission of SO_2 as natural gas has no Sulphur. • As per design, the emission of CO from the gas turbine would not be an issue.
Duration of Impact	Long term	This impact will continue for the life of the plant, i.e. 30 years
Impacted Area	Area level	The impact of the plant will be localized within the boundary.
Likelihood of Occurrence	High	Daily for the period of 6 months, when all units are operational
Severity of Impact	Low	There will be no effect on human health or ecology due to incremental GLC of 0.01 µg/m^3

Environmental Impact Rating	Criteria	Reason
Significance of Impact	**Moderate**	**Detectable impact but no significance to human health or ecology**

6.3.1.6 Air Impact during de-Commissioning Phase

The impact during de-commissioning phase, hereinafter mentioned as 'D' Stage of the proposed plant, will be same as the 'PC' phase as the activities will involve dismantling of the whole plant. There will be no major emission of fugitive dust unless the paved surfaces are broken. As the plant will not contain any asbestos, there will be no disposal problem with asbestos. However, the foul water and spent oil is to be drained in containers and disposed of at nearest CETP and TSDF respectively. All the dismantled plant and machinery should be disposed off by transporting using river transport instead of road transport as the roads are expected to be heavily trafficked.

Thus, the significance of impact on air quality will continue to remain minor (same as Table 6.3 of Pre-Construction).

6.3.2 Impact on Surface Water

During the construction and operation phases, different activities have the potential to generate waste-water; accidental spills, sedimentation, and need of fresh water, which could lead to impacts on the hydrology and quality of surrounding freshwater bodies. In the Project Study Area, the Hlaing River is identified as the most prominent potential receiving body. Therefore, it is important to understand the interaction between impacts generated from various activities of the Project at different stages and the subsequent effects on surface water quality and hydrology.

6.3.2.1 Identification of Sensitive Receptors

As mentioned above, the Hlaing River is adjacent to the plant on the western side. There is also a water channel flowing along the western and southern boundary of the plant and ultimately crossing Ywama settlement and joining Hlaing River. All domestic waste water from the residential quarters is discharged through this channel. There are no static water bodies in the vicinity of the plant which could be affected by the project.

6.3.2.2 Competitive Users of Water

As mentioned earlier, make-up water for the proposed plant will be from Hlaing River. Presently water for the plants to be dismantled is sourced from ground water, which will be discontinued. As the water drawal system for the proposed plant will be a floating deck system, there will be no construction on the river bed. Thus no impact is envisaged on the water quality of the river during construction of the water intake system as well as the operation phase.

The main users of water from the points near to the plant are mainly industrial. Due to the saline nature of the water at this point, water for domestic purpose is not drawn from the river. No fishing is also allowed in this area due to heavy traffic of barges and ship movements. The lean season flow rate and usage of water upstream in river at this point is not available. However, as this is a perennial river and the water is allowed to be drawn by statutory bodies, they have taken into consideration lean season flow rate and competitive users. Thus, water drawl of 700m^3/ hour will not have any impact on the flow of the river and the competitive users even during lean season flow rate.

6.3.2.3 Consumption of Water

During pre-construction phase, the water requirement will be mainly for labour at construction site. The approximate number of workers for both civil and mechanical works is expected to be around 300. As there will be no labour camps and all workers will be locally sourced, the estimated consumption of water has been taken as 45 liter per capita per day (lpcd), amounting to 13.5 KLD. This water will be sourced from existing wells. It can be concluded that this quantity of water will have negligible impact on the surface water resources of the area.

During construction phase, the water requirement will be for about 800 labours at construction site and for construction needs. As there will be no labour camps and all workers will be locally sourced, the estimated consumption of water has been taken as 45 liter per capita per day (lpcd), amounting to 36 KLD. The main construction water requirement will be for water sprinkling for dust suppression, water for curing of concrete, plantations, etc. Water consumption for construction has been estimated about 2.5 KLD. Assuming the construction continues for 32 months, total water need would be 13824+960 =14784 KL for period during which civil construction will take place. The water will be sourced from the existing wells. This water will be sourced from existing wells. It can be concluded that this quantity of water will have negligible impact on the surface water resources of the area.

6.3.2.4 Impact in Pre-construction and Construction Phase

During pre-construction stage, the main consumer of water is 300 workforce and water for dust suppression only at lay-down area. No other process water will be needed for dismantling during pre-construction stage. The sanitary sewage will be discharged to septic tanks and no process effluents will be generated.

During construction phase, the pattern of sanitary water consumption and sanitary waste water generation will be same but for 800 workforce. However, process water will be needed for dust suppression in larger area as well as other construction needs and no process effluents will be generated. The nature of impact will remain the same in both the phases only duration and magnitude will change. Thus, the analysis has been done together.

During the pre-construction phase, the initial work will be related to electrical and mechanical aspects related to removal of structures. During C phase, potential water quality impacts may arise from higher domestic waste-water discharge, inappropriate waste storage and disposal, contaminated surface water run-off, and sedimentation.

6.3.2.4.1 Sanitary Wastewater Discharge

Wastewater discharge and run-off during the pre-construction and construction phase may lead to contamination of freshwater sources if sewage is discharged untreated. As it will be for duration of 6 and 32 months respectively, quantity of sewage will be approximately 11 to 36 KLD respectively assuming 80% of sanitary water consumption as sewage. However, as a municipal sewerage system is absent, a septic tank and soak pit is to be provided. In septic tank effluent from WC is collected. The effluent here gets treated biologically and the treated water will then be connected to the soak pit. The waste water from the bathroom, kitchen etc. is directly connected to the soak pit. Ultimately the waste water in the soak pit will get absorbed by the surrounding soil. It should be minimum 18 m and preferably 30m away from any source of drinking water, such as well, even bore well to mitigate the possibility of bacterial pollution of water supply.

As there will be no labour camps, the waste-water generation will be restricted to day-use only. Similarly, it has been learnt that in the JICA sponsored sub-station renovation project also, no labour camp will be set-up. However, if the raw sewage is not disposed properly, it can impact surface water quality by promoting the growth of algae and delivering pathogens that may be harmful to human and ecological receptors

During rainy season, there may be a risk of overflowing of septic tank if not designed properly.

Sanitary wastewater is generally characterized as having a high concentration of solids (suspended and dissolved), BOD and COD, nutrients (nitrogen, ammonia) and faecal coliform counts. The organic substances (e.g. hydrocarbon, protein) are decomposed in water, and the decomposition of organic matter will reduce the oxygen content dissolved in water. Quantities of sanitary wastewater discharge have been estimated around 29 m^3/day with assumption that 800 persons will consume 45 litre per capita per day.

6.3.2.4.2 Construction Wastewater from Site

Construction activities such as site clearance, earthworks, disposal of back fill materials, installation of hard standing areas, etc., could cause runoff of unconsolidated sediments during rainfall. The generation of sediment laden run off could be transferred to the nearby freshwater bodies, which could increase total suspended solids and turbidity in receiving waters. Construction or retrofit of the pumping station at the Hliang River may cause impacts on surface water quality if piling or dredging activities are required. This could result in localized impacts such as runoff and erosion of exposed bare soil, slopes and earth, and release of cement materials into surface water bodies with storm-water runoff. Baseline surveys for the Hliang River found that there were already elevated levels of TSS.

Wastewater may also be generated from washing of equipment and machinery onsite, as well as from the concrete batching plant. This wastewater may contain oil and grease, suspended solids and traces of hydrocarbons. The discharge of waste-water produced during concreting can also lead to changes in the pH of the receiving water-body, if not first treated by installing oil & grease traps and sedimentation pits before discharging to surface water bodies. (Table 6.13).

Table 6-13: Impact Rating for Water during Pre-construction & Construction Phases

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse	• Run-off water from stock-piles having high turbidity. However as all waste water will be

Environmental Impact Rating	Criteria	Reason
		passed through settlement pond, turbidity will be low • Sanitary Wastewater • Oil and grease from machine washing
Duration of Impact	Short-term	Will be confined for 6 months for PC phase and 32 months for C phase.
Impacted Area	Vicinity	The waste water from the construction site, if not passed through sedimentation pits after removing oil & grease, will be affecting the nearby drain on the eastern site and Hlaing River on the west. The impact will be confined within short distance ~~500m~~ from the site.
Likelihood of Occurrence	Medium	May occur daily during PC and C phase, especially during monsoons
Severity of Impact	Low	Will have low impact on nearby water environment, if passed through sedimentation pits after removing oil & grease, but no impact on human health
Significance of Impact	**Moderate**	**Detectable impact but no significance to human health**

6.3.2.5 Impact in Operation Phase

The operation phase is expected to continue for about 30 years. The assessment of operational phase impacts includes those arising both from routine operations and maintenance of the power plant. During the operation phase, potential surface water impacts may arise from domestic waste-water discharge, inappropriate waste storage and disposal, contaminated surface water run-off, cooling water withdrawal and discharge, erosion and sedimentation.

Cooling water intake structures do not affect the flow or direction of river. Being static, it may become safe habitat for some aquatic organisms. Some small organisms may, however, be sucked in. The intakes are provided with nets for protection of organisms as well as plant machines. However the impacts will be insignificant.

Sources and estimated quantities of waste-water generation from the plant during the operation and maintenance phase are as follows:

- Sludge from river water pre-treatment: 1m^3/hr
- DM plant neutralized water: 5m^3/hr
- Cooling tower blow-down: 70.5 m^3/hr
- Storm-water: intermittent
- Washing water from main block: intermittent
- Sanitary wastewater (sewage): ~ 4 m^3/hr

6.3.3 Impact of Discharge

It is foreseen that the waste waters from different streams will not have any chemical or any other materials having adverse effect on the environment. All water from the process will be discharged to Hlaing River after necessary curing. The cooling tower blow down with temperature not exceeding 3^{0}C above river water temperature will be drained into river directly. The other industrial wastewater treatment plant consists in ponds for sedimentation and treatment of the water from industrial areas and equipment. Equalization is expected in the tank.

The brine from RO will be directly discharged to Hlaing River **after equalization in an equalization tank**. However it has been ascertained that due to the saline nature of the river water, there will be negligible increase in the river salinity.

As for treating sanitary sewage, the existing septic tank and soak pits system will continue. However, it is suggested to explore the possibility of installing a STP as then there will be no discharge, as entire treated sewage will be reused for toilet flushing and plantation.

All the waste water generated at the various sources will be collected at one point in the **equalization tank** before treatment and then treated to meet the statutory requirements. Treated and equalized effluent will be disposed through plant's effluent outfall with regular monitoring. This discharge will thus meet the permissible standards. The other aspect which may have an impact on the river water is that the discharge of cooling tower blow-down directly into the river will increase the ambient water temperature of river water. However, as per the design, it will be ensured that the incremental temperature of the discharge water will not exceed 3°C so that the impact remains localized. Even with all these facilities, the impact on river water due to discharges is considered as Moderate considering accidental failure of treatment facilities and blow down water temperature (Δt) exceeding 3^{0}C.

Corrosion occurs more rapidly under acidic conditions. Effective pH control is required to reduce the effects of corrosion. In addition, to control toxicity of cooling tower blow down to aquatic fauna and flora the following is recommended:

- Choosing chemical additives: Biocides: Carbamates and triazines are considered to have a moderate to low toxicity to aquatic fauna and flora. They should be used instead of hydantoins, isothiazolones and quaternary ammonium compounds, which have a higher toxicity rating.
- Corrosion inhibitors: Borax and non-ionic surfactants are considered to have a low toxicity to aquatic flora and fauna. They should be used instead of tolytriazole and glycols, which have a higher toxicity rating.

The overall impact on water quality during operation phase is rated in **Table 6.14**.

Table 6-14: **Impact Rating for Water during Operation Phase**

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Negligible	• Cooling tower blow-down • Effluent from Demin Plant • Sanitary Waste-water • Discharge of RO water • Oily waste from machine washing

Environmental Impact Rating	Criteria	Reason
		• Incremental temperature of blow-down water, although it will be maintained within 3°C. • Discharge through submarine pipeline.
Duration of Impact	Long term	Daily for the period of 30 years, when all units are operational
Impacted Area	Vicinity	Will be localised restricted within a few meters from the point of discharge in Hlaing River
Likelihood of Occurrence	Moderate	May occur daily
Severity of Impact	Slight	Will have low impact on the water quality of Hlaing River and is not expected to have any impact on aquatic ecology
Significance of Impact	**Moderate**	**The variation due to impact of the project will remain within the natural variation of the river water quality**

6.3.4 Solid Waste

6.3.4.1 Impact in Pre-construction Phase

Dismantling of the plants will lead to generation of negligible solid wastes from mechanical and electrical dismantling and dismantling of civil structures. The list of units to be dismantled including power plant equipment, structures, transmission equipment and materials from civil structure is as follows in **Table 6.15.**

Table 6-15: Common Decommissioning Waste Streams

Sector	Type of Wastes
Powerhouse Equipment	Generators, turbines, boilers, precipitators, pumps
Structures	Buildings, pads and cooling towers
T&D Equipment	Cables, Wiring, Poles, Underground Cables
Power Electronics	Inverters, transformers and other power electronics
Recyclable/Salvageable Decommissioning Wastes	Steel, copper, brick, concrete

The powerhouse equipment of the 23.4MW Hitachi Plant will be dismantled and transported to its new location for reinstallation, while the equipment of the John Brown plants will be sold off to registered recyclers. Other industrial wastes will be managed just as maintenance wastes are treated during operation: they will be put in containers, characterized and labeled, stored briefly and transported to an appropriate off-site disposal facility through a recycler. Impacts could be serious if these wastes are not properly handled and are released to the environment (**Table 6.16**). In Yangon region, the system of industrial waste management system is not well developed. Till a few years back, industrial waste also used to be disposed in MSW land-fill sites. However recently Dowa Holdings Co., Ltd. of Japan has established and begun operating Myanmar's first industrial waste treatment and controlled landfill facility at the Thilawa Special Economic Zone. It is proposed that all the industrial wastes during pre-construction phase will be sent to this industrial waste disposal site.

The C&D wastes estimated to be generated during this phase is about 5400 tons[19]. Most of the materials can be either recycled and sold or used for land-filling. It was found that there are recyclers for C&D wastes in Yangon. These agencies will be hired by the plant for proper disposal of C&D wastes. Demolition, evacuation, site preparation and discharge will confirm to the World Bank standards.

In addition to that, municipal solid waste will be generated from the workers. It is estimated that about 60kg of MSW[20] will be generated per day, which is easily manageable and will be collected by YCDC. Waste Management is the responsibility of YCDC. They will collect, treat the biodegradable part and dispose off the non-biodegradable part to recyclers as a standard practice. There are 6 final disposal sites (FDS) for MSW in Yangon City. The nearest FDS to the site, where all the MSWs of the area are disposed is Htein Bin FDS, which is also the largest one with a capacity of 847TPD. Segregation is done at site and will be done by YCDC.

Table 6-16: Impact Rating for Solid Waste during Pre-construction Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse Insignificant	• Generation of Municipal Solid waste from workers • Improper disposal can lead to damage on host environment
Duration of Impact	Short term	Initial solid waste will be more of steel followed by C&D wastes. However the whole activity will be limited to 6 months
Impacted Area	Within project site	All stock-piles will be located within the plant site and lay-down area
Likelihood of Occurrence	High	Solid wastes in some form will be generated through-out the pre-construction period.
Severity of Impact	Medium	Will have impact of the host environment if not managed properly as the quantity of industrial and C&D waste is quite high
Significance of Impact	**Moderate**	**Will have impact on human life and host environment if not disposed properly**

6.3.4.2 Impact in Construction Phase

During the construction phase the solid waste generated will be mainly C&D wastes and municipal solid waste from about 800 labours and materials such as woods, polythene, plastics and cartons from casings of machineries. Much of the brick, concrete and metals used to build the structures of the plant will be recycled..

[19][19] As the construction type is similar to that of India, estimation has been done on the basis of calculations done by Central Pollution Control Board, India. The estimate is on basis of 400kg of C&D waste per square metre.

[20]The MSW generation has been taken @ 0.2kg per person per day

The C&D wastes estimated to be generated is about 675 tons[21]. Most of the materials can be either recycled and sold or used for land-filling. Thus, no impact is foreseen on solid waste during construction.

It is estimated that 160 kg of MSW[22]per day will be generated during the construction phase. As there will be no labour camps, the generation of MSW (paper, plastic and food waste) will be negligible. The mode of disposal will be the same as in the pre-construction phase and as per World Bank Criteria.

Table 6-17: Impact Rating for Solid Waste during Construction Phase

Environmental Impact Rating	**Criteria**	**Reason**
Nature of Impact	Adverse Significant	• Generation of solid wastes, recyclable and non- recyclable from demolition and removal of foundations and civil structures. • Generation of C&D wastes, both recyclable and non- recyclable from construction activities of about 675 tons, which will be recycled or used as landfills • Municipal Solid Waste will be generated of about 60kg per day • Improper disposal can lead to damage on host environment
Duration of Impact	Medium term	However the whole activity will be limited to 32 months
Impacted Area	Within project site	All stock-piles will be located within the plant site and lay-down area
Likelihood of Occurrence	High	Solid wastes in some form will be generated through-out the construction period.
Severity of Impact	Low	Will have impact of the host environment if not managed properly
Significance of Impact	**Minor**	**Will be insignificant with proper disposal systems**

6.3.4.3 Impact in Operation Phase

During the operation phase, the plant is expected to produce limited additional waste streams than those estimated during C phase. The waste streams will be generally municipal solid wastes from labours or a range of wastes such as waste papers from office, scraps of steel or plastic during maintenance activities. While most of them will be non-hazardous, there will be some such as paints, engine oils, spent solvents, lubricating oils, batteries, which may be hazardous. However, generation of hazardous and other solid wastes will be very less and occurrence far in between (**Table 6.18**).

Table 6-18: Impact Rating for Solid Waste during Operation Phase

[21] The C&D Waste for this phase has been taken as 50kg/m^2 (TIFAC 2000)
[22]The MSW generation has been taken @ 0.2kg per person per day

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse Insignificant	Generation of municipal solid wastes and maintenance wastes
Duration of Impact	Long term	Will continue for the life of the plant
Impacted Area	Inside the plant	There is no risk of generation of waste outside the plant
Likelihood of Occurrence	High	MSW will be generated on daily basis
Severity of Impact	Slight	No impact on human life or ecology expected
Significance of Impact	**Negligible**	

6.3.5 Hazardous Waste

6.3.5.1 Impact in Pre-construction Phase

During dismantling, the hazardous wastes contained in the mechanical and electrical equipment are to be drained and disposed off. Wastes like lubricating oils, hydraulic fluids, dielectric fluids, coolants, solvents and cleaning agents are managed just as maintenance wastes are treated during operation. For avoiding spillage to soil and then to ground water, they will be put in containers, characterized and labeled, stored briefly and transported to an appropriate off-site disposal facility through a recycler. Impacts could be serious if these wastes are not properly handled and are released to the environment. The tanks containing hazardous wastes are also to be disposed off through certified agencies. During dismantling, the soil may get contaminated if there is uncontrolled spills of oil. Though most of the area is paved, contaminants may percolate to soil through cracks. The removal of entire quantity of floor and contaminated soil will be very costly As such, in-situ bioremediation is recommended . The application of microorganisms or microbial processes to remove or degrade contaminants from soil is called bioremediation. This microbiological decontamination is claimed to be an efficient, economic and versatile alternative to physicochemical treatment of soil contaminated with petroleum products.

Asbestos: Out of the 3 units to be dismantled, 2 will be scrapped and 1 will be relocated. It was informed by EPGE that the asbestos insulated pipes are only used in the Hitachi H25 CCGT plant, which will be reinstalled at another site. The other 2 units to be scrapped do not contain any asbestos. One of the major concerns in the H25 CCGT plant to be relocated is presence of asbestos as insulations in the hot air pipes. The pipes will be dismantled, packed and dispatched along with the casing after wrapping in LDPE sheets. Thus there will be no issue of storage of asbestos. The only concern will be when the piping having asbestos will be cut during dismantling. Only trained personnel will be allowed to remove the ancillary parts having any asbestos with proper PPEs recommended for asbestos.

Asbestos, if not handled and stored properly may have negative impact on the health of the personnel handling them. Asbestos has been linked to *mesothelioma* and other asbestos-related diseases. The inhaled or ingested, the microscopic asbestos fibers work their way into the lining of the lungs, abdomen or heart. Over a period of 10 to upwards of 50 years, the fibers can cause inflammation and scarring, which can eventually develop into *mesothelioma*tumours or other related conditions.

Thus, the significance of impact has been classified as major (**Table 6.19**).

Table 6-19: Impact Rating for Hazardous Waste during PC Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse Significant	• Removal of pipes containing asbestos from existing hot air pipes • Handling, packaging and transportation of asbestos insulated pipes.
Duration of Impact	Short term	Will be limited to the period when the pipes will be cut and dismantled
Impacted Area	Vicinity	Impact will be local.
Likelihood of Occurrence	Low	It is not necessary that there will be risk of contamination of the air environment with asbestos, if the process is handled with proper mitigation measures.
Severity of Impact	High	Has severe impact on human health
Significance of Impact	Moderate	

6.3.5.2 Impact in Construction and Operation Phases

Construction Phase:

No handling of asbestos and other hazardous materials except for spent oil is foreseen during the C and OP phases. Foundation of transformers will be made of reinforced concrete. The foundations will include holding sumps with adequate provision for rainwater and will have a special oil removal system in case of oil spillage. The new plant and Machinery which have been erected for the plant will be free of asbestos. However during construction spent oil is expected from construction equipment.

However maintenence of construction machinery will be done outside of the plant therefore there will be no impact expected within the plant.The quantification of such leakages of hazardous waste are not possible at this stage as it will depend on the frequency and type of plant maintenance.

Table 6-20: Impact Rating for Hazardous Waste during Construction Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse Negligible	Handling and storage of spent oil occasionally
Duration of Impact	Short term	Will be stored and sold to recyclers. Will not be stored for long
Impacted Area	Inside the plant	Even in case of spillage, it will be within the plant
Likelihood of Occurrence	Medium	This risk is not a normal feature and will occur only in case of careless handling or accidental spillage
Severity of Impact	Low	The quantity of oil will be very less, and thus even in case of spillage, severity will be less
Significance of Impact	**Minor**	

Operation Phase:

Each transformer will be enclosed by reinforced concrete blast/fire walls on three sides and by a removable fence with personnel access gate on the remaining side. Industrial wastes like lubricating oils, hydraulic fluids, dielectric fluids, coolants, solvents and cleaning agents are generated and needs to be disposed of. In both the phases, for avoiding spillage to soil and then to ground water, they will be put in containers, characterized and labeled, stored briefly and transported to an appropriate off-site disposal facility through a recycler. Impacts could be serious if these wastes are not properly handled and are released to the environment. Even generation of spent oil will not be frequent and will be limited to periods when there is a major maintenance. Thus, the significance of impact has been classified as negligible (Table 6.20).

Environmentally sound management of hazardous and other waste are managed in a manner which shall protect health and environment against the adverse effect which may result from such waste.

Table 6-21: Impact Rating for Hazardous Waste during Operation Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse Negligible	Handling and storage of spent oil occasionally
Duration of Impact	Short term	Will be stored and sold to recyclers. Will not be stored for long
Impacted Area	Inside the plant	Even in case of spillage, it will be within the plant
Likelihood of Occurrence	High	This risk is not a normal feature and will occur only in case of careless handling or accidental spillage
Severity of Impact	Medium	The quantity of oil will be very less, and thus even in case of spillage, severity will be less
Significance of Impact	**Moderate**	

6.3.6 Impact on Soil and Ground Water

There are different activities which have the potential to generate waste water, accidental spills, and hazardous wastes which could lead to contamination of soil and ground water through leaching. As already informed, in order to avoiding spillage to soil and then to ground water, they will be put in containers, characterized and labeled, stored briefly and transported to an appropriate off-site disposal facility through a recycler. In addition, excessive ground water use by the project may impact the depletion of ground water for users in surrounding communities. The ground water use will continue only till end of construction after which, water from river will be used.

6.3.6.1 Impact in Pre-Construction, Construction and De-commissioning Phases

The activities which could lead to impact on soil and ground water are:

- Accidental events (spills, leaks and uncontrolled releases)associated with storage, handling and disposal of hazardous materials including fuels and spent oils;
- Excavation during site preparation
- Waste-water discharge
- Storage of hazardous and non-hazardous materials
- Ground water abstraction

Generally, the impact on soil during construction activities in construction phase is due to spillage, run-off from stock piles and improper storage of materials. The leaching causes impact on the quality of ground water **(Table 6.21).**The other risk may be depletion of ground water due to excessive withdrawal for domestic and industrial use.

At the present site, there is very little presence of top-soil as the area is already graded and developed for the existing power plant. The only top-soil will be from the northern part of the site and it is estimated that 18000 m^3 of soil will be produced. This soil will be conserved and later used for plantation and landscaping.

Spillage of oil can lead to contamination of soil. However, the probability of oil spillage of large quantum, which can contaminate the soil, is very low. Also exposed soil in the area is very less as most of the area is presently concrete. So during pre-construction and construction phase, there will be negligible chance of soil contamination.

Table 6-22: Impact Rating for Soil during Pre-construction and Construction Phases

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse Insignificant	• Removal of top soil • Spillage leading to contamination of soil
Duration of Impact	Short-term	The top soil to be removed will be reused for plantation and landscaping The risk of contamination of soil from spillage of oil will be limited to 6 months of pre-construction and 32 months of construction.
Impacted Area	Inside plant	The only means of soil contamination is from spillage. All activities related to oil handling will be done inside the plant or lay-down area and any impact also will be restricted within the plant.
Likelihood of Occurrence	Low	The likelihood of spillage of oil will be low and may occur once or twice a year due to careless handling or leakage
Severity of Impact	Low	Will have negligible impact as the quantity of spillage will be small and will not come in contact with any water sources
Significance of Impact	**Negligible**	

6.3.6.2 Impact in Operation Phase

As already mentioned, ground water will be used only for drinking purpose. Also, the plant area will be paved, thus reducing the risk of leaching of oils. Exposed soil in the plant area will be non-existent. Overall there will be negligible impact of the plant activities on soil as well as groundwater (**Table 6.22**).

Table 6-23: Impact Rating for Soil and Ground water during Operation Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse	• Abstraction of water • Leaching of pollutants in ground water leading to degradation of water quality
Duration of Impact	Short term	There will no impact due to water abstraction, as the process water will be sourced from Hlaing River. As the quantity of oil, even in incident of leaching will be so less, that the impact will be short-term.
Impacted Area	Localized	If there is contamination of ground water, it may travel through the aquifer
Likelihood of Occurrence	Unlikely	Spent oil will only be produced at long intervals, when there is maintenance.
Severity of Impact	Low	Even if there is contamination of ground water, the quantity of oil will be so less, that the severity will be low.
Significance of Impact	**Negligible**	

6.3.7 Impact on Noise & Vibration

6.3.7.1 Identification of Sensitive Receptors

The impact of noise from the plant on the nearby residential area is a major cause of concern. At present the baseline noise level recorded about 76.5 dB(A) during day time and 65.5 dB(A) during night time at nearest residential area which is about 100m from the center of the existing power plant. Introduction of new units may lead to the risk of further increase of sound pressure level. The residential areas are located adjacent tothe boundary of the plant, specially 80 apartments (buildings E6-E10) located closest to the power plant. There are also settlements on the southern side of the plant which may be affected by the noise emitting from the plant.There are also settlements on the southern side of the plant which may be affected by the noise emitting from the plant.

For impact of noise on workers, OSHA NOISE Standards can be referred.

OSHA Noise Standards

General Industry: 29 CFR 1910.95, "Occupational Noise Exposure." This standard is designed to protect general industry workers, such as those working in the manufacturing, utilities, and service sectors. The General Industry standard establishes permissible noise exposures, requires the use of engineering and administrative controls, and sets out the requirements of a hearing conservation program. Paragraphs (c) through (n) of the General Industry standard do not apply to the oil and gas well-drilling and servicing operations; however, paragraphs (a) and (b) do apply.

The general industry noise standard contains two noise exposure limit tables. Each table serves a different purpose:

- ***Table G-16:*** This table applies to the engineering and administrative controls section, which provides a 90-dBA criterion for an 8-hour TWA PEL and is measured using a 90-dBA threshold (i.e., noise below 90 dBA is not integrated into the TWA). This table limits short-term noise exposure to a level not greater than 115 dBA (for up to 15 minutes).
- ***Table G-16A:*** This table, presented in Appendix A of 29 CFR 1910.95, provides information (e.g., reference durations) useful for calculating TWA exposures when the work shift noise exposure is composed of two or more periods of noise at different levels. Although this table lists noise levels exceeding 115 dBA, these listings are only intended as aids in calculating TWA exposure levels; the listings for higher noise exposure levels do not imply that these noise levels are acceptable.

As per the FS, the gas turbine may be installed inside a noise enclosure usually designed for 85 db(A) at 1 meter. Low noise enclosure to limit the pressure level at 1 meter to 80 db(A) is possible but not standard. The other solution is to install the GT inside a building (indoor GT). Thus, the noise level in work zone, i.e., beyond 1m from the plant shall not exceed 80 db(A) at 1 meter which is well within OSHA Standards. Thus, the impact of noise on workers will be negligible.

6.3.7.2 Impact in Pre-construction and ConstructionPhase

During the construction phase of the site, the main source of noise pollution would be construction equipment, transportation activities and impact of noise due to work at night. Noise from earth-moving equipment has the potential to cause nuisance, especially if large numbers of machinery used that are in poor operating condition (i.e. without noisy mufflers). Therefore, the earth-moving activities associated with the excavation of waste have the potential to create a social disturbance as a result of generating nuisance noise. Noise will be generated from vibrating machinery, movement of trucks, operation of front-end loaders and vehicle reversing alarms. Other sources include generation of noise during the operation of DG sets, during concreting, hammering, etc. and from mechanical operations, like, drilling, fitting, etc.

Table 6-24: Noise Level of Different Machineries during Construction

Machines	Noise Pressure Level dB(A) at 1m from equipment
Vehicles bringing material to the site	70
DG set	85
Excavation	80
Concrete Breaker	80
Hammering	85
Loaders	85
Scrappers	85
Pavers	89
Grader	85

A noise modeling was done to understand the extent to which the impact of incremental noise will reach outside the plant boundary. It was found that at 200 m the noise level reaches the day-time standard of 55dB (A), while the night-time standard is reached of 45dB (A) is reached at 600m. It can be also noted from the table below, that the incremental noise pressure level at the residential building on the eastern boundary of the plant is much higher than the standard. Further it can be observed that at the densely populated Ywama West Quarters the night time standards are not met. Thus there has to be reduction of construction activities using heavy machineries at night.

Table 6-25: Predicted Noise Level during Construction

Distance in m from source	Predicted Noise Level	Remarks
50	71.30	Noise level at residential buildings located at 50m
100	59.20	
200	54.00	Day-time Standard of 55dB(A)
300	50.80	
400	48.40	Noise level at Ywama West Quarters located at 400m
500	46.60	
600	45.00	Night-time Standard of 45dB(A)
700	43.70	
800	42.60	
900	41.60	
1000	40.70	

Mitigation measures have to be taken to reduce impact of noise on residential areas.

Table 6-26: Impact Rating for Noise-PC and C Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse Significant	Noise from heavy construction equipment, transportation activities
Duration of Impact	Short term	Will be restricted to the pre-construction and construction phase
Impacted Area	Vicinity	The sound pressure from construction will reach the permissible limit of 55dB (A) at a distance of 200 m from the site.
Likelihood of Occurrence	High	There will be continuous noise above 55dB(A) in the area
Severity of Impact	Medium	Will have impact on human life and fauna
Significance of Impact	**Moderate**	

Table 6-27: Distances at which certain construction activities relevant to the proposed development give rise to a just perceptible level of vibration

Construction Activity	Approximate distances at which vibration may just be perceptible it is generally accepted (between 0.15 and 0.3 mm/s peak particle velocity).
Heavy Vehicles (e.g. dump trucks)	5-10 m
Excavation	10-15 m
Vibratory compaction	10-15 m
Hydraulic breaker	15-20 m

Rotary bored piling	20-30 m
Auger piling	15-20 m

Note:

(i) *Ref. 162 megawatt CCGT Power Station of Palm Paper Limited, Former British Sugar Site, Poplar Avenue King's Lynn, Norfolk, PE34 3AL.*

(ii) These figures are based upon historical field measurements at various similar construction sites. Table 7-6 Distance from activity when vibration may just be perceptible

6.3.7.3 *Thus, it is observed that the construction vibration shall not reach beyond the boundary level.*

6.3.7.4 Impact in OP Phase

The sources of noise associated with the operation of the power plant are expected to include the HRSG, gas turbines, steam turbine and cooling tower. The key assumption for the noise assessment is that the power plant will be generally operated for 24 hours per day throughout the year, unless dispatched off-line by the grid control center or shut down for maintenance. The sound pressure levels of various equipments are given in **Table 6.27**.

Table 6-28: Sound Pressure Level of Various Equipment

Sources of Noise	Noise Level dB(A)	
Noise level of different units (Existing)		
Hitachi turbine (33.4MW) (will be removed after expansion)	109	
Mitsubishi turbine-1 (120 MW)	95	
Mitsubishi turbine-2 (120 MW)	95	
Gas engine (50 MW)	95	
John Brown turbine 1 (18.45 MW) (will be removed after expansion)	95	
John Brown turbine 2 (18.45 MW) (will be removed after expansion)	95	
Noise level of different units (Expansion) as per Technical Consultant		
	Without Control	**With Control**
Gas Turbine Building	85	45
Gas Turbine step-up transformer	75	55
Gas Turbine air intake	75	65
Gas Turbine diffuser	85	60
Heat Recovery system generator	85	50
Heat Recovery system generator stack generator	70	65
Steam turbine step-up transformer	75	55
Steam turbine building	85	50
Cooling tower	85	80

6.3.7.5 Predicted Noise Levels

Noise level modeling was done to ascertain the predicted noise level after expansion of the plant. Noise modeling output shows the calculated pristine condition noise level at project site is 66.7 dB (A) while in present condition observed and calculated values are 96.0 dB (A) and 95.9 dB (A) respectively. Its output also indicates that the measured as well as calculated values have an insignificant difference in project site and nearest residential areas. However at the two other monitoring sites, there is a significant difference between calculated and monitored values due to other background noise sources.

Table 6-29: Predicted Noise Levels due to Existing Plant in different distance and compare with monitored Values

Sl No	Distance	Existing	Monitored value
Unit	m	dB(A)	
1	5	95.8	96.0
2	50	75.8	76.5
3	100	68.7	
4	200	63.4	
5	300	60.0	
6	400	57.8	
7	500	55.8	
8	600	54.2	
9	700	52.8	
10	800	51.7	
11	900	50.7	55.4
12	1000	49.8	

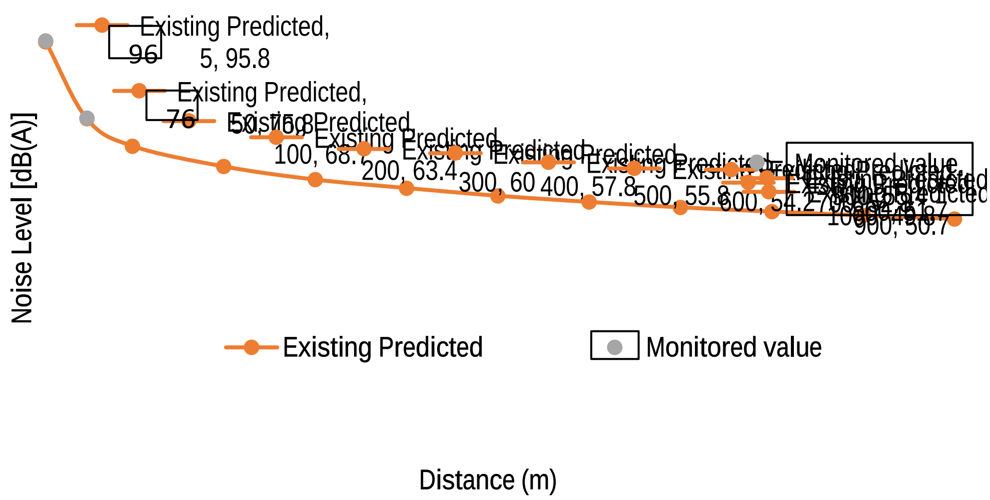


Figure 6-6: Noise level with distance in existing condition and monitored value

Modeling result shows that the calculated values of operation phase noise level with control and without control conditions (**Table 6.29**). During the operation phase noise level will be 85.0 dB (A) at project site and in control condition it will be 53.9 dB (A). The combined noise of existing units and new units at operation phase will be within the limits at a distance of 200m (**Figure 6.6**).

Table 6-30: Predicted Noise Levels in OP phase of project with and without control

Sl No	Distance		Without Control	With Control
Unit	m		dB(A)	
1	Towards River	500	44.7	42.8
2		400	46.4	44.3

Sl No	Distance		Without Control	With Control
3		300	48.5	46.1
4		200	51.4	48.4
5		100	55.9	49.9
6	Project site	0	85.0	50.2
7	Towards Residential Area	100	66.3	53.9
8		200	54.2	43.6
9		300	48.7	41.7
10		400	45.9	40.7
11		500	43.7	39.2

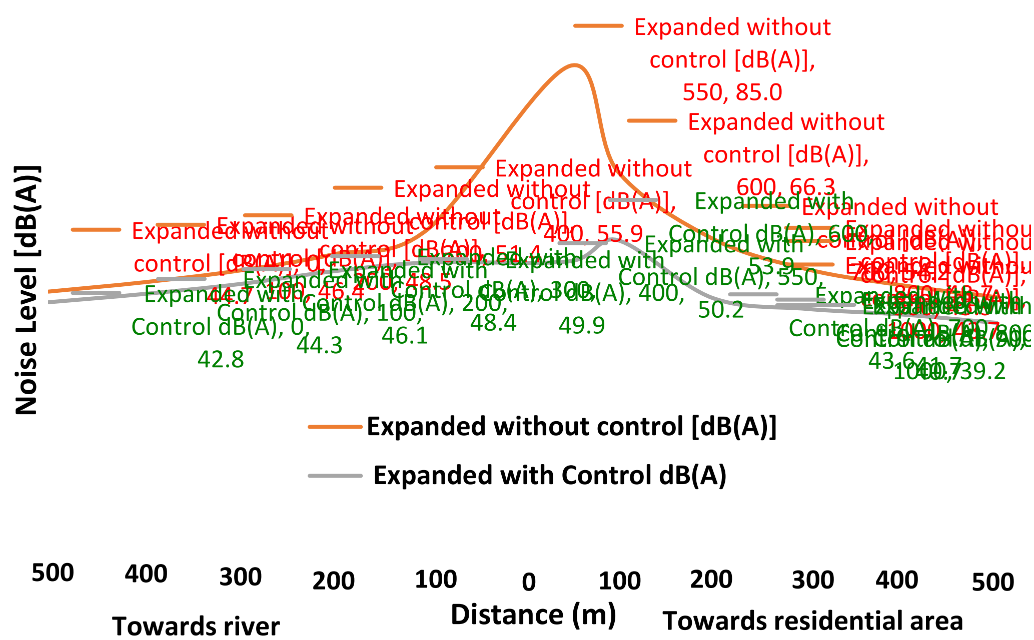


Figure 6-7: Predicted Noise Levels in operation phase at different distance with and without control conditions

From the above results it can be ascertained that the noise level at the residential buildings will be much higher than the standards, without control. In most cases, it will exceed the prescribed WBG EHS Guidelines' limit of 55 dB(A) during day time and 45 dB(A) during night time for residential areas. Because of that, sufficient noise control measures should be adopted as part of the detailed plant design for expansion and the equipment will be designed to achieve the noise power levels defined. The EPC contractor will be responsible for undertaking additional noise studies and implement adequate mitigation measures to ensure that noise levels for the residential area will be within the WBG ESH Guidelines. In case those noise thresholds cannot be met by implementing cost-effective measures, EPGE will relocate staff living in the areas affected by noise.

Table 6-31: Impact Rating for Noise during Operation Phase

Environmental Impact Rating	Criteria	Reason
Nature of Impact	Adverse	Noise emitted from the Gas Turbines, steam turbines, cooling tower and other ancillary units of the plant
Duration of Impact	Long term	The noise will be continuous for the period of operation
Impacted Area	Vicinity	The noise will reach the standard within 200m from the plant
Likelihood of Occurrence	High	There will be continuous noise above 55dB(A) till 200m of the plant
Severity of Impact	Medium	Will have impact on human life and fauna
Significance of Impact	**Moderate**	

6.3.7.5 Vibration during Operation

The vibration level of turbine and all rotating parts shall be monitored on regular basis to avoid unbalance which is needed for the plant to operate effectively. Special attention will be paid to minimize the expected impacts caused to the nearby residential areas by the sporadic emergency shutdowns. Therefore, the vibration levels produced by CCGT equipment will be minimized by ensuring that equipment is maintained properly in balance at all times to reduce the generation of vibration at its source, and by providing suitable vibration isolation for all plant items such as turbines, generators, pumps, compressors, and fans from foundations or other structures and from connecting vents, ducts and pipes that might transmit the vibrations to the ground or to other plant items. During operation, the uses of these anti-vibrational support and equipment connections shall correspond to the requirements of the Best Available Technologies. The expected vibration level from sources in the CCGT units will not exceed 50 dB and will not be felt beyond operational area.[23]

6.4 ECOLOGICAL IMPACT

As already mentioned, the proposed plant is being set up in an urban area and is surrounded by a river on one side and industrial and residential area on the other three sides. Thus, the floral and faunal diversity is very low. In the whole study area, vegetation was found only near the boundary of the plant. However, some of these trees are to be felled to make space for the proposed plant and the lay-down areas.

6.4.1 Nature of Impact

The assessment refers to the land development, construction and operation of the power plant including the main and ancillary facilities. The nature of impact on diversity is provided in **Table 6.31**.

Table 6-32: **Nature of Biodiversity**

Nature of Impact	Description

[23] Environmental Impact Assessment Project Number: 43151 Date: December 2009, Republic of Uzbekistan: Talimarjan Clean Power Project

Direct Impact	Direct physical cutting of trees or impact from project on species habitat
Indirect Impact	Secondary impact resulting from the project on species habitat
Spatial Impact	Impact on species habitat including isolation of population, impact on heterogeneity of species, connectivity between various habitats, etc.
Temporal Impact	Reversible impact due to certain activities in a project cycle

For the assessment of impact, on terrestrial and aquatic biodiversity, the resources and receptors identified are based on:

- Habitat and flora identified in baseline survey
- Terrestrial wildlife found in the baseline survey
- Aquatic fauna due to proximity of site to the river

6.4.2 Impact in Pre-construction and Construction Phase

Disturbance to habitat in modified and natural habitat areas during construction has the potential to impact the local biodiversity. In the project it is expected that 129 trees will be felled to make space for new plant and preparation of lay down areas. Though the trees are planted, it has gained some ecological values over the period of time.This can be defined as the direct impact on ecology. However, the habitat to be destroyed is an isolated patch of land and is not linked with any larger ecosystem or habitat. Thus, there will be no impact on any larger habitat.

Among the trees to be cut, there are no endangered species planted. However, the trees are located on the eastern and southern boundary of the plant and acted as a natural green belt for the residents of Ywama and EPGE colonies. Once these trees are cut, the residential areas will be exposed to fugitive emission, especially during the construction period. The summary of the impact on habitat is given **Table 6.32**.

Table 6-33: Impact matrix for Ecology during Construction

	Impact	Description/ Comment	Sensitivity	Magnitude	Significance
Permanent loss of habitat	There will be permanent loss of vegetation consisting of 49 trees, other than shrubs, etc.	The habitats that are to be lost are common (low sensitivity) and will be limited to those absolutely required for construction. Where possible topsoil will be managed locally and natural regeneration or rehabilitation using native species will be undertaken in areas not required for the operation of the Project	Low	Medium	Minor
Temporary disturbance to fauna behaviors	Disturbance to fauna due to lights, noise	It is found that there is no faunal presence in the area except for domesticated animals. No important avi-fauna	Low	Small	Negligible

	Impact	Description/ Comment	Sensitivity	Magnitude	Significance
	and vibration	was also identified in the area			
Fauna mortality	Small animals, mainly amphibians, which are unable to disperse may be affected	Mortality of small animals, mainly amphibians may die or get injured during site clearing activities. This concern is related to the lay-down areas as the plant will be set up where plants are presently located.	Low	Small	Negligible

6.4.3 Impact on Fishes

The temporal variation in water temperature is important to the survival of fish. The effect of temperature is evident through its control in order of the alteration of biochemical reactions. Fish are poikilotherms, so, metabolism is dependent on temperature, with ambient water temperature controlling molecular activity of metabolites. The optimal temperature of species is at which primarily biochemical reactions are at most efficient.

The surface water temperature has an impact on chemical concentration. An increase or decrease in temperature of the water leads to the speeding up of the chemical reactions in water and reduces the solubility of gases like dissolved oxygen. At elevated temperature metabolic activity of the organisms increase demand for oxygen, but the solubility of oxygen decreases.

Table 6-34: Criteria& Effects of Temperature (°C) on some Fish Species

Species	Lower lethal temperature tolerance range	Range for growth	Range for egg incubation & larval development	Upper lethal temperature range
Intermediate species				
Cyprinuscarpio	2-4	30-32	18-23	32-41
Micropterussalmoides	6	25-27	16-24	36
Warm-water species				
Clariasgariepinus	8-10	28-30	27-30	40-43
Oreochromismossambicus	9-11	28-30	24-28	40

As mentioned before, the waste water to be discharged into the river will have an incremental temperature of 3°C. The ambient temperature of the river water was found to be 32°C. Some fishes available in the rivers in the area were analyzed for their tolerance of temperature for survival and egg incubation. Thus, it can be seen from **Table 6.33** that the incremental temperature will not affect the fish life in the river.

6.4.4 Impact in Operation Phase

The impact on ecology during operation phase is not envisaged as there will be no further destruction of habitats during this phase. The noise, which is the most impacting factor will reach 55dB (A) at 800m. As there is no other floral or faunal habitat within this range, the impact will be non-existent.

6.5 SOCIAL IMPACT ASSESSMENT

6.5.1 Receptors

For conducting socio-economic impact assessment, the main target groups are as follows:

Direct Impact area: The area which will be utilized for the project and where the population/facilities will not have access.

Indirect Impact area: This is the area around the project site which may be indirectly impacted due to environmental and social issues.

6.5.2 Anticipated Impacts

As the project is being developed in an area already under possession of the proponent, there is no requirement of any land acquisition or involuntary displacement. No impact on any indigenous groups are envisaged. The detailed analysis of the socio-economic impact due to the project is described in the section below.

6.5.2.1 Labor Influx, Skill Training and Employment Generation

It is estimated that there will be recruitment of about 300 workers during the dismantling of the old plant (PC stage). This will increase to about 800 during the construction phase. It was found that the unskilled and semi-skilled workers will be recruited locally. As the project site is located in an industrially developed area, there is no dearth of workers. The nearby settlements of Ywama sub-quarters have population who are trained as electricians, welders, masons, etc.

The general risks associated by in-migration of workers are social conflict, increased pressure on the existing infrastructure, increase in crime rate, risk of communicable diseases and gender-based violence. During the construction works, labor influx is expected to be moderate. Workers camps are not expected, and the project activities will be carried out near residential areas. However, to reduce labor influx and boost local benefits of the project, a training program will be in place for EPGE together with the EPC contractor to provide skill training to eligible local people so that they become skilled workers that can be employed in the plant, at least, for the pre-construction and construction phases. Most of the people in the area are casual workers and are employed for temporary jobs in the neighboring areas. So, getting employment for about 3 years at a stretch during the construction phase will be beneficial to them and help in providing them with a steady source of income at least for 3 years. During the operation phase, there will be mainly requirement of skilled workers. It was found that the manpower is already available with EPGE and there will not be any requirement of additional manpower, except for maybe about 10-12 technicians who are specialized in operation of a CCGT plant.

However, even during operation phase indirect job opportunities will be created in the plant and in petty business outside the project boundary such as restaurants, shops in order to cater to the needs of the workers. Thus, the impact of the project in terms of employment generation are expected to be positive.

6.5.2.2 Business Development

Operation of a large power plant will lead to requirement of ancillary units for supply of spare mechanical and electrical parts. Thus, there will be generation of business in the area which will help in boosting the economy.

6.5.2.3 Land Acquisition and Resettlement

As already mentioned, the proposed project is a brownfield project and there is no requirement of additional land outside the existing plant boundary. The laydown area proposed to be taken on rent outside the boundary is also vacant land and has industrial land-use. Thus there will be no issues related to displacement or resettlement.

6.5.2.4 Impact on Indigenous People

The proposed project is located in an urban area, which has a heterogenous population in terms of social and ethnic background. The area is mainly dominated by the Bamars, who constitute about 88% of the population. Although there may be some ethnic groups, they do not have collective to attachment to land in these areas which is in built-up urban area. Thus, no impact on any indigenous groups are envisaged.

6.5.2.5 Prevention of Gender Based Violence

Addressing Gender Based Violence (GBV) is the top priority for both the Government of Myanmar (GoM) as indicated in the National Strategic Plan for the Advancement of Women (NSPAW) and the World Bank Country Gender Action Plan (CGAP).

The 2016 Demographic and Health Survey (DHS) for Myanmar found that 21% of women reported experiencing physical, sexual or psychological violence at the hands of an intimate partner. Rape and sexual violence remain a widespread problem in Myanmar, women and girls are victims of rape in their homes and their communities. According to the Ministry of Home Affairs, the number of rape cases reported to the authorities increased from 1,100 in 2016 to 1,405 in 2017, the majority of these rape cases involve child victims (61% in 2016, 63.8% in 2017). However, these figures cannot be taken as an accurate reflection of the situation on the ground. Social stigma and a culture of victim-blaming often prevents survivors from reporting sexual violence.

In this context, the project must design a package of measures to prevent GBV (GBV Plan) including, among others, provisions to promote local recruitment of workforce, mitigation measures such as a worker’s Code of Conduct, for both worker-community and worker-worker interactions and training and public awareness activities to avoid sexual harassment, sexual assault and exploitation and human trafficking.

6.5.2.6 Strain on Local Infrastructure

Project activities during all phases will be restricted in the existing project site. All infrastructure facilities such as water supply, drainage system, etc are already existent within the plant boundary and no additional facilities from the nearby communities are required. The only impact that is foreseen is that on the access road connecting Bayint Nauung Road to the plant. There is chance that this road will be affected during the construction of the project and thus has to be widened, strengthened and maintained during the project to ensure it is at least in the same condition as pre-project.

6.5.2.7 Community Disturbances and Safety

During the construction works, provisions will be in place to ensure that the local communities affected by the project works are properly notified of the timing and scope of the planned works and disturbances are minimized. Such minimization of disturbances may include limiting working hours to daylight, special precautions when the work is carried out near children's institutions or traffic management including, if required, the establishment of alternative temporary traffic routes.

The safety issue envisaged on the local community is risk of accidents only during the pre-construction and construction phase of the project, when there will be movement of heavy machineries and vehicles. The capacity of the main roads for movement of large vehicles is enough. The 650m access road to the plant will be the area where there is a risk of accidents as it is narrow and has just enough width to allow maneuver of the vehicles. Proper mitigation measures will have to be adopted to reduce the risk of any incidents on this road. As mentioned, this road has to be widened so that there is scope of proper movement of over-sized vehicles.

Chapter-7

Risk Assessment

Risk Assessment discusses the risks from artificial and natural sources, extent of damage in different scenarios and disaster management plan.

7 RISK ASSESSMENT

7.1 INTRODUCTION

The problem of protecting human health and the environment may best be defined as the management of risk. The failure to manage risk effectively and to establish priorities rationally translates ultimately into a failure to protect health, safety and the environment. Through the use of risk assessment, concerned authorities can estimate the relative level of risks posed by different substances, products and activities and can establish priorities in determining whether and how to regulate.

Risk assessment is the technical process for estimating the level of risks posed by operational processes or products, i.e. the probability that a given harm will occur as a result of the processes or products. Risk assessment is applied to a substance, proceeds in four major steps:

- **Hazard identification:** determining what kinds of adverse health effects a substance, product or activity can cause
- **Dose-response assessment:** predicting the degree of adverse effects at a given exposure level
- **Exposure assessment:** estimating the amount of exposure, and
- **Risk characterization:** combining the foregoing into a numerical range of predicted deaths or injuries associated with actual exposure event

Risk management options are then evaluated in a proposed solution to provide reduction of risk to the exposed population. Specific actions that are identified and selected may include consideration of engineering constraints as well as regulatory, social, political and economic issues related to the exposure. Quantitative assessment of risks associated with hazard identification, dose-response assessment, exposure estimation and risk characterization were beyond the scope of the present study. However, this study takes a qualitative approach to identify common hazards within the power plant and recommends measures for managing these risks with accidents and external threats.

7.2 RISK ASSESSMENT FOR POWER PLANT

7.2.1 Identification of Risks

The process of electricity generation from gas is by no means risk free because of high temperature and pressure conditions within the plants, rotating machineries and high voltages involved. Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation, the gas fired power plants put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. It is therefore essential that a risk management plan be devised in order to both reduce risk of accident and to take the correct action during accidents. Important risks of accidents in Thermal Power Plants leading to disasters or emergency situations may occur during following events.

- Risk due to plant emergency: Fire, explosion, oil spill, toxic chemical spill and electrocution
- Risk due to natural disaster: Flood, cyclone, earthquake, lightning

In power plants accidents can occur at two different levels. First, these may occur due to fires, explosions, oil or chemical spillage and spontaneous ignition of inflammable materials. In such events, operators working inside the plant and at various strategic hazard locations will be affected. Failure of automatic control/warning systems, failure of fuel oil storage tanks and chemical release from acid and alkali stores and handling also pose great degree of associated risks. Natural disaster from flood, cyclone or earthquake are also risks associated with a power plant. The Ywama plant is more prone to natural disaster due to its proximity to the Hliang River.

7.2.2 Risk Assessment for Fire and Explosion

7.2.2.1 Risk Quantification

In a gas-fired power plant, the main risk is of fire in the plant due to rupture of gas pipeline or fire from oil storage tanks. Thus, the risk quantification has been done for a scenario where there is complete rupture and the end of the pipe at the plant end is completely open. The details are given in the section below. In the present case, risk assessment has been done using USEPA approved model. For predictions, following assumptions/data has been utilized:

7.2.2.2 Site Data

Location: Myanmar	
Latitude: 16°54'4.776" N	Longitude: 96°5'19.931" E
Wind Speed: 5.7m/s	Wind Direction: South – East
Air Temperature: 33.7°C	Relative Humidity: 62%
Stability Class: D	

7.2.2.3 Chemical Data

Chemical Name: Methane	
CAS Number: 74-82-8	Molecular Weight: 16.04 g/mol
Ambient Boiling Point: -161.5°C	Vapor Pressure at ambient temperature: greater than 1 atm.
PAC-1: 65000 ppm	PAC-2: 230000 ppm
LEL: 50000 ppm	LEL: 50000 ppm

7.2.2.4 Source Strength

Unbroken end of the pipe is closed off	Pipe Diameter: 30.48centimeters
Pipe Length: 200 meters	Pipe Roughness: Smooth
Hole Area: 730 square cm	Pipe pressure: 3700000 Pascal
Pipe Temperature: 33.7°C	Flame Length: 26 meters
Burn Duration: 20 seconds	Burn Rate: 438 kilograms/second
Total Amount Burned: 330 Kilograms	

Note: Flammable gas is burning as it escapes from pipe

In case of an accident, the burning gas will escape from the pipe as jet fire. The possible situation has been predicted with affected distance Level of Concern ("LOC").

7.2.2.5 Thermal Radiation from Jet Fire

Threat Modeled: **Thermal Radiation from Jet Fire**	Red: 33 meters (10.0 kW/(m^2) = potentially lethal within 60 sec)
Orange: 46 meters (5.0 kW/(m^2) = 2nd degree burns within 60 sec)	Yellow: 71 meters (2.0 kW/(m^2) = pain within 60 sec)

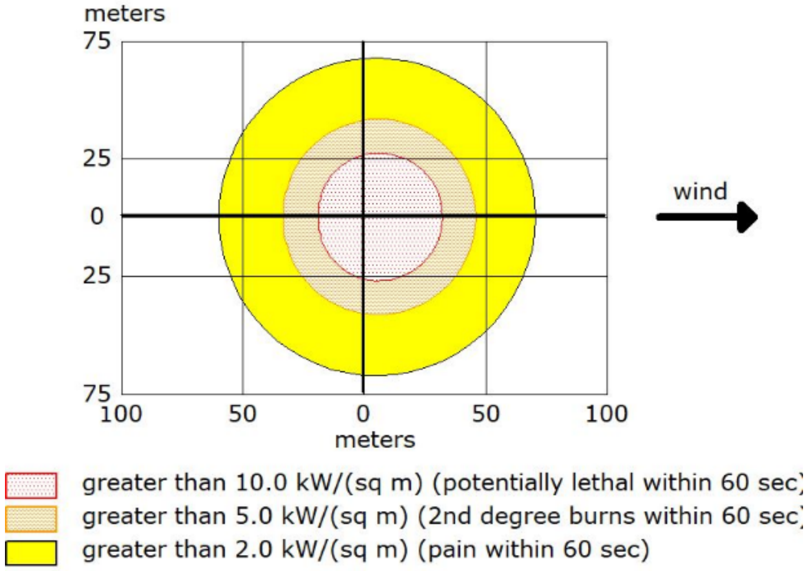


Figure 7-1: Thermal Radiation from JET Fire

It has been interpreted that the worst-case scenario will be thermal radiations from jet fire and the travel distance will be up to 71m as shown in **Figure 7.1.**Therefore, it requires immediate evacuation of population up to 100m and arrangement for immediate medical facilities for injured person. The receptor within this range is the residential quarters of EPGE which is located about 60m from the plant.

The worst-case scenario graph has been plotted which shows that if the wind is from west to east, i.e. towards the residential buildings, then the lethal impact will be till 35 m. Residents of the building will also feel the pain within 60 seconds and thus will have to be evacuated immediately.

It can be also interpreted from the model, that as the impact of explosion and consequent fire will be till 35m and may have fatal impact on workers and staff who are within 35m of the explosion. The administration building is located about 50m on the southern side and occupants in the building may feel only pain. They also will have to be evacuated immediately to avoid any casualty.

7.2.3 Risk from Oil Spills

There will not be any large volume storage of oil in the proposed plant. The only oil type to be stored are lubricant oil. Transformer oils used will not be stored and will be supplied by external agencies as and when required. Thus, there will be no risks foreseen from the tanks containing oils. Oil spills may occur which will not have any risk issues related to it. Mitigation measures for preventing significant impact of oil spills on soil and water is provided in the EMP chapter.

7.3 RISKS RELATED TO OCCUPATIONAL HEALTH AND SAFETY

Potential risks to workers during project cycle in the plant are similar to those associated with any construction project involving earth-moving, use of large equipment, transportation of overweight and oversized materials, and construction and installation of facilities. Impacts associated with health and safety are significant because most of the activities on site during construction and O&M stage will require interaction of humans with equipment and electrical machineries.

7.3.1 Fall from height

Working at height remains one of the biggest causes of occupational fatalities and major injuries. Cases commonly involve over-reaching, over-balancing or the failure of a fragile surface. Falls from height can also be due to unguarded holes in floors such as hatchways, inspection holes and pits, and from falls into process tanks and machinery. During construction activities and O&M work, there will be regular requirement of working on high poles and tall structures, which increases the risk of fall and fatalities. The risk will be similar during all the phases of the project. During the pre-construction and construction phase, the risk of fall is associated with structure erection and transfer of materials from heavy vehicles. During the operation phase the activities which increase the risk include maintenance of machineries and working in switch-yards. Although the likelihood of occurrence is low, the life safety consequence is high, i.e. can cause life threatening injury or death on-site. Thus, this is a risk which should be treated seriously and mitigation measures taken positively.

7.3.2 Risk of getting struck by Falling Objects

During construction phase, there is always risk of instruments or equipment falling from height and injuring workers on the ground. It has been found that this is the most common way of workers getting injured in a construction site. Even during maintenance during the O&M stage, there is the risk of object/tools falling from height and injuring or killing people. In this case also the life safety consequence is very high and as per OSHA records, highest fatality takes because of falling objects.

7.3.3 Electrocution

In a Power Plant, there will be instances when the workers will be working with live power lines. This increases the risk of electrocution unless proper preventive measures are taken.The common types of electrical accidents are electrocution (leading to death), electrical shock, burns from arc flash and at times fall due to shock. The likelihood of occurrences of electrical accidents is quite high in a power plant, the life safety consequence is low if proper precautionary measures are taken.

7.3.4 Exposure to Electromagnetic field

Extremely low frequency (ELF) fields designate electromagnetic fields with frequencies below 300 Hz, the frequencies that are lower than intermediate frequencies. The main source of extremely low frequencies is alternating current carried in power lines, wiring and household appliances. The electromagnetic field generated has the same frequency as the current that causes it, i.e.50Hz or 60Hz (the latter predominantly in US). Besides power lines and household appliances, important sources of extremely low frequency fields include power plants and substations, welding machines, induction heaters, and railway, tramway and subway systems.

As mentioned above, the exposure to high electromagnetic fields and high current carrying wires is another risk while working in a power plant. It has been found that over exposure to EM field may increase the risks of cancer, have negative reproductive and developmental effects, premature pregnancy termination; and neuro-biologic effects, and behavioural modifications. It has been found that extended exposure to EM waves can lead to sleep disorders resulting in fatigue and psychological stress.

7.3.5 Work in Confined Space

In the operational phase of the plant, the work will mainly be limited in confined spaces. In this phase, noise pollution may pose risk to health. It has been observed that the measured noise level near the generators and turbines ranged from 90 dBA to 110 dBA. This level of noise limits the continuous exposure to the workers from 2 to 4 hrs beyond which hearing impairment may be caused. If the installation of generators and turbines are within a confined space and monitored through glass windows, it will not pose any serious threat.

However, precautions should be undertaken during routine inspections and maintenance works. Supervisors, inspectors and related personnel should wear noise protectors like ear plugs or ear muffs. Wearer should be given a choice between ear muffs and plugs as muffs are easy to use but may be a nuisance in a confined work space and be uncomfortable in hot environment. Whereas ear plugs don't get in the way in confined spaces but may provide little protection if not used carefully.

7.4 RISKS FROM CLIMATE CHANGE

Some of the recent impacts of the global climate change that occurred in late 20th century and will continue in the 21st century are increase in the areas affected by droughts, increase of activities of intense tropical cyclone and increased incidence of extreme high sea level. Future trends predict also precipitation decreases in sub-tropical land regions, decreased water resources in many semi-arid areas, contraction of snow cover areas, increased thaw in permafrost regions, decrease in ice extent, increased frequency of hot extremes, heat waves and precipitation increases in high latitudes.

7.4.1 General Impacts of Climate Change on Thermal Power Plant

7.4.1.1 Increase in Ambient River Water Temperature

The global ambient temperature increase in the past century and is expected to increase in the coming years. Thermal power generation is mainly related to converting thermal energy into mechanical energy then electrical mostly through steam turbines which depend on thermodynamics of the heat cycle. The efficiency of this process is called Carnot efficiency and is determined by the temperature of the heat source and the heat sink (air or water). Therefore, any increase in the temperature of the sink which can be most the surrounding air or water river will result into a decrease in efficiency of the plant.

Gas turbine powered generation plants will be most affected by the increase in ambient temperature as this impact the cooling process.

7.4.1.2 Sea-level Rise

Rising sea level will cause damages to power plants situated at coastal areas and near tidal rivers because mainly of potential floods and/or erosion. It is expected that the global-mean sea level will rise significantly within the current century.

7.4.2 Assessing Climate Risk for Ywama Power Plant

7.4.2.1 Rise of Water Level in Hlaing River due to Sea Level Rise

Myanmar's climate is projected to shift in the coming decades, having a lasting and significant impact on Myanmar's eco-systems and, in turn, on human health, agriculture, food security, infrastructure, local livelihoods and the larger economy[24].

The entire coastal area of Myanmar, middle range sea level rise estimates for 2020-2029 time period are 5 cm to 13 cm above the baseline level. By the 2050-2059 time periods, sea level may rise 20 cm to 41 cm above the baseline. In the 2080-2089 time period, the middle range of projections estimate sea level to be between 37 cm to 83 cm above the baseline, with the potential for up to 122 cm in the highest range[1] of projections for this time period.

Ywama Power Plant is located on the banks of River Hlaing, which is a tidal river and will have a direct impact on the water level in the river. As per the study, the water level rise predicted by 2050 (i.e. till the project duration) in Hlaing River is 56 cm and by 2080 river level is expected to rise by 121cm (**Table 7.1**). It was found that the present level difference between the plant and the river during high tide is about 3.8m, whereas the rise of water in Hlaing River due to sea level rise by 2080 is predicted to be 1.21m. Thus there will be no risk of the plant getting submerged due to the rise in water level during the next 60 years.

Table 7-1: Estimated Water Level Rise in Myanmar and Hlaing River

Time Period	Middle range of future sea level rise
In Myanmar	
2020s	5 cm to 13 cm
2050s	20 cm to 41cm
2080s	37 cm to 83 cm
In Yangon (Hlaing River)	
	90th percentile - high estimate
2020s	18
2050s	56
2080s	121

Note: The middle range refers to the 25th to 75th percentile of model-based outcomes for sea level rise projections
Source: Assessing Climate Risk in Myanmar, APPENDIX E

[24] *Flood Mitigation Of Yangon City Downtown Areas, (2014), "Design Report on Storm Water Drainage," National Engineering & Planning Service (NEPS) Horton, R., De Mel, M., Peters, D., Lesk, C., Bartlett, R., Helsingen, H., Bader, D., Capizzi, P., Martin, S. and Rosenzweig, C. 2017. Assessing Climate Risk in Myanmar: Technical Report. New York, NY, USA: Center for Climate Systems Research at Columbia University, WWF-US and WWF-Myanmar.*

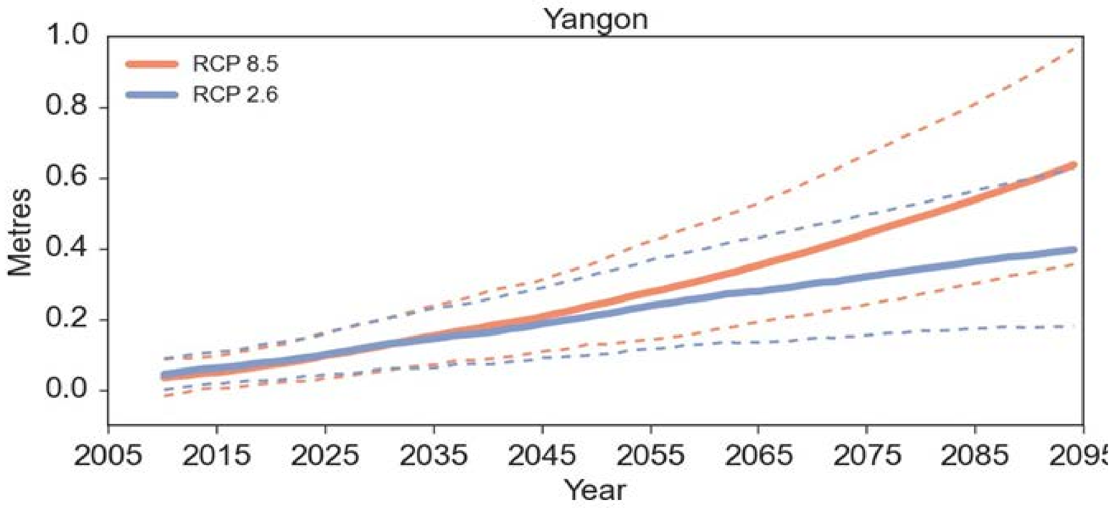


Figure7.2:Projected relative sea level rise (RSLR) over the 21st century, for Yangon for the RCP2.6 and RCP8.5 scenarios

RSLR is calculated relative to the 1986-2005 reference period. The nearest ocean grid cell was selected to generate the plots. The solid line for each RCP shows the median projection; while the dashed lines either side enclose the 90% confidence interval.

Source data: ICDC, University of Hamburg

As the sea level rises, the frequency and magnitude of flooding and associated infrastructure damage, as well as assets at risk, may increase. The most damaging flooding in this region is typically associated with tropical cyclones and accompanying storm surges. Water heights associated with storm surges are driven by low pressure and very strong winds, superimposed upon mean sea level and tidal conditions. As such, storm surges are not simply related to changes in mean sea level. While there is no strong evidence to indicate how the magnitude and frequency of tropical cyclones may change in south Asia, rising sea levels will clearly change the background mean sea level. Under an assumption of no change in the magnitude and frequency of tropical cyclones, water levels associated with storm surges would be expected to increase over the 21st century[25].

There are three main classes of adaptation response to sea level rise, these are:

- **Planned retreat:** where sea level rise is allowed to happen and, through careful spatial planning, exposed assets are either relocated, and/or possibly compensated for losses.
- **Accommodation:** sea-level rise is allowed to happen, and is accommodated for by making infrastructure more resilient to the impacts, for example, through raising buildings and insurance schemes. Accommodating sea level rise may also require careful spatial planning.
- **Protection:** here sea level rise is combated through the use of hard and soft engineering solutions, such as, and the construction of dikes and sea walls, or storm surge barriers[26].

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25 NASA NEX GDDP,2015 Woodruff, J.D., Irish, J.L., and Camargo, S.J., 2013, Coastal flooding by tropical cyclones and sea-level rise, Nature, 504, 44-52, doi:10.1038/ nature12855
26Syvitski, J.P.M., et al., 2009, Sinking deltas due to human activities, Nature Geo-science, 2, 681-686, doi:10.1038/NGEO629

7.4.2.2 Precipitation Projections

Precipitation patterns across Myanmar are projected to change over the coming century Figure. However, because precipitation processes are more complex and less well-understood than those governing mean temperatures, spatial and seasonal patterns in precipitation projections are often less clear than those for temperature.

The IPCC 5thAssessment Report emphasizes the high uncertainty and spatial variation in projected precipitation shifts under climate change compared to temperature projections, which are generally more spatially uniform and less uncertain. As a result, the uncertainty ranges presented for precipitation change are higher than for temperature and this should be accounted for in planning.

Although the uncertainty range is relatively large, overall the current wet season months (June to October) are projected to see more rainfall. Wet season total precipitation is projected to increase in both the near and long term relative to the 1980-2005 baseline. These changes are expected to raise the national average wet season total precipitation after 2040, and could exacerbate wet season flooding in some regions (**Table7.2**)[27].

Table 7-2: Projections for mean annual and seasonal precipitation change from the baseline across Myanmar

Seasons	Model baseline* (1980 to 2006)	Precipitation range 2011-2040	Precipitation range 2041-2070
In Myanmar			
Annual	2000 mm	+1% to +11%	+6% to +23%
Hot Season	300 mm	-11% to +12%	-7% to +19%
Wet Season	1700 mm	+2% to +12%	+6% to +27%
Cool Season	100 mm	-23% to +11%	-12% to +11%
YangonDeltaic	**Precipitation range 2011-2040**		**Precipitation range 2041-2070**
Annual	0 to +12%		+5 to +24%
Hot Season	-12 to +19%		-4 to +17%
Wet Season	+196 to +1196%		+5 to +26%
Cool Season	-29 to +14%		-5 to +15%

* The NASA NEX baseline data reflects model values averaged over a .25 degree (25km). For this and other reasons, the actual observed station temperatures may differ from the model baseline shown here

7.4.2.3 Perceived Risk from Flood

As can be understood from the above analysis, the risk from sea water level rise or increased precipitation is that of flooding or bank erosion at the plant. It has been already mentioned in previous chapters that there has been no history of flooding at the Ywama Power Plant. Even in case of heavy rain, the water is properly drained out, either directly to the river or through the drain running along the eastern and southern side of the plant.

It has been also found that the level of the river bank opposite to the plant is almost lower by 1.0m. Due to this, even in event of water level rise in the river, the water overflows through the opposite bank and does not impact the plant area.

The other issue related to water rise is the change in current system in the Hlaing River. This may lead to erosion of the river bank near to the plant. Preventive action to stop erosion has been already initiated by the Plant. An embankment is being constructed to

[27] *Source data: NASA NEX GDDP,2015*

provide bank stability near the plant. This action will take care of any threat of erosion in the future.

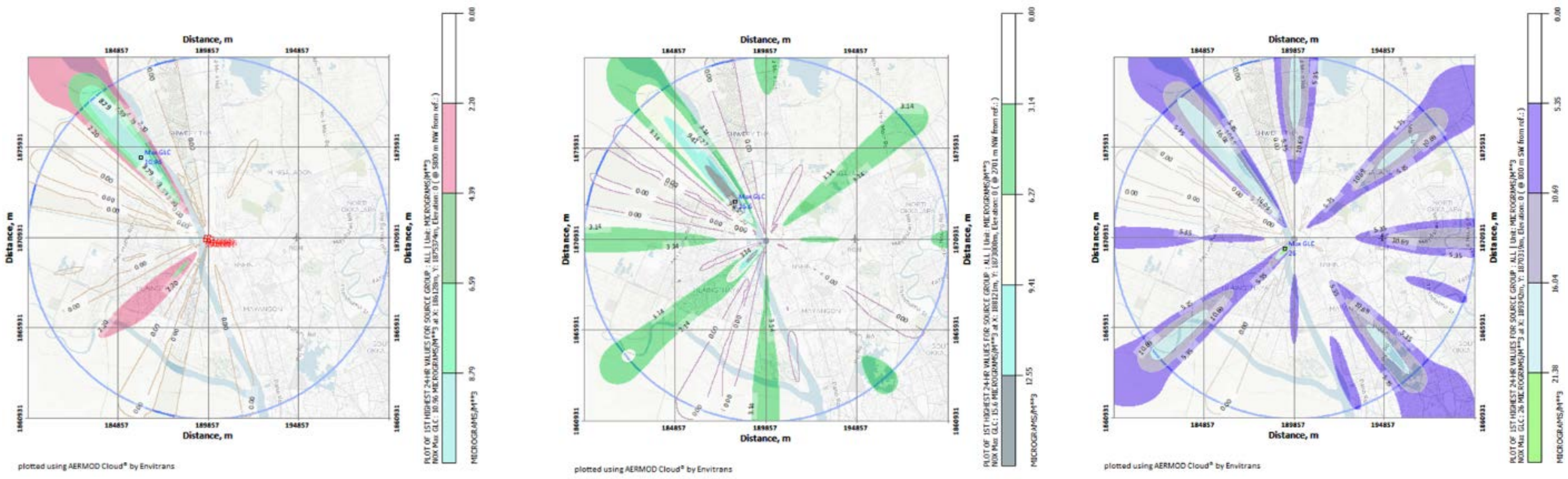
Figure 7.3: Embankment at Ywama Power Plant

7.4.2.4 Climate Change and Wind Speed

Myanmar has already experienced climate change over recent decades. Although climate change trends that span only a few decades are often statistically weak at individual weather stations, a robust signal emerges when considering many weather stations at once (IPCC 2014).Inland regions warmed faster than coastal ones, both in terms of average temperature (0.35°C per decade increase in inland regions versus 0.14°C per decade coastally) and maximum temperature (0.57°C increase per decade inland versus 0.23°C increase per decade along the coasts). Similar to national trends, maximum temperatures rose slightly faster than daily average temperatures in both coastal and inland areas. This increase in temperature profile may affect wind speed. Increased wind speed will impact in dispersion of stack emission i.e., NO_2 dispersion over a period of time.

Three different dispersion models were done to predict the NO_2 concentration at a varying climate change impact on wind speed (Figure 7.5). The model result showed that there is a significant variation in direction; distance (X_{max}) and concentration (C_{max}) of predicted NO_2 concentration. If there is an increase of 25% and 50% of wind speed over the present scenario NO_2 concentration may increase upto 16 µg/m^{3}at 2700m distance in NW direction and 26µg/m^3 at 800m distance in SW direction respectively. The prediction of NO_2 concentration in existing as well as after expansion in present climatic condition had been mentioned previously.

Thus considering the present baseline concentration of NO_2 of about 25µg/m^3, the resultant GLC will be about 51µg/m^3 in the worst case scenario (50% increase in wind speed) which will be a little higher than the stipulated standards. However the maximum impact will be on the river and will not be over the residential areas. Thus there won't be any impact on the health of local population or nearby flora.



After Expansion 25% increase in Wind Velocity 50% increase in Wind Velocity

Figure 7.4: Comparative Isopleths showing Ground Level NO_2 Concentration After Expansion, 25% and 50% increased wind velocity

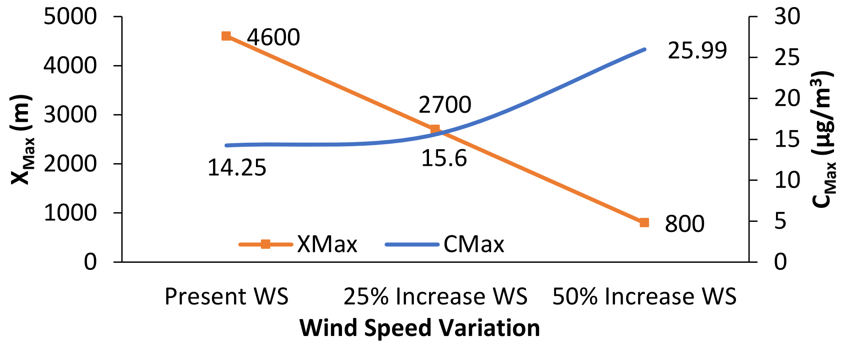


Figure 7.5: Graphical representation of maximum concentration (Cmax) at a distance (Xmax) with variation of wind speed in comparison with After Expansion

	C_{max} (µg/m³)	X_{max} (m)	Direction
After Expansion	14.24	4600	NW
25% increased wind velocity	15.60	2700	NW
50% increased wind velocity	25.99	800	SW

Chapter-8

Cumulative Impact Assessment

Cumulative Impact Assessment gives the description and prediction of the potential impacts of the proposed development along with other future projects for the impacts identification for environmental, biological and socio-economic parameters.

8 CUMULATIVE IMPACT ASSESSMENT

8.1 INTRODUCTION

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity (collectively referred to in this document as “developments”) when added to other existing, planned, and/or reasonably anticipated future ones. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected community

Cumulative Impact Assessment is the process of (a) analyzing the potential impacts and risks of proposed developments in the context of the potential effects of other human activities and natural environmental and social external drivers on the chosen environment and social components over time, and (b) proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible.

The key analytical task is to discern how the potential impacts of a proposed development might combine, cumulatively, with the potential impacts of the other human activities and natural phenomenon such as droughts or extreme climatic events. The components contains

- Physical features, habitats, wildlife populations (e.g., biodiversity),eco-system services,
- Natural processes (e.g., water and nutrient cycles, micro-climate),
- Social conditions (e.g., health, economics), or
- Cultural aspects (e.g., traditional spiritual ceremonies).

The impact assessment for the stand-alone Ywama Power Plant project has been done in Chapter 6. However, it has been reported that EPGE has planned a JICA-funded project for rehabilitation and upgrade of the 66kV and 33kV sub-stations from AIS to GIS and construct a new 230kV GIS sub-stations. The constructions of both these activities are planned in the same period. Thus, a cumulative impact assessment is required to comprehend impact during construction.

It is envisaged that the construction of the two projects (Ywama Plant and sub-station) may have some combined impact on ambient air quality and noise level. Other than that, no other impact is foreseen on physical features, social conditions or cultural aspects. During the operation phase also, no cumulative impact is expected. The features of the power project have been provided in Chapter 3 of this report, while a brief description of the substation project is given in the following sections.

Figure 8-1: Existing Sub-stations

Presently, Ywama has 3 switchyards of 33, 66 and 230 kV levels. The YWAMA sub-station has a capacity of 380 MW; the same for the 230kV line. The Hlaing Tharyar sub-station has a capacity higher than 380 MW. The 66kV grid is consuming max 94 MW. The 33kV switchyard is separated from above switchyards. One 100MVA 230/66kV step-down transformer has been installed recently to increase the system reliability. Connection to the 66kV grid is made by underground cables. The existing CCGT (3x11kV Gas turbine generators + 1x11kV Steam turbine generator) is connected to the 33kV through 11/33 kV step-up transformers. The IPP Gas Engine plant is connected to the 66kV level. The switchyard includes outgoing feeders. The 2 MHI GT generators are connected on the 230kV level using 13.8/230 kV step-up transformers and their station service transformer. YWAMA supplies maximum of 13 MW to the nearby Steel Mill (Figure 8.1).

EPGE has planned the rehabilitation and upgrade the existing 66kV and 33kV substations from AIS to GIS, and also construct a new 230kV GIS sub-station the layout of which is provided in Figure 8.2.

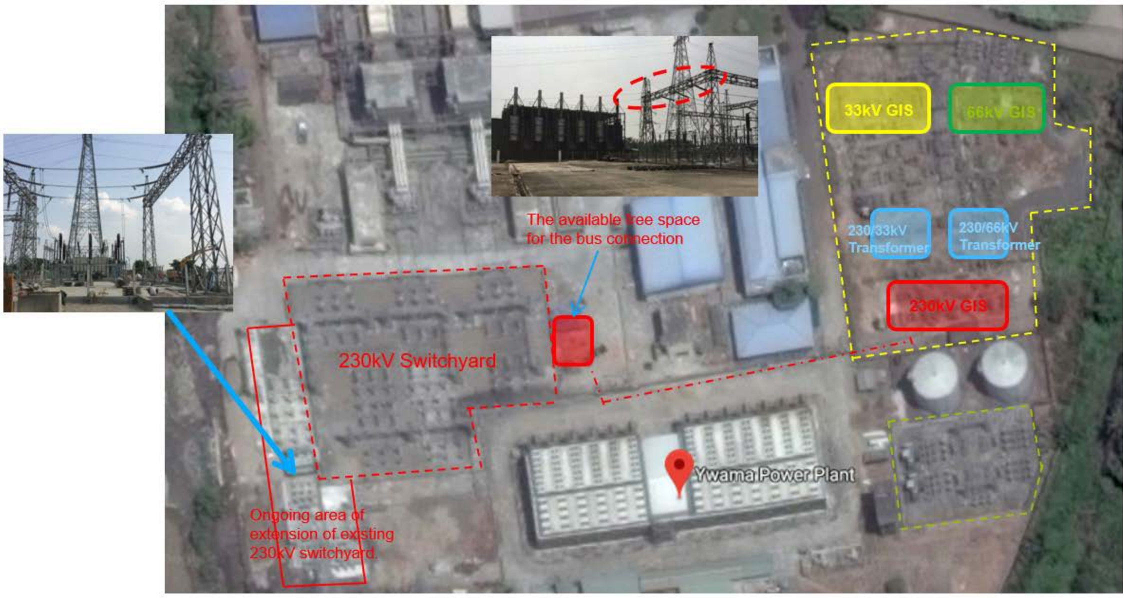


Figure 8-2:Proposed Sub-stations

As the construction of the proposed expansion of Ywama Plant and refurbishment of the sub-station is planned to be done at the same time, this chapter will identify the environmental and social impact due to construction in the area.

8.2 IMPACT ON AIR QUALITY

As mentioned, the construction for both the phases will be carried out simultaneously. Thus, there will be possibility of fugitive emissions from both the sites at the same time period, thus increasing the impact. Therefore, in this study, the cumulative impact on ambient air quality has been assessed by considering equivalent concentrations of the power plants using data USEPA AP-42 documents. AP-42 Section 13.2.3, Miscellaneous Sources, Heavy Construction Operations, provides information on emission factors to assess particulate emissions from construction. Construction emissions include demolition and debris removal (bulldozing, truck loading and unloading of debris, truck travel), site preparation (bulldozing, scrapers, truck loading and unloading), and general construction (vehicular traffic). The input data along with the emission factors are already provided in Chapter 4.

The modeling was done for cumulative PM_{10} concentration increase with the proposed construction site, i.e., the proposed 300 MW CCGT expansions and JAICA site. The modeling result showed an incremental GLC of about 130µg/m^3 at a distance of 100m in the South-South-East direction. (**Figure 8.3**) Thus, it can be concluded that the resultant cumulative GLC during construction phase will be about 219.6µg/m^3, which is much above the present scenario.

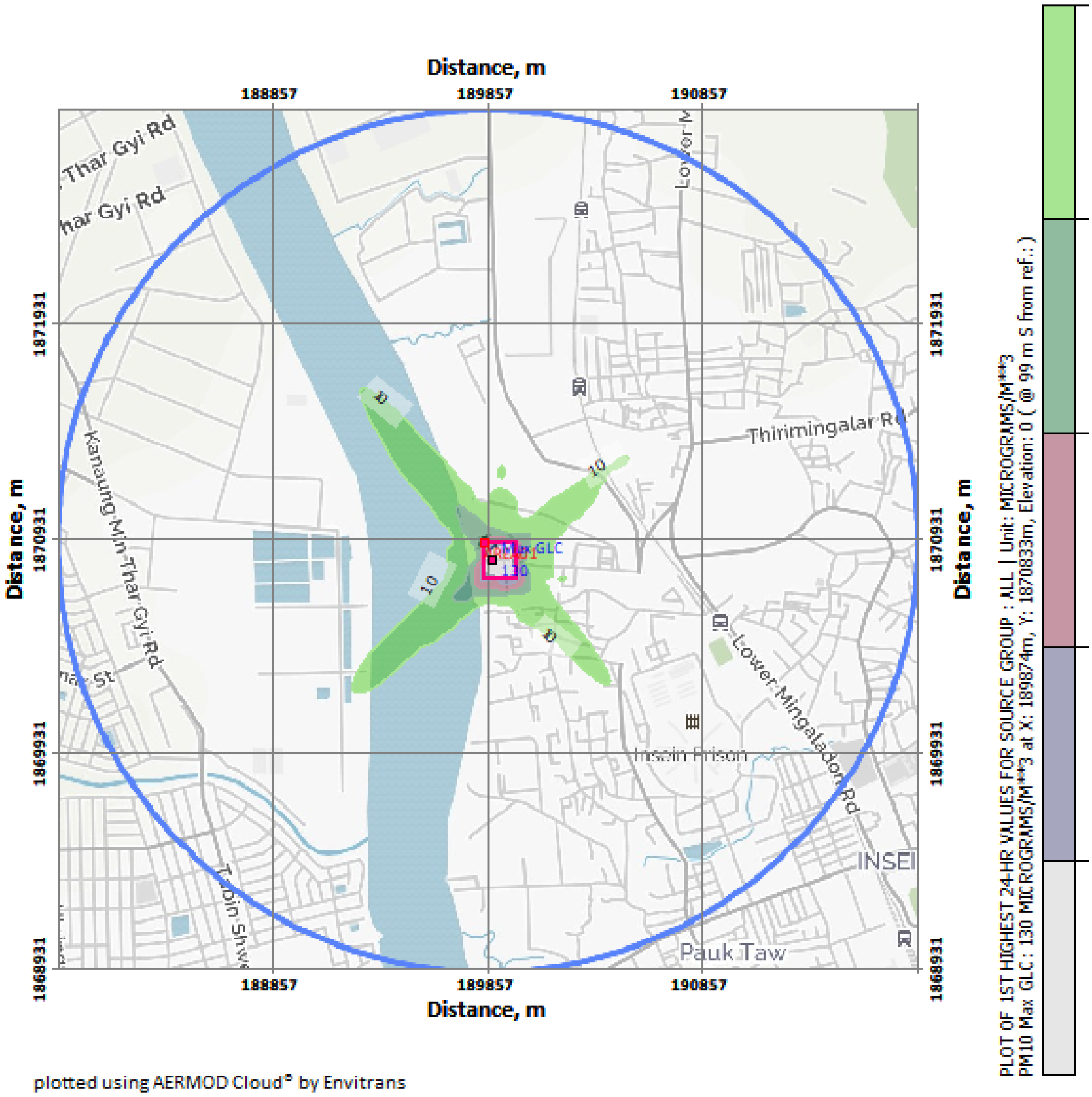


Figure 8-3:Isopleth showing Ground Level PM_{10}Concentration for Cumulative Impact at Ywama Plant and sub-station site

The increase of GLC due to the JICA project will be about 21µg/m^3 which is negligible.Also, the impact will be short-term and reversible. Also, proper mitigation measures will be taken to ensure that the fugitive emissions are minimized. Thus, the significance of impact will be minor on the neighbouring receptors.

During the operation phase, no air pollution is envisaged from the refurbished sub-station, which can impact the air quality of the area.

8.3 IMPACT ON WATER QUALITY

No additional impact is envisaged on water quality due to the construction of the sub-station. About 150 workers are expected for the construction phase, which will lead to more water consumption. All water requirements will be fulfilled from existing bore-wells and thus no additional water sources shall be required. It is estimated about 6.75 KLD water will be consumed for domestic purpose as there will be no labour camps at site.

Construction water will also be sourced from existing bore-wells. Thus, the cumulative water usage will also have negligible impact on the existing resources.

Domestic waste water will be treated in septic tanks before discharge. Temporary toilets will be set-up at the site. The construction waste-water will also be drained to a settlement tank before discharge to Hlaing River, if required. The existing drainage system will be used for channelizing the waste water. Water from the settlement tanks will be re-used for construction activities. No other risks of polluting the existing water systems of the area are foreseen.

8.4 IMPACT ON NOISE

Simultaneous construction activities at two sites will lead to increase in the ambient noise level of the area. As mentioned earlier, the impact of noise from the plant on the nearby residential areas is a major concern.

A combined modeling was done to ascertain the impact of noise on the host environment due to simultaneous construction at both Plant and Sub-station site. While modeling, it was assumed that machines at both the sites will be operational at the same time. The findings of the calculations are given below in Table 8.1. It can be seen that the increase in noise level due to simultaneous construction activities in two sites is almost negligible and is around 1 dB(A) at any given distance. The noise-level at the residential buildings in the eastern side will experience a noise level of 72.1 dB(A) while the Ywama Quarters will receive about 49.3 dB(A). These levels exceed the prescribed WBG EHS Guidelines' limit of 55 dB(A) during day time and 45 dB(A) during night time for residential areas.

Table 8-1: Predicted Noise Level during Construction of Power Plant & Sub-station

Distance in m from Source	Noise Level in dB(A) during Construction			Remarks
	Power Plant	Power Plant + Sub-station	Monitored value	
50	71.30	72.10	**76.0**	Noise level at residential buildings located at 50m
100	59.20	60.30		
200	54.00	55.00		Day-time Standard of 55dB(A) attained at 200m for combined
300	50.80	51.70		
400	48.40	49.30		Noise level at Ywama West Quarters located at 400m
500	46.60	47.50		
600	45.00	45.90		
700	43.70	44.60		Night-time Standard of 45dB(A) attained at 700m for combined
800	42.60	43.50		
900	41.60	42.50		
1000	40.70	41.60	**49.7**	

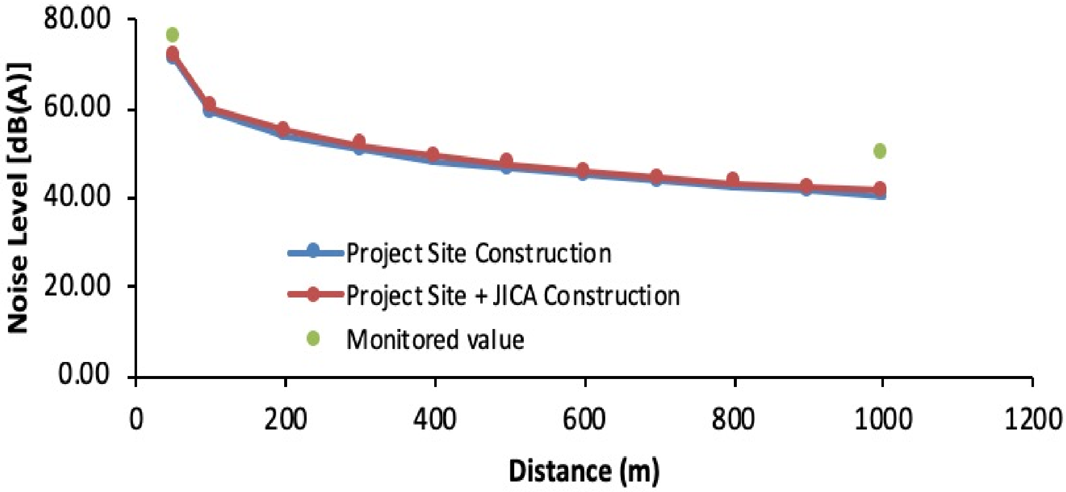


Figure 8-4: Predicted Noise Level during Construction of Power Plant & Sub-station

8.5 IMPACT ON SOIL

It is not envisaged that there will be any additional impact on soil due to simultaneous construction at two sites. However the storage and utilization/disposal of soil may create a problem if not managed properly. As the construction schedule for both the projects does not have clarity, there is chance of overlapping of excavation activities.

The total area of the sub-station is 0.8Ha. The soil from excavation of removal of installations will be mostly used in back-filling the area as the area required for setting up GIS modules is much less than AIS ones. It is perceived that there will be no requirement of disposal of soils.

8.6 IMPACT ON SOLID WASTE

As there will be removal of transformers containing polychlorinated biphenyl (PCB), there is a risk of leakage or spillage from the transformers while decommissioning and dismantling. PCBs can be transported long distances and they bind strongly to soil and sediment so they tend to be persistent in the environment. They have been found in air, water, soil, and sediments throughout the world.

Although PCB is not a direct impact of the power project, PCB can indirectly impact the project due to the proximity to the sub-station. Although EPGE cannot do any direct intervention for proper handling and management of PCBs, the construction workers and other employees can be made aware of the health impact of PCBs and risk mitigation measures in case of leakage/spillage from the adjacent sub-station area.

Chapter-9

Environment & Social Management Plan

Environment & Social Management Plan discusses the management plan and enhancement measures incorporating recommendations to mitigate the adverse impact likely to occur on environmental parameters during construction and operation phase.

FINAL ESIA REPORT

Project Proponent: Electric Power Generation Enterprise

MINISTRY OF ELECTRICITY AND ENERGY, NAYPYITAW

9 ENVIRONMENT & SOCIAL MANAGEMENT

This chapter discusses the mitigation and enhancement measures for environment and social impacts identified during the study for the different phases of the project. The specific mitigation measures against the significant impacts and risks that have been identified during the study have been explained in this chapter. The institutional arrangements and responsibilities of various agencies/officialsfor environment and social management are also discussed in this chapter. The chapter also discusses the schedule and cost of environment monitoring during pre-construction/construction and O&M stages.

9.1 MITIGATION MEASURES

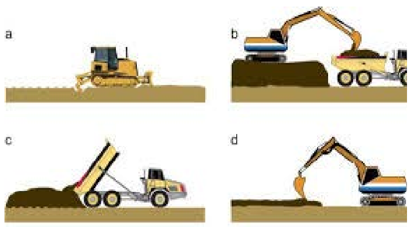
As discussed in the previous chapters, there will be different types of impact of the project on the physical, ecological and social environment. There are also certain risks which require preparedness in case of emergencies. The risk management is also given in this section. As these impacts are unavoidable if the project is to be implemented, it is important to put into practice mitigation measures which will at least reduce the adverse impact of the project. This chapter suggests various measures which will help mitigate the impacts.

9.1.1 Mitigation Measures for Air Pollution

9.1.1.1 Pre-construction and Construction Phase

During the pre-construction and construction phase, there will be mainly fugitive emission from the project site and lay-down areas due to movement of heavy vehicles, drilled, excavation and piling activities. In addition to the particulate matters, there may be some gaseous emissions (mainly NO_2) from movement and operation of heavy vehicles and machineries. The mitigation measures suggested to reduce impact of air pollution on the neighboring areas are given in the sections below.

Table 9-1:Air Pollution Mitigation Measures during Pre-construction and Construction Phase

Aspects and Impact	Sensitive receptors	Pre-Construction & Construction Phase	
		Mitigation Measure	**Method & Technique**
Air Pollution: **A-1:Pre-construction** Increase in particulate matter due to dismantling of plant and transportation, storage and disposing of machineries. **A-2 Construction:** There will be mainly fugitive emission from the project site and lay-down areas. In addition, there may be some gaseous emissions from heavy vehicles and machineries.	**Pre-Construction:** Worker, EPGE staffs **Construction:** EPGE officials and residential staffs who live in staff quarters at distance of 50 m East direction of the construction area and inhabitant of the nearby residential area at southern direction of the project site.	Erect screens of minimum 5m height along the boundary of the project site to avoid wind-blown dust from entering the nearby residential areas	
	Pre-Construction: Worker, EPGE staffs	Keep the unpaved working areas and stockpiles moist all the time by water sprinkling. In unpaved roads water sprinkling at least two times every day.	
		Specifying transport networks and locating stockpiles as far away from the site boundary which is close to the residential buildings, as practicable to minimize the impact of air pollutants and dust	

Aspects and Impact	Sensitive receptors	Pre-Construction & Construction Phase Mitigation Measure	Method & Technique
		 Figure 9-1: Stock piling area at Project site  Figure 9-2: Stock piling area at lay-down area	
		Minimizing the size of exposed areas and material stock-piles and the periods of their existence.	The dimension of stock pile at project site is 0.04 ha and lay-down area is 0.07 ha.
		Cover temporary stockpiles of dusty materials entirely by impervious sheets or spray with water to keep the entire surface moist all the time;	The dimension of stock pile at project site is 0.04 ha and lay-down area is 0.07 ha.

Aspects and Impact	Sensitive receptors	Pre-Construction & Construction Phase	
		Mitigation Measure	**Method & Technique**
		Cover construction materials transported by trucks with tarpaulin to prevent dust emissions while the truck is travelling through populated areas	
		Cleaning wheels and the lower body parts of trucks at all exits of the construction site. This will prevent mucks and earth from the site affecting the outside roads which passes through residential areas	Mobile wheel wash system will be used. The wash systems include a wash frame, a settling water tank with an integrated conveyor for automatic sludge removal 
		Cleaning the entire construction work sites at least once per week.	The housekeeping department will be mainly involved in removal of debris, sand piles, loose soils from within the plant to control emission of dust
		It is usually found that vegetations and packages/ wooden crates are burnt in the site. This practice should be prohibited as it creates fumes which may have negative impact on the nearby residential areas.	All wooden crates and plastic packaging shall be stored in the storage area and sold to recyclers. The vegetations and municipal solid waste removed from site shall be removed from site and put in composting pit located outside the plant but in the EPGE area.

Figure 9-3: Compost pit area at Project site

Aspects and Impact	Sensitive receptors	Pre-Construction & Construction Phase	
		Mitigation Measure	Method & Technique
		Compacting the reclaimed land immediately to avoid fugitive dust emissions	Immediately after civil structures have been completed, all areas having loose soil compact. As these areas to be compacted are small, hand compactors used for the purpose.
		Maintenance and checking the construction equipment & vehicles regularly to avoid gaseous emission above the stipulated norms.	Regular vehicle maintenance log-books in order for monitoring the pollution level from vehicles and machineries.
		Switching off engines of vehicles, when idling	
		Using low sulphur diesel for trucks and diesel-fuelled construction equipment if available	Low Sulphur Diesel has 93% less sulphur content than normal diesel. In Myanmar, diesel oil is available with sulphur content from 500ppm to 10ppm. At the plant site during construction it shall be ensured that modern machines which can operate on low sulphur diesel.

9.1.1.2 Operation Phase

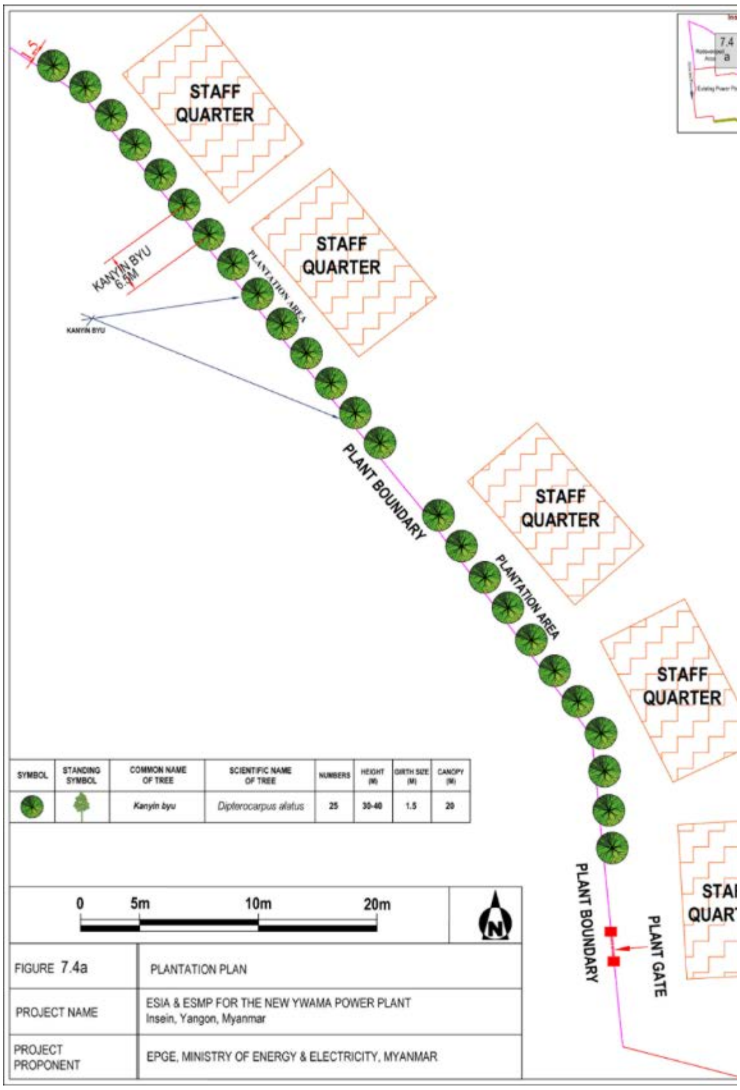
During the operation phase it has been seen that the air impact will be mainly due to emission of $NO_2$from the plant. As the plant will be completely paved, with no open area, and also no requirement of raw materials by road, there is no risk of fugitive emission from the plant. The mitigation measures to be adopted during operation are given in **Table 9.2**.

Table 9-2: Air Pollution Mitigation Measures during Operation Phase

Aspects and Impact	Sensitive receptors	Operation Phase	
		Mitigation Measures	Method & Technique
Air impact will be mainly due to emission of NO_2 from the gas-based plants	EPGE officials and residential staffs who live in staff quarters at distance of 50 m East direction of the Project Site. Nearby residential area at southern direction of the project site.	Ascertain that the emission limit for NO_2 is limited to $50mg/Nm^3$(as per EHS Guideline for Thermal Power Plant) as the study area has been found to be falling in a non-degraded air-shed	Natural gas-fired plants generally produce negligible quantities of PM and sulfur oxides, and levels of nitrogen oxides. All the GTs short-listed for this plant comply to the $50mg/Nm^3$(15ppm) norm
		Installation of stack to ascertain wider dispersion of gaseous pollutants in the atmosphere and hence reduce the Ground Level Concentration.	Based on the modelling it has been proposed to install a 40m height stack which will be enough to allow wide dispersion of pollutant
		Installation of dry low NO_2 burners	Reduce NO_2 emissions to as low as 5 ppm across large load and ambient temperature range of -15°C to 50°C. Low NO_x burners with

Aspects and Impact	Sensitive receptors	Operation Phase	
		Mitigation Measures	Method & Technique
			other combustion modifications, such as low excess air (LEA) firing, over-fire air, or flue gas recirculation for boiler plants. Use of dry low-NO_x combustors for combustion turbines burning natural gas. For flue gases with high particulate loadings post-cleaning selective catalytic reduction, with lower temperature catalysts (e.g. 150-200°C) is feasible. These will be included in the detailed technical design stage during the project implementation.
		Plantation of large canopy trees in the eastern and southern	Trees such as jack-fruit,

Aspects and Impact	Sensitive receptors	Operation Phase Mitigation Measures	Method & Technique
		side of the plant. As there is no space inside the plant boundary, plantation should be made on the outside, as the land belongs to EPGE only.	Vendara, fig will be planted along the boundaries . Along the eastern boundary, single row green belt develops while along the southern boundary, three rows will be planted.



Aspects and Impact	Sensitive receptors	Operation Phase Mitigation Measures	Method & Technique

Figure 9-4a: Green belt development at E side of the Project site

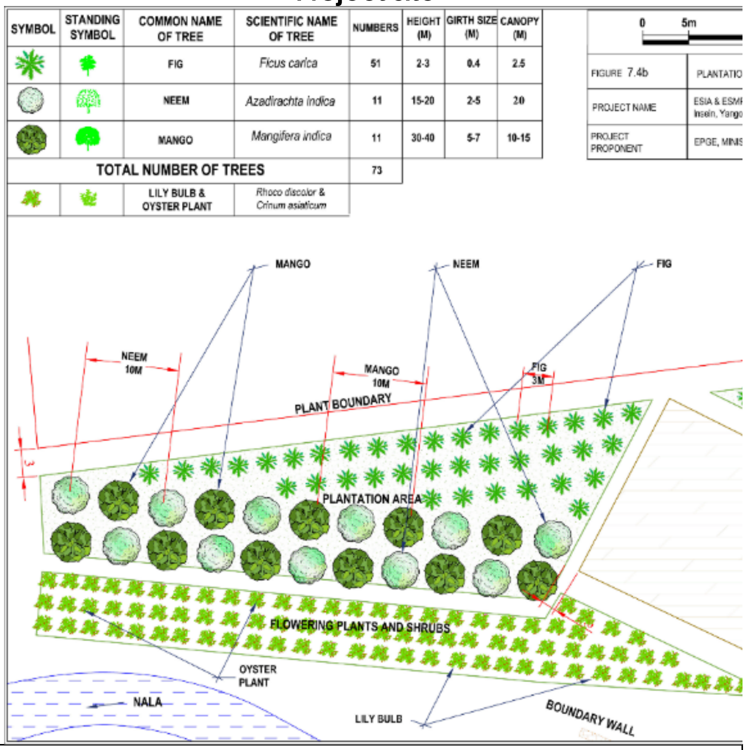


	Figure 9-4b: Green belt development at SE- side of the Project site

Aspects and Impact	Sensitive receptors	Operation Phase Mitigation Measures	Operation Phase Method & Technique

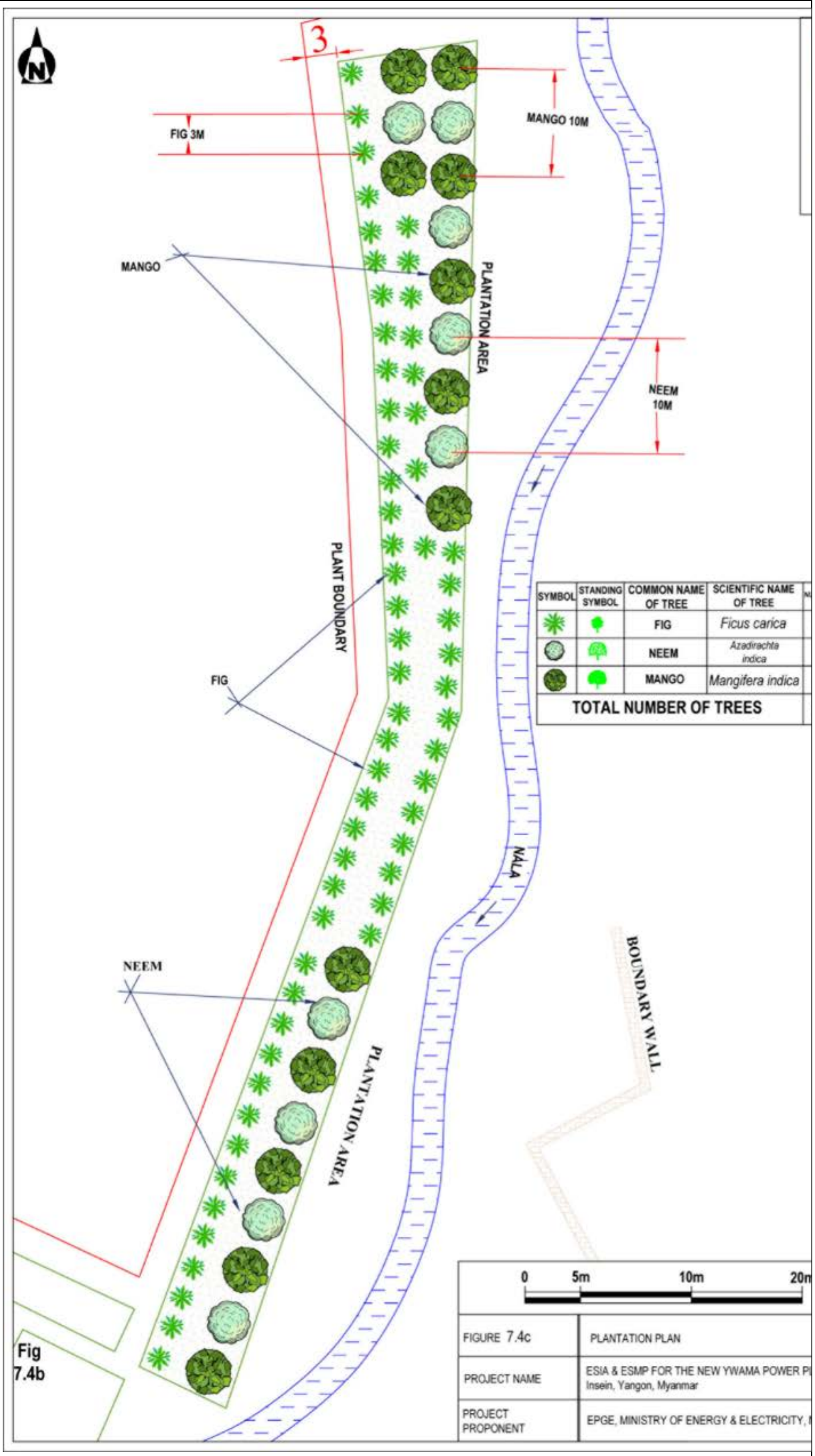


Figure 9-4c: Green belt development at S-side of the Project site

9.1.2 Mitigation Measures for Water Pollution

9.1.2.1 Pre-construction and Construction Phase

During these phases, the water pollution will be due to domestic waste-water and run-offs from stock-piles and excavated areas. There may be also risk of waste water with oil and grease flowing in to the nearby water-bodies, if not managed properly. The mitigation measures to be adopted for waste water management during construction phase is given below.

Table 9-3: Water Pollution Mitigation Measures during Pre-Construction Phase

Aspects and Impact	Pre-Construction & Construction Phase	
	Mitigation Measures	Method & Technique
• Pollution from domestic waste water generated by construction workers	Implement adequate sanitary facilities, (one temporary toilet for every 25 workers up to the first 100, and one for every 50 thereafter) provide for the construction work-force. Total number of 8 toilets has to be provided.	
	Regularly inspection and maintenance of drainage systems and erosion control and silt removal facilities to ensure proper and efficient operation at all times;	This is the responsibility of the house-keeping Department to ensure there is no siltation in the drains.

Table 9-4: Water Pollution Mitigation Measures during Construction Phase

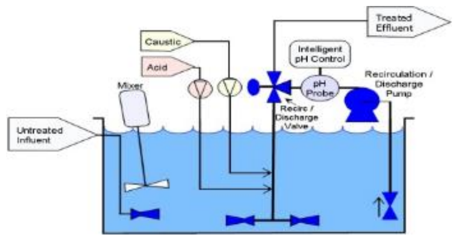
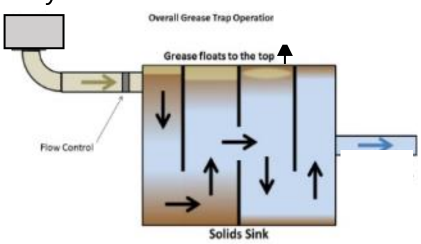
Aspects and Impact	Pre-Construction & Construction Phase	
	Mitigation Measures	Method & Technique
• Risk of run-off from stock piles and construction sites into neighbouringresidential areas • Contamination ofHlaing River and nearby drains from oil and grease of machineries • Pollution from domestic waste water generated by construction workers	Install oil/water separators to treat surface run-off from bounded areas prior to discharge to the storm-water system;	
	Garland drains around all open stockpiles of construction materials have to construct. The garland drains will be diverted through a settlement tank so that suspended solids do not	The garland drains around stockpiles will be connected to the main drainage of the lay-down area after passing through a settlement tank.

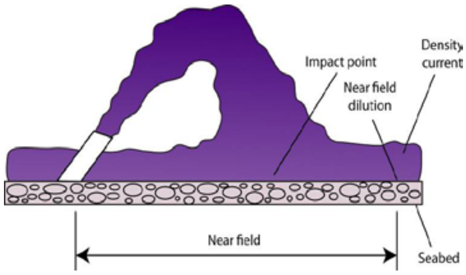
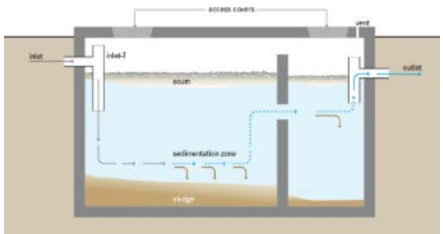
Aspects and Impact	Pre-Construction & Construction Phase	
	Mitigation Measures	Method & Technique
	flow into the main drains or the Hlaing River. A drain will be connected from the lay-down area to the main drainage system of the plant after passing through the settlement tank. The existing drainage system of the plant has to be modified so that its volume is increased.	
	Implement adequate sanitary facilities, (one temporary toilet for every 25 workers up to the first 100, and one for every 50 thereafter) provide for the construction work-force. Total number of 10 toilets has to be provided.	
	The toilets will be connected to septic tanks to treat sanitary discharge.	All the toilets connect to the existing septic tank in the plant.
	Open stockpiles of construction materials such as sand, gravels or construction wastes such as debris on-site cover with tarpaulin or similar fabric during rain-storms to prevent run-off into nearby drains.	
	Regularly inspection and maintenance of drainage systems and erosion control and silt removal facilities to ensure proper and efficient operation at all times;	This is the responsibility of the house-keeping Department to ensure there is no siltation in the drains.

9.1.2.2 Operation Phase

Waste-water from separate effluent streams will be treated through different methods. There will be no risk of any chemical pollutants in the water except for oil and grease from maintenance of machineries. The pH of the Power Plant wastewater sample is basic with pH values inlet ranging varies. The details of the different treatment methods are provided in **Table 9.5**.

Table 9-5: Water Pollution Mitigation Measures during Operation Phase

Aspects and Impact	Operation Phase	
	Mitigation Measures	**Method & Technique**
The effluent streams from the power plant will be mainly process water discharge, oily effluents from maintenance, cooling tower blow-down, effluent from DM Plant, etc. Domestic waste-water will be generated from workers	Water from process cycle will have to be pH neutralized and will be discharged to Hlaing River. Cleaning water from RO membrane will be neutralized before discharge to Hlaing River	In this system, effluent flows into the holding tank where a pH sensor senses the pH of the solution. The sensor provides input to the pH controller device which operates chemical pump(s) to inject acid or caustic as required to neutralize the effluent. Chemicals dosages have to do under pH control in order to maintain the pH. The mixer serves to evenly distribute the neutralizing chemicals throughout the holding tank to ensure complete neutralization. 
	Oily effluents will be separated to ensure that there is no contamination from the plant area to external water bodies. O&G separators will be put in all drain outlets so that accidental spillage during maintenance or leakage from vehicles will not impact the ground water or surface water bodies	Oil and Grease separators installe at the inlet of all storm water drainage near the plant areas for accidental spillage. The separated oil collects and stored along with the used oils. These oils sell to recyclers. 
	Cooling tower blow-down water will be directly discharged into the Hlaing River.	As the blow-down water will contain no pollutants except for high temperature and high TDS, there is no requirement for any treatment. As per FS blow down water will be directly discharge in river water but the blow-down waste water has to send to the evaporation pond if its TDS level becomes too high. The incremental temperature restricts within 3°C above ambient water temperature.
	Chlorides, nitrates and sulfates can deposit on	Cooling tower feed water is provided by distillation and deionization plants.

Aspects and Impact	Operation Phase	
	Mitigation Measures	Method & Technique
	compressor blades and may result in stress corrosion attack and/or cause corrosion Pitting. Sodium and potassium are alkali metals that can combine with Sulfur to form a highly corrosive agent and that will attack portions of the hot gas path.	One deionization plants units have been constructed for sufficient capacity to supply de-mineralized water.
	Brine from RO will be directly discharged to Hlaing River.	Brine from RO contains other contaminants such as metals, nutrients, trace organic chemicals, etc. So, a diffuser with single point jet is proposed so that brine gets diluted fast. The brine from RO will be directly discharged to Hlaing River after equalization in an equalization tank. However, it has been ascertained that due to the saline nature of the river water, there will be negligible increase in the river salinity. 
	Domestic waste-water will be treated in septic tank	It is estimated that the capacity of the septic tank should be enough to cater to about 400 persons so that both construction and operation phase is taken care of. The estimated capacity of the tank has been taken as 3000 liters considering that the toilets will not be for residential use. The ideal size of concrete tanks of 3000 liters will be about 4.0m X 2.5m x 2.0m. Sanitary Effluents treat in STP with no discharge 

9.1.3 Solid Waste

9.1.3.1 Pre-Construction and Construction Phase

During the dismantling of the old plant, C&D wastes and plant scraps will be generated, which will have to be managed properly to avoid littering and dumping in the locality. In addition to that, municipal solid wastes will be generated from the construction workers, although it will be negligible as there will be no labour camps at site. The mitigation measures to be taken are as given in **Table 9.6**.

Table 9-6: Solid Waste Mitigation Measures for Pre-construction & Construction Phase

Aspects and Impact	Pre-construction & Construction Phase	
	Mitigation Measures	**Method & Technique**
C&D wastes and metal scraps from plant dismantling will be generated which unless disposed properly will have adverse impact on neighbouring residential areas. C&D waste is estimated about 5400 tons during pre-construction phase and 675 tons for construction phase Municipal solid waste of about 60kg/day and 160kg/ day will be generated during the pre-construction and construction phases respectively.	Proper segregation of hazardous and non-hazardous waste and provide appropriate containers for the type of waste type	The steps include training of personnel for identification and segregation of wastes at source. Proper storage will be demarcated for hazardous and non-hazardous wastes. It will be collected by YCDC. The biodegradable part will be treated and the non-bio-degradable part disposed off to recyclers as a standard practice.
	Ensure that storage areas have impermeable floors to prevent any type of leaching to soil and ground water. There separate receptacles for different wastes streams such as steel, bricks/mortar, wood, etc. Industrial Wastes will be sent to industrial waste treatment and controlled landfill facility at the Thilawa Special Economic Zone	 
	Proper segregation, storage and disposal of municipal solid wastes in separate dust bins. Wastes to be collected by Pollution Control and Cleansing Department, YCDC. All MSW will be sent to Htein Bin FDS for disposal.	

9.1.3.2 Operation Phase

The only solid waste envisaged during the operation phase is municipal solid waste. The main mitigation measures to avoid pollution due to spillage, improper disposal or storage of MSW are given in **Table 9.7**.

Table 9-7: Solid Waste Mitigation Measures for Operation Phase

Aspects and Impact	Operation Phase	
	Mitigation Measures	Method & Technique
The adverse impact of MSW can be due to aspects such as improper storage and disposal, which can lead to spillage to drains, Hlaing River and open spaces and consequently pollute the area.	Proper segregation of wastes at source with separate bins for bio-degradable (kitchen wastes, garden wastes, vegetables, etc) and non-biodegradable wastes (plastics, paper, glass, metal)	Provision of separate colored bins and training to staff for proper disposal of MSW as per color codes. All the solid waste disposal bins place away from water streams
		MSW put in containers, characterized and labeled, stored briefly and transported to an appropriate off-site disposal facility through a recycler. It collected by YCDC and treat the biodegradable part and dispose off the non-biodegradable part to recyclers as a standard practice. Waste Management is the responsibility of WCDC.

9.1.4 Mitigation Measures for Hazardous Waste

9.1.4.1 Pre-Construction Phase

The most probable hazardous waste to be found while dismantling is asbestos. Asbestos fumes are carcinogenic and causes many diseases such as cancer (lungs, ovarian, laryngial), asbestosis and pleuritis amongst others. As already mentioned, the concern is limited to dismantling and packaging. The mitigation measures to be taken are given in **Table 9.8**.

Table 9-8: Hazardous Waste Mitigation Measures for Pre-construction Phase

Aspects and Impact	Pre-construction& Construction Phase	
	Mitigation Measures	Method & Technique
During dismantling of plant, the two major source of impact will be asbestos fumes from pipe insulations and spent oils from machines	An asbestos management plan has to be developed for the pre-construction phase. Identification of areas having possibility of containing ACMs Survey of type of asbestos and chances of breakage. Asbestos removal should take place before demolition starts. Only authorized specially trained persons wearing Personal Protective Equipment including	

Aspects and Impact	Pre-construction& Construction Phase	
	Mitigation Measures	Method & Technique
	full-body overalls have to allow to handle asbestos. Water sprinkling has to done for keeping on all materials containing asbestos moist before cutting. No discharge generates from water sprinkling. Asbestos handling to be done inside enclosures designed to capture any asbestos containing particles. Separate area should be demarcated for asbestos handling away from the main activity areas. Shower room to be provided for the workers so that they can immediately shower after handling asbestos. Pipes containing asbestos should be immediately packed in plastic sheets of at least 500 gauge and sealed. If temporary storage after packaging is required, then the area should be isolated and proper warning notices put up. After ensuring that all asbestos containing materials has been removed, the enclosures be taken down in accordance with regulatory requirements and disposed of at a licensed facility. The contractor will be required to prepare a hazardous management plan which also include occupational health and safety mitigation measures and implement it during preconstruction and construction phase. Follow the following guidance: i) WBG General EHS Guidelines https://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES&CVID=jOWim3p; ii) US Occupational	 Portable Shower Units

Aspects and Impact	Pre-construction& Construction Phase	
	Mitigation Measures	Method & Technique
	Safety and Health Administration - Asbestos: https://www.osha.gov/SLTC/asbestos/.	
	For avoiding spillage to soil and then to ground water during removal concrete floor and high wall enough to prevent over flow and run off. All waste oils store in drums and kept on concrete surface to prevent spillage of oil on soil and subsequent leaching to ground water. It will be disposed through local recyclers. The oil tanks to be demolished and the sludge generated in the past will be stored in containers in a space with concrete surface and oil and grease traps will be put in all drains and will be transported for later treatment or disposal in an adequate facility. The bidding document will require that the EPC contractor develops and implements a hazardous waste management plan which also includes occupational health and safety mitigation measures during pre-construction and construction phase.	

9.1.4.2 Construction and Operation Phase

During these phases, the hazardous waste expected to be generated is spent oil from turbine, generator and other machineries. The management of spent oil will be same as the pre-construction phase. However, during this period, a covered temporary structure with concrete floor will be constructed for storage of oil.

Table 9-9: Hazardous Waste Mitigation Measures for Construction& Operation Phase

Aspects and Impact	Construction & Operation Phase	
	Mitigation Measures	Method & Technique
There will be spent oils from plant machineries, which are classified as hazardous. Spillage of oil will lead to contamination of soil and ground water.	All spent oils of the plant store in drums and kept on concrete surface to prevent spillage of oil on soil in the vicinity, and subsequent leaching to ground water sources. It will be disposed through local recyclers.	The concreted area for the storage of drums about 5m x 5m with a corrugated sheet roof. The area surrounds by wire mesh and have locking facility so that there is access for only authorized personnel.

9.1.5 Mitigation Measures for Soil and Ground-Water

9.1.5.1 Pre-construction, Construction and Operation Phase

As the project area is small and there is no abstraction of ground water, the impact envisaged is negligible. The concern for environment issues for soil and groundwater include contamination of soil and subsequently groundwater through leaching from chemicals and oils. In the present case the major concern is contamination from spent oil from machines

Table 9-10: Soil & Ground Water Mitigation Measures for Pre-construction, Construction& Operation Phase

Aspects and Impact	Pre-Construction, Construction & Operation Phase	
	Mitigation Measures	Method & Technique
Contamination of soil and ground-water from oil spillage	All oil storage (especially spent oil) to be done on impervious surfaces	Special space with concrete surface specifies in lay-down area for storing drums of spent oil. Oil and grease traps put in all drains so as to avoid draining of oil and grease. All staff trained to understand the importance of proper handling of oil.

9.1.6 Mitigation Measures for Noise

9.1.6.1 Pre-construction and Construction Phase

As mentioned in Chapter 6, the main concern for this project is impact of noise on the adjacent residential areas. The noise level during the pre-construction, construction and de-commissioning phase will be high due to operation of heavy machines and increase in heavy vehicles. The following mitigation measures will be adopted to attenuate the noise level outside the site.

Table 9-11: Noise Mitigation Measures for Pre-construction& Construction Phase

Aspects and Impact	Pre-construction & Construction Phase	
	Mitigation Measures	Method & Technique
During the construction phase of the site, the main source of noise pollution would be construction equipment, transportation activities vibrating machinery. Noise level outside the boundary of the plant will be higher than the prescribed level. Thus, there will be constant disturbances in the adjacent residential area due to movement of heavy vehicles and machineries.	Regular maintenance of machineries such as lubricating moving parts, tightening loose parts and replacing worn out components.	
	Typical management decisions that reduce worker exposures to noise are: moving workers away from the noise source; restricting access to areas; rotating workers performing noisy tasks; and shutting down noisy equipment when not needed.	
	Earplugs are the typical PPE given to workers to reduce their exposure to noise. Earplugs are the control of last resort and should only be provided when other means of noise controls are infeasible. As a general rule, workers should be using earplugs whenever they are exposed to noise levels of 85 dB (A) or when they have to shout in order to communicate.	
	Noise barriers to be installed to reduce the noise levels outside the boundary of the construction site and lay-down area. The barrier material has a mass per unit of surface area in excess of about 7 kg/m^2 and no gaps at the joints. The minimum height of barriers will be such that no part of the noise source is visible from the receptor.	
	Loading and unloading of heavy machines, construction materials along with noisy equipment to be done during day time.	

9.1.6.2 Operation Phase

As was found from the noise modeling done as part of the study, the noise level with 'zero' control at the nearby receptors were found to be much higher than the stipulated standards. Thus, there is a requirement of taking up mitigation measures so as to reduce the ambient noise level in the residential areas. The suggested mitigation measures are as follows.

Table 9-12: Noise Mitigation Measures for Operation Phase

<table>
<tr><th rowspan="2">Aspects and Impact</th><th colspan="3">Operation Phase</th></tr>
<tr><th>Mitigation Measures</th><th colspan="2">Method & Technique</th></tr>
<tr><td rowspan="6">The noise level due to the proposed plant with 4 gas turbines, one steam turbine and the gas engine plant is predicted to be much higher than the permissible limit of 55 dB(A) during the day time and 45 dB(A) during night. This is expected to create an impact on the health of the residents residing near the boundary of the plant.</td><td>Install silencers, mufflers or acoustic enclosures to reduce sound power level of noisy equipment at all times. The gas turbine to be kept inside acoustic enclosures and the gas turbines locate inside buildings. Although the capital cost increases slightly by estimated 1.9% of the EPC price[28], due to predicted high impact of noise on nearby residential areas, it has been planned to design indoor turbines.</td><td colspan="2">It has been predicted that unless the turbines are placed indoors, it not be possible to attenuate the noise level at the residential buildings to 45 dB(A). Thus, the turbines have an enclosure and also placed indoors.

Acoustical Turbine Enclosure</td></tr>
<tr><td rowspan="4">Install steam turbine inside a building for noise level reduction at the nearby residential areas. It is estimated that the incremental cost over the EPC cost will be about 0.4% of the EPC price.</td><td>Plant Machinery</td><td>Measures</td></tr>
<tr><td>Steam Turbine</td><td>• Building is compulsory
• Improved cladding</td></tr>
<tr><td colspan="2">The technical design of mitigation measures during the project implementation have to include measures to ensure that noise levels in the nearby residential areas do not exceed the limit of 55 dB(A) during day time and 45 dB(A) during night time.</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Development of upgraded wall and/or greenbelt on the eastern and southern boundary of the plant site</td><td colspan="2">Trees such as jack-fruit, Vendara, Fig plant along the boundaries. Along the eastern boundary, single row plant</td></tr>
</table>

[28]Tractabel Noise Modelling

Aspects and Impact	Operation Phase	
	Mitigation Measures	Method & Technique
	to reduce noise at the EPGE residential buildings and Ywama West Sub-quarters 5 & 6.	while along the southern boundary, three rows have to develop. Install acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m2 in order to minimize the transmission of sound through the barrier. Barriers should be located close to the source or to the receptor location to be effective. The wall height will be increased by another 5 meters (presently it is 5 meters) and acoustic barriers will be installed on top of it. Before its construction, the design of upgraded wall/acoustic barriers will be previously consulted with the families living in the 80 apartments (buildings E6-E10) located closest to the power plant, in order to make sure that it doesn't block the sunlight entering through their windows.
	Additional noise control and insulation measures	In case the above-listed noise mitigation measures are not enough to reach the prescribed WBG EHS Guidelines' limit, additional noise control and insulation measures should be adopted to protect the surrounding apartments from the impacts of noise and vibration (acoustic insulation of windows and doors, etc).

The other measures to be taken for noise attenuation are provided in **Table 9.13**.

Table 9-13: Additional Noise Mitigation Measures

GT air intake	Improved silencer
Exhaust gas diffuser	To be housed in enclosure and hot silencer could be added
By-pass stack	Improved silencer in stack
HRSG body	Improved noise abatement
HRSG stack	Improved cold silencer
Feed water pump	Housed inside enclosure
Cooling tower	Low noise design and air opening on one side (if needed)
Step-up transformers	Low noise type

At the implementation stage, the EPC contractor will be responsible for undertaking additional noise studies, include cost-effective noise mitigation measures in the design phase and implement adequate mitigation measures to ensure that noise levels for the residential area will be within the WBG ESH Guidelines. Such requirements will be included in the EPC bidding package/contract.

The Borrower will perform noise monitoring in the operational phase. In case those noise thresholds cannot meet the WHO limits, the Borrower commits to relocate staff living in the areas affected by noise.

9.1.7 Mitigation Measures for Ecology

9.1.7.1 Pre-construction and Construction Phase

As explained in the previous chapter, trees are to be cut as part of the site clearance process. This loss will also deplete the tree curtain present between the plant and residential areas. However, as the site already is an existing plant, the destruction of flora will be minimum. The mitigation measures to be taken up, which are given in **Table 9.14**.

Table 9-14: Ecological Mitigation Measures for Pre-construction& Construction Phase

Aspects and Impact	Pre-construction & Construction Phase	
	Mitigation Measures	**Method & Technique**
Site clearance will be done for preparation of the site in lay-down area. Tree cutting will also do in plant site. However, trees near the boundaries will be retained. About 49 trees will be cut for the project	Develop green belt in EPGE properties to compensate the trees felled for the project.	Trees such as jack-fruit, Vendara, fig will be planted along the boundaries. Along the eastern boundary, single row will be planted while along the southern boundary, three rows will be planted along with residential areas to compensate the trees cut.
	Water sprinkling for dust suppression two times in a day in order to reduce deposition of dust on leaves of existing trees.	 Water Sprinklers

9.1.7.2 Operation Phase

No new impact is envisaged in this phase which is new from the construction phase.

9.1.8 Socio-economic Measures

The socio-economic mitigation measures are the following.

Stakeholder Engagement Plan: Develop and implement a Stakeholder Engagement Plan. As part of this, a local recruitment and procurement management plan will be also developed. Development of the plan should involve consultation with relevant stakeholders, including government authorities and local people. The stakeholder engagement plan will be formulated before the pre-construction stage and the implementation will also be initiated before any activity is started at site. The responsibility of the preparation and implementation of the SEP will be with the EPGE. The implementation during the pre-construction and construction phase will be done by the EPC contractor under guidance and supervision of EPGE.

Grievance Redressal: Grievance may be raised by stakeholders due to various reasons such as failure to fulfill commitments, poor management of construction activities, inappropriate planning of vehicle movement, and conflicts between workers and local communities. Therefore, it is imperative to have an internal mechanism in place where the aggrieved party/s can lodge their complaints and get it amicably settled prior to approaching the formal mode of solution available to them i.e. access to legal system through courts.

EPGE, together with the EPC contractor, will make sure that the Grievance Redress Mechanism (GRM) will be developed for the Project in order to settle as many disputes as possible through consultations. The Grievance Redressal Cell will be formed with members from the Ywama Plant while the HO GRC will have members drawn from EPGE Nay Pyi Taw and MOEE. The GRC will have officials from Ywama Plant, local representative of nearby residential areas, local political leaders.

Labor Influx, skill training and prevention of Gender Based Violence: During construction works, labor influx is expected to be moderate. Workers camps are not expected, and the project activities will be carried out near residential areas. However, it is estimated that about 300 workers will be recruited during the dismantling of the old plant at pre-construction stage. This will increase to about 800 during the construction phase. To reduce labor influx and boost local benefits of the project, a training program will be in place for EPGE together with the EPC contractor to provide skill training to eligible local people so that they become skilled workers that can be employed in the plant, at least, for the pre-construction and construction phases.

EPGE, together with the EPC contractor, will make sure that the following activities are in place before the beginning of the works: (i) provisions to promote local recruitment of workforce, including a training program to provide skill training to eligible local people, (ii) prepare and implement a GBV Plan, including the following minimum contents: (a) Assign a GBV Focal Point, (b) Map oy GBV prevention and response actors, (c) GBV sensitive, effective grievance redress mechanism, (d) Codes of Conduct, (e) Training for workers and local community on Sexual Exploitation and Abuse and Sexual Harassment.

Disturbances during construction works: EPGE, together with the EPC contractor, will make sure that during construction works, provisions will be in place to ensure that the local communities affected by the project works are properly notified of the timing and scope of the planned works and disturbances are minimized. Such minimization of disturbances may include limiting working hours to daylight, special precautions when the work is carried out near children's institutions or traffic management including, if required, the establishment of alternative temporary traffic routes.

Especial attention will be paid to the 650 meters long access road to the plant is an area with risk of accidents, as it is narrow and has just enough width to allow maneuver of the vehicles. Therefore, proper mitigation measures will have to be adopted by the EPC contractor to reduce the risk of any incidents on this road.

Table 9-15: Socio-economic Mitigation Measures

Aspects and Impact	Pre-construction & Construction Phase	
	Mitigation Measures	**Method & Technique**
There will be no land acquisition or displacment due to the project. Thus negative impact on the social environment is not envisaged. There will be positive impact due to generation of job opportunities and increase in indirect employment in form of market development, petty suppliers, etc	Develop stakeholders engagement programme (SEP) including regular disclosures, consultation with direct and indirect stakeholders	SEP will be formed before the pre-construction phase so that opinion of stakeholders are considered for project planning. The preparation and implementation will be done by EPGE Environment and Social Unit (ES) during O&M stage while. It will be done by the EPC contractor under guidance and supervision of EPGE during PC and C stages.
	GRM	EPGE, together with the EPC contractor, will make sure that GRM will be developed by project effectiveness in order to settle as many disputes as possible through consultations. The Grievance Redressal Cell will be formed with members from the Ywama Plant while the HO GRC will have members drawn from EPGE Nay Pyi Taw and MOEE. The GRC will have officials from Ywama Plant, local representative of nearby residential areas, local political leaders.
	Labor Influx, skill training and prevention of Gender Based Violence	EPGE, together with the EPC contractor, will make sure that the following activities are in place before the beginning of the works: (i) provisions to promote local recruitment of workforce, including a training program to provide skill training to eligible local people, (ii) Prepare and implement a GBV Plan, including the following minimum contents: (a) Assign a GBV Focal Point, (b) Map of GBV prevention and response actors, (c)

Aspects and Impact	Pre-construction & Construction Phase	
	Mitigation Measures	Method & Technique
		GBV sensitive, effective grievance redress mechanism, (d) Codes of Conduct, (e) Training for workers and local community on Sexual Exploitation and Abuse and Sexual Harassment.
	Disturbances during construction works	EPGE, together with the EPC contractor, will make sure that during construction works, provisions will be in place to ensure that the local communities affected by the project works are properly notified of the timing and scope of the planned works and disturbances are minimized

9.1.9 Green Belt

In order to reduce the air pollution and for noise attenuation in the residential areas near to the plant, a green belt will be required at the boundary of the plant. As discussed before, there is no space inside the plant site for plantation. Thus, it is proposed to plant trees along the boundary, outside the plant area. The lands identified belong to EPGE and thus there will be no requirement for any additional land for green-belt.

The design of the Green Belt will be previously consulted with the families living in the 80 apartments (buildings E6-E10) located closest to the power plant, to make sure that it does not block the sunlight entering through their windows.

9.1.9.1 Plantation along the Eastern Boundary of the Plant Site

There are residential buildings near the eastern boundary of the plant site. It has been confirmed from the impact assessment that the maximum impact (especially due to noise) will be on these buildings. Thus, plantation of trees along the boundary wall is suggested (**Figure 9.4 a, b and c**). As the area between the boundary wall and buildings is on an average 4.0m, only one line of trees with small girth size but high canopy cover has to be planted. It is suggested to plant tree such as *Dipterocarpusalatus* (Kanyinbyu)for this area. It has been estimated that about 25 trees can be planted in this space in a linear manner. The noise attenuation of this green belt will be less than 4 dB(A).

9.1.9.2 Plantation on the Southern Side of the Plant Site

There are densely populated residential areas of Ywama (West) Sub-Quarter 5 and 6 on the southern side of the site. The land adjacent to the plant is owned by EPGE and is suggested for use as green belt. Here it is proposed to have a three-tier green belt with local species. The preferred trees suggested in this area are *Azadirachtaindica* (Neem), *MangiferaIndica* (Mango) and *FicusReligiosa* (Fig tree) and herbs like *Rhoco discolor* (Lily Bulb)*Crinum asiaticum* (Oyster Plant). It is estimated that about 155 trees will be planted along the southern and south-eastern boundary of the plant site (**Table 9.16)**. The types of trees proposed will have a height of about 15m with high canopy cover to help in air pollution mitigation and act as a barrier for noise attenuation. The noise attenuation of this green belt will be 4 dB(A).

Table 9-16: Mitigation Measures for Pre-construction & Construction Phase

Sl. No.	Common Name	Scientific Name	Number	Height (M)	Girth Size (M)	Canopy (M)
1	Kanyinbyu	*Dipterocarpusalatus*	25	30-40	1.5	20
2	Fig	*Ficuscarica*	112	2-3	0.4	2.5
3	Neem	*Azadirachtaindica*	20	15-20	2-5	20
4	Mango	*Mangiferaindica*	23	30-40	5-7	10-15
5	Lily Bulb	*Rhoco discolor*	-	-	-	-
6	Oyster Plant	*Crinumasiaticum*	-	-	-	-

9.2 ENVIRONMENT AND SOCIAL MANAGEMENT PLAN

The primary objective of the environmental and social management plan is to record environmental and social impacts resulting from the project activities and to ensure implementation of the “mitigation measures” identified earlier in order to reduce adverse impacts and enhance positive impacts from specific project activities. Besides, it would also address any unexpected or unforeseen environmental and social impacts that may arise during construction and operation phases of the project.

The Environment & Social Management Plan should clearly define:

- the measures to be taken during both construction and operation phases of the project to eliminate or offset adverse environmental impacts, or reduce them to acceptable levels;
- The actions needed to implement these measures;
- A monitoring plan to assess the effectiveness of the mitigation measures employed.

The environmental and social management and monitoring activities for the proposed power plant project could be divided into management and monitoring: (a) during construction phase, and (b) during operation phase.

In this chapter, ESMP has been dealt for pre-construction, construction and operational phase of the proposed plant. The following are the components of ESMP:

- Monitoring Programme - Construction and Operation
- Institutional arrangements for implementation
- Mode of implementation

9.2.1 Monitoring Programme

The purpose of the monitoring program is to ensure that the intended environmental and social measures are achieved and result in desired benefits to the target population. To ensure proper implementation of the Environment and Social Monitoring Programme, it is essential that an effective monitoring program is designed and carried out. The broad objectives of the environment monitoring program are:

- To monitor impacts on the surrounding environment and social, and the effectiveness of mitigation measures during the construction and operation phases.
- To ensure that the environmental and social control systems are installed at the plant and are operating satisfactorily.
- To suggest ongoing improvements in mitigation measures, if required, for subsequent effective monitoring.
- In the sections below the proposed environment cell, its functions and financial implications are described.

The monitoring program has been formulated to take care of impact of the proposed project in all phases. The monitoring for different parameters of environment and social aspects, outlined in the following sections, is based on the findings of the impact assessment. Environment and Social Monitoring Plan during pre-construction and construction phase is given in **Table 9.17**. The monitoring during these phases will be the responsibility of the EPC contractor and will be supervised by EPGE and the plant manager, Ywama Power Plant. An Independent Environmental and Social monitoring consultant will be appointed by EPGE, who will be having the responsibility of implementing the monitoring.

Table 9-17: Environment Monitoring Program during Construction Phase

Sl. No	Aspect	Parameters	Frequency	Location
1	Septic tank effluent quality	pH, BOD, COD, TDS	Quarterly	After treatment from each septic tank
2	Waste-water Quality	pH, Electrical Conductivity, TDS, Oil & Grease, Hardness, Alkalinity Chlorides, Sulphate, Sodium, Potassium, Nitrates and Heavy Metals, BOD, COD, Total Coliform	Quarterly	Discharge point to Hlaing River
3	Water Quality	pH, Electrical Conductivity, TDS, Oil & Grease, Hardness, Alkalinity Chlorides, Sulphate, Sodium, Potassium, Nitrates and Heavy Metals	Quarterly	Upstream & downstream of Hlaing River
4	Noise Level	Equivalent noise pressure level	Once a fortnight	Inside construction site, near EPGE residential buildings, Ywama&Insein
5	Air quality	PM_{10}, $PM_{2.5}$, SO_2 and NO_2, CO, HC	Twice in a week	Inside construction site, near EPGE residential buildings, Shwe Lin Ban Industrial Zone, Insein
6	Occupational Health & Safety	General Heath monitoring of workers Regular safety drills and training	Once every quarter	For all workers, permanent and contractual

The monitoring program during the O&M stage, including number and location of monitoring stations, frequency of sampling and parameters to be tested is summarized and presented in **Table 9.18**.

Table 9-18: Environment Monitoring Program during O&M Phase

Aspect	Parameter	Methods	Frequency	Locations	Responsibility
Ambient Air Quality	PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, HC	Electro-chemical Methods	Twice in a week and 24hour at each station	4 locations including on-site, predominant down-wind direction, nearest settlement (Ywama) and one upwind	Independent Environmental and social monitoring consultants (IESMC)
Stack Emission	PM, SO_2, NO_2	Electro-chemical Methods	Quarterly	Stacks	IESMC
Surface water quality	pH, Electrical Conductivity, TDS, Oil & Grease, Hardness, Alkalinity Chlorides, Sulphate, Sodium, Potassium, Nitrates and Heavy Metals, DO, BOD, COD, Total Coliform	Standard methods of APHA, 2012	Monthly	3 locations within the impact zone including upstream and down-stream from plant on Hliang River	IESMC
Ground water quality	pH, Electrical Conductivity, TDS, Hardness, Alkalinity Chlorides, Sulphate, Sodium, Potassium, Nitrates and Heavy Metals	Standard methods of APHA, 2012	Quarterly	2 locations from nearby bore-hole at Ywama and plant site	IESMC
Plant effluents	pH, Electrical Conductivity, TDS, Hardness, Alkalinity Chlorides, Sulphate, Sodium, Potassium, Nitrates and Heavy Metals	Standard methods of APHA, 2012	Monthly	Before recycling	IESMC
Drainage and effluent Management	Visual inspection of drainage and records		Periodic during operation phase	Plant site	IESMC
Soil	Physical parameters		Once every six months	On-site near to waste disposal area	IESMC
	Moisture	Gravimetric			
	Soil Texture	Hygro meter			
	Bulk Density	Gravimetric			
	Porosity	Calculation			
	Conductivity	Conductivity meter			

Aspect	Parameter	Methods	Frequency	Locations	Responsibility
	Chemical parameters				
	pH	pH meter			
	Organic Matter	Black method			
	Organic Carbon	Calculation			
	Potassium	Flame Photometric			
	Phosphorus	Spectrophotometric			
	Nitrogen	Distillation & Titration			
	Heavy Metals	Atomic Absorption Spectrophotometric			
Noise level	Noise	Sound pressure meter	Once a fortnight	One near IPP plant. one at CrCGT, one at EPGE residential quarters, one at Ywama sub-quarter 5	IESMC
Waste Management	Records of solid waste generation, treatment and disposal	Record maintain and Survey	Periodic during operation phase	Plant site	IESMC
Maintenance of flora and fauna	No. of plants, species and survival rate	Survey	Periodic during operation phase	Green belt along the boundary and plantation in EPGE colony	
Occupational Health and Sefety	General Heath monitoring of workers Regular safety drills and training	Health check up camps and safety drills	Once every quarter	Inside plant	EPGE

During the life of the project, social aspects will also be monitored to ascertain the impact of the project on the socio-economic status, health status and quality of life of the people. For this, continuous interaction with the stake-holders is necessary throughout the life of the project. The consultations and audits/evaluation proposed for the project is given in **Table 9.19**.

Table 9-19: Social Audit/Evaluation Program during Construction Phase

Aspect	Parameter	Responsibility
Social Audit of directly and indirectly affected population	Annual audit should be done among the residents of the neighbouring areas to understand the overall performance of the socio-economic mitigation measures included in this ESIA: stakeholder engagement, grievance mechanism, noise mitigation	Independent Environmental and social monitoring consultants (IESMC)

Aspect	Parameter	Responsibility
	measures, labor influx, skill training, prevention of GBV, disturbances during construction works.	
Stakeholders Consultation	Quarterly consultation with stakeholders, ie. EPGE families, families in Ywama quarters 5 & 6, residents of steel mill, etc to understand the overall performance of the socio-economic mitigation measures included in this ESIA	EPGE and EPC contractor
Grievance Mechanism	Grievance Redressal Cell in place before the beginning of the construction works	EPGE and EPC contractor
Labour Influx and Skill Training	Promote local recruitment of workers and put in place, prior the beginning of the construction works, a training program to provide skill training to eligible local people so that they become skilled workers that can be employed in the plant. At least, for the pre-construction and construction phases.	EPGE and EPC contractor
Prevention of Gender Based Violence	Prepare a GBV, including the following minimum contents: (i) GBV Focal Point, (ii) Map of GBV prevention and response actors, (iii) GBV sensitive, effective grievance redress mechanism, (iv) Codes of Conduct, (v) Training for workers and local community on Sexual Exploitation and Abuse and Sexual Harassment	EPGE and EPC contractor

9.2.1.1 Data Analysis

Data generated from monitoring and analysis of the samples will be compared with the prescribed/ stipulated limits. If any parameter is not found within the prescribed/stipulated limit appropriate control measures will be taken to satisfy the limit.

9.2.1.1.1 Ambient Air Quality Monitoring

The ground level concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, HCin the ambient air shall be monitored at regular intervals. Any abnormal rise shall be investigated to identify the causes and appropriate action shall be initiated. Greenbelt shall be developed for minimizing dust propagation. The ambient air quality data should be transferred and processed in a centralized computer facility equipped with required software. Trend and statistical analysis should be done. Methane and non-methane hydrocarbons shall be monitored in oil storage area once in a season.

9.2.1.1.2 Stack Monitoring

The emissions from the stacks shall be monitored regularly. The exit gas temperature, velocity and pollutant concentrations shall be measured. Any unacceptable deviation from the design values shall be thoroughly examined and appropriate action shall be taken. Air blowers shall be checked for any drop in exit gas velocity.

9.2.1.1.3 Water and Waste-water Monitoring

To ensure a strict control over the water consumption, flow meters shall be installed for all major inlets. All leakages and excess shall be identified and rectified. In addition, periodic water audits shall be conducted to explore further possibilities for water conservation. Methods prescribed in "Standard Methods for Examination of Water and Wastewater" prepared and published jointly by American Public Health Association (APHA), American Water Works Association (AWWA) is recommended.

9.2.1.1.4 Noise Levels

Noise levels in the work zone environment such as packing house, grinding unit, material loading and unloading areas shall be monitored. The frequency shall be once in three months in the work zone. Similarly, ambient noise levels near habitations shall also be monitored once in three months. Audiometric tests should be conducted periodically for the employees working close to the high noise sources.

9.2.1.2 Reporting Schedule

Regular monitoring and data analysis shall be followed through proper documentation and reporting system. Provision will be made for regular monitoring of emission and effluent data and reporting to Head Office. The monitoring outcomes should be also disclosed to the various stakeholders during the stakeholder consultation. A report with recommendations will be prepared and submitted to the ECD as and when required.

9.2.1.3 Monitoring Cost

The monitoring costs which will be incurred due to the environmental aspects in O&M phase are given in **Table 9.19**.

Table 9-20: Annual Environment Monitoring Cost In O&M Phase

Component	No. of Locations	Total No. of samples/ location	Frequency	Total cost (USD)
Stack Monitoring	2 stacks	4	Quarterly	1,000
Ambient Air Quality	4	96	Twice a week	19,200
Water	3 surface water	12	Monthly	5,400
	2 ground water	4	Quarterly	1,200
Waste Water	Effluent	12	Monthly	1,800
Noise	4	12	Monthly	2,400
Soil	4	4	Quarterly	1,600
TOTAL				**32,600**

9.2.2 Institutional Arrangement

Electric Power Generation Enterprise (EPGE) will be the main PIU of the proposed project under the overall oversight of the MOEE for the Ywama Power Plant. It will use its existing organizational structures and processes to implement the procurement and financial management project implementation tasks. Amongst other tasks, this will include preparing budget and annual work plans, manage project funds in line with eligibility guidelines, operate the designated accounts, enable the project funds' disbursements and apply for withdrawals.

The technical supervision of the project will also be responsibility of EPGE. To support the PIU on this task, the project will procure an owner's engineer. The owner's engineer will work in close collaboration with EPGE to oversight the implementation of all components. Given the very limited institutional capacities for safeguards compliance of the PIUs, the project is also procuring an ESIA consultant to reinforce supervision of safeguards implementation throughout the development of the project.

The implementing agencies have appointed teams as focal units that will work with the WBG to accomplish the fiduciary, safeguards and supervisory tasks over the project implementation. The focal units include designated PIU staff in each project management area, comprising of one project coordinator and two or more: chief engineers, procurement specialists, FM specialists and environmental and social specialists. The project coordinators will act as liaison and nexus between the WBG and all designated focal points. The focal points will be responsible for implementing and supervising the project in each specific domain and the chief engineers will manage all technical aspects of the project.

The bi-annual progress reports will be submitted to the WBG. The progress reports will include updates on the functionality of the grievance redress mechanism (GRM), which will be in place for citizen engagement and submission of any complaint, concern or issue that might arise in relation to the project.

Contractors will be responsible for implementing mitigation measures. These measures will be included in bidding documents and their costs are to be included in construction bid packages;

CSC will be responsible for monitoring the day-to-day implementation of mitigation measures. Related costs are included in the CSC service contract;

IESMC will be responsible for overall environmental monitoring which includes support to the PMU in implementing environmental supervision and monitoring and responsible for reporting on the implementation through monitoring reports.

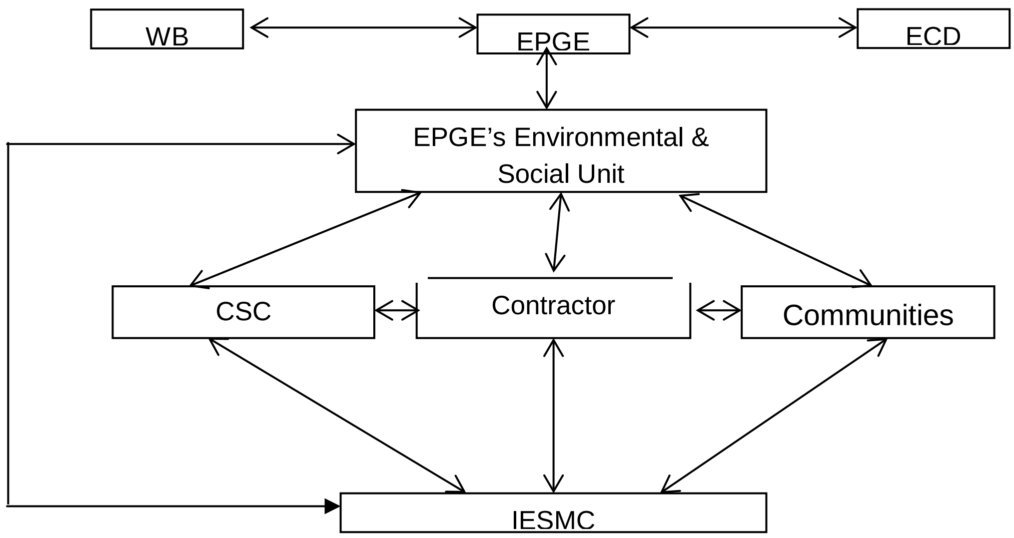


Figure 9-5: Organization chart for ESMP Implementation

The tables and figures below summarize the roles and responsibilities of the key parties and their relationships regarding the implementation of the ESMP (Table 9.20).

Table 9-21: Roles and responsibilities of key parties

Community/Agencies	Responsibilities
EPGE	EPGE will be responsible for monitoring the overall project implementation, including environmental compliance of the project. EPGE will have the final responsibility for ESMP implementation and environmental performance of the project during the construction and operational phases. Specifically the EPGE will: (i) closely coordinate with local authorities in the participation of the community during project preparation and implementation; (ii) monitor and supervise ESMP implementation including incorporation of ESMP into the detailed technical designs and bidding and contractual documents; (iii) ensure that an environmental management system is set up and functions properly; (iv) be in charge of reporting on ESMP implementation to the ECD and the World Bank. In order to be effective in the implementation process, EPGE will establish an Environmental and Social Unit (ESU) to help with the environmental and social aspects of the project.
EPGE Environmental and Social Unit (ES)	The ESU, which includes an ESIA consultant, is responsible for monitoring the implementation of the World Bank's environmental and social safeguard policies in all phases and process of the project. Specifically, ES will be responsible for: (i) helping EPGE incorporate the environmental, social, health, and safety (ESHS) and ESMP requirements into the detailed technical designs and civil works bidding and contractual documents; (ii) helping EPGE incorporate responsibilities for ESMP monitoring and supervision into the TORs, bidding and contractual documents for the Construction Supervision Consultant (CSC) and other safeguard consultant (IESMC) as needed; iii) providing relevant inputs to the consultant selection process; (iv) reviewing reports submitted by the

Community/Agencies	Responsibilities
	CSC and safeguard consultants; (v) conducting periodic site checks; (vi) helping the EPGE on solutions to handle environmental and social issues of the project; and vii) preparing environmental and social performance section on the progress and review reports to be submitted to the ECD and the World Bank.
Construction Supervision Consultant (CSC)	The CSC will assign Environmental and Social Staff(s) and will be responsible for routine supervising and monitoring all construction activities and for ensuring that Contractors comply with the requirements of the contracts and the ESMP. The CSC will engage sufficient number of qualified staff (e.g. Environmental Engineers) with adequate knowledge on environmental protection and construction project management to perform the required duties and to supervise the Contractor's performance. The CSC will also assist the EPGE in reporting and maintaining close coordination with the local community.
Contractor	The contractor will assign Environmental and Social Staff(s) to carry out Environmental and Social mitigation measures provided in ESMP. Based on the ESHS and the ESMP requirements in the bidding and contractual documents, the Contractor is responsible for preparing a Contractor ESMP (CESMP) for managing environmental impacts of the construction activities as required, submit the CESMP to CSC for review and subsequent approval by EPGE before commencement of construction. In addition, it is required that the Contractor get all permissions for construction (traffic control and diversion, excavation, labor safety, etc. before civil works) following the national regulations. The Contractor is required to appoint a competent individual as the contractor's on-site Safety and Environment Officer (SEO) who will be responsible for monitoring the contractor's compliance with health and safety requirements, the ESHS and CESMP requirements, and the environmental specifications (ECOP). Take actions to mitigate all potential negative impacts in line with the objective described in the CESMP. Actively communicate with local residents and take actions to prevent disturbance during construction. Ensure that all staff and workers understand the procedure and their tasks in the environmental management program. Report to the PMU and CSC on any difficulties and their solutions. Report to local authority and PMU and CSC if environmental accidents occur and coordinate with agencies and keys stakeholders to resolve these issues.
Independent Environmental and social monitoring consultants (IESMC)	IESMC will, under the contract scope, provide support to EPGE to establish and operate an environmental and social management system, conduct periodical environmental and social audit of the project environmental and social performance, offers suggestions for adjusting and building capacity for relevant agencies during project implementation and monitor the CESMP implementation in both construction and operation phases. IESMC will also be

Community/Agencies	Responsibilities
	responsible to support EPGE to prepare monitoring reports on ESMP implementation. The IESMC will have extensive knowledge and experience in environmental and social monitoring and auditing to provide independent, objective and professional advice on the environmental performance of the project.
Local community	Community: The community has the right and responsibility to routinely monitor environmental performance during construction to ensure that their properties and safety are adequately protected and that the mitigation measures are effectively implemented by contractors and the EPGE. If unexpected problems occur, they will report to the Contractor, CSC, and EPGE.
City Environmental Conservation Department (ECD)	ECD oversees implementation of the project environmental safeguard to ensure compliance of Government policy and regulations. ECD is responsible for monitoring the compliance with the Government environmental requirements.

9.2.2.1 Environmental and Social Compliance Framework

9.2.2.1.1 Environmental Duties of the Contractor

The contractor firstly shall adhere to minimize the impact that may be result of the project construction activities and secondly, apply the mitigation measures under ESHS and ESMP requirements to prevent harm and nuisances on local communities and environment caused by the impacts in construction and operation phases.

Remedial actions that cannot be effectively carried out during construction should be carried out on completion of the works (and before issuance of the acceptance of completion of works)

The duties of the Contractor include but not limiting to:

- Compliance with relevant legislative requirements governing the environment, social public health and safety;
- Work within the scope of contractual requirements and other tender conditions;
- Organize representatives of the construction team to participate in the joint site inspections undertaken by the Environmental Staff of the CSC;
- Carry out any corrective actions instructed by the Environmental and Social Staff of the EPGE and CSC;
- In case of non-compliances/discrepancies, carry out investigation and submit proposals on mitigation measures, and implement remedial measures to reduce environmental impact;
- Stop construction activities, which generate adverse impacts upon receiving instructions from the Environmental Staff of EPGE and CSC. Propose and carry out corrective actions and implement alternative construction method, if required, in order to minimize the environmental impacts; Non-compliance by the Contractor will be cause for suspension of works and other penalties until the non-compliance has been resolved to the satisfaction of the ESU of EPGE and CSC.

9.2.2.1.2 Contractor's Safety, Social and Environmental Officer (SEO)

The contractor shall be required to appoint competent staff(s) as the Contractor's on-site safety, Social and environmental officer (SEO). The SEO must be appropriately trained in environmental management and must possess the skills necessary to transfer environmental management knowledge to all personnel involved in the contract. The SEO will be responsible for monitoring the contractor's compliance with the ESHS and ESMP requirements and the environmental specifications. The duties of the SEO shall include but not be limited to the following:

- Help the contractor to prepare the CESMP;
- Carry out environmental site inspections to assess and audit the contractors' site practice, equipment and work methodologies with respect to pollution control and adequacy of environmental mitigation measures implemented;
- Monitor compliance with environmental protection measures, pollution prevention and control measures and contractual requirements;
- Monitor the implementation of environmental and mitigation measures;
- Prepare audit reports for the site environmental conditions and social aspects;
- Prepare audit reports (in consultation with the residents of the neighboring areas) to understand the overall performance of the socio-economic mitigation measures included in this ESIA: stakeholder engagement, grievance mechanism, noise mitigation measures, labor influx, skill training, prevention of GBV, disturbances during construction works.
- Investigate complaints and recommend any required corrective measures;
- Advise the contractor on environment and social improvement, awareness and proactive pollution prevention measures, with special focus on noise prevention;
- Recommend suitable mitigation measures to the contractor in the case of non-compliance. Carry out additional monitoring of noncompliance instructed by the ESU of EPGE and CSC
- Inform the contractor and ESU of EPGE and CSC of environmental and social issues, submit contractor's ESMP Implementation Plan to the ESU of EPGE and CSC, and relevant authorities, if required;
- Keep detailed records of all site activities that may relate to the environment.

9.2.2.1.3 Independent Environmental and Social Monitoring Consultant (IESMC)

In order to minimize the environmental impacts during construction phase of the Project, the project owner shall ensure that environmental quality monitoring requirements are established for the project. An IESMC appointed by EPGE shall carry out the monitoring.

IESMC will be responsible for carrying out environmental sampling, monitoring and marking report during all phases of the project. Environmental quality monitoring will be report periodically to EPGE and World Bank (respectively every 03 months for EPGE and every 6 months for WB in construction phase). IESMC will prepare audit reports (in consultation with the residents of the neighboring areas) to understand the overall performance of the socio-economic mitigation measures included in this ESIA: stakeholder engagement, grievance mechanism, noise mitigation measures, labor influx, skill training, prevention of GBV, disturbances during construction works.

IESMC will also supply specialized assistance to EPGE and ESU in environmental matters.

9.2.2.1.4 Environmental and Social Supervision during Construction (CSC)

During construction phase, a qualified CSC reporting to the EPGE shall carry out the environmental and social supervision. The CSC will assign environmental and social staff(s), will be responsible for inspecting, and supervising all construction activities to ensure that mitigation measures adopted in the ESHS and ESMP are properly implemented, and that the negative environmental impacts of the project are minimized. The CSC shall engage sufficient number of Environmental and Social Supervision Specialists (ESSS) with adequate knowledge on environmental protection and construction project management to perform the required duties and to supervise the Contractor's performance. Specifically, ESSS of CSC will:

- Review and assess on behalf of the EPGE whether the construction design meets the requirements of the mitigation and management measures of the ESHS and ESMP,
- Supervise site environmental management system of contractors including their performance, experience and handling of site environmental issues, and provide corrective instructions;
- Review the ESHS and ESMP implementation by the contractors, verify and confirm environmental supervision procedures, parameters, monitoring locations, equipment and results;
- Report ESHS and ESMP implementation status to EPGE and prepare the environmental supervision statement during the construction phase; and

9.2.2.1.5 Compliance with Legal and Contractual Requirements

The constructions activities shall comply not only with contractual environmental protection and pollution control requirements but also with relevant national laws and regulations related to environmental protection and pollution control.

All the works method statements submitted by the Contractor to the CSC and EPGE for approval to see whether sufficient environmental protection and pollution control measures have been included.

The CSC and EPGE shall also review the progress and program of the works to check that relevant environmental laws have not been violated, and that any potential for violating the laws can be prevented.

The Contractor shall copy relevant documents to the SEO and the ESS of CSC and ESU of EPGE. The document shall at least include the updated work progress report, the updated work measure, and the application letters for different license/permits under the environmental protection laws, and all the valid license/permit. The SEO, ESS, and ESU shall also have access, upon request, to the Site Log-Book.

After reviewing the documents, the SEO or the ESS shall advise the ESU of EPGE and the contractor of any non-compliance with the contractual and legislative requirements on environmental protection and pollution control for them to take follow-up actions. If the SEO or the ESS concludes that the status on license/permit application and any environmental protection and pollution control preparation works may not comply with the work measure or may result in potential violation of environmental protection and pollution control requirements, they shall advise the Contractor and the EPGE accordingly.

9.2.2.1.6 Environmental and Social Claims and Penalty System

In the compliance framework, if non-compliance with environmental and social regulations is discovered by CSC/ESU/IESMC/EPGE during the site supervision, 2% values of interim payment of the contractor of this month will be held back. The contractor will be given a grace period (as determined by CSC/EPGE) to repair the violations. If the Contractor performs the repair within the grace period (confirmed by CSC/EPGE), no penalty is incurred. However, if the Contractor fails to successfully make the necessary repairs within the grace period, the Contractor will pay the cost for a third party to repair the damages (deduction from keeping money).

In case of IESMC/CSC/EPGE not detected of non-compliance with environmental and social regulations of the contractor, they will be responsibility payment to repair the violation.

9.2.2.2 Reporting Arrangements

ESMP monitoring and reporting requirements are summarized in Table 9.21 below.

Table 9-22: **Regular Reporting Requirements**

Sl. No.	Report Prepared by	Submitted to	Frequency of Reporting
1	Contractor to the Employer	EPGE	Once before construction commences and monthly thereafter
2	Construction Supervision consultant (CSC)	EPGE	Weekly and monthly
3	Independent Environmental and Monitoring Consultant	EPGE	One week after completion of the monitoring
4	Environmental management report prepared by EPGE	EDC	Every three-month
5	Progress report prepared by EPGE including reporting on project environmental management	WB	Every six-month, one week before the Bank official mission

9.2.3 Mode of Implementation

9.2.3.1 Mitigation measures to be considered during technical design phase

The technical design during the project implementation will address the measures to be considered and incorporated. These measures are attended to address the project impacts during operation phase such as the high of the tacks and landscape design to mitigate the impact of NO_2 emission during operation phase. The following measures could be considered during the detailed design to mitigate the potential socio-environmental impacts and traffic safety risks during operation phase:

- The height of the stack (with 40m height)

- Landscape design with green belt (provided in this Chapter)
- Drainage system to avoid localized flooding
- Design elements to reduce impacts on workers OHS such as noise, heat, electric and magnetic fields, and confined spaces

Table 9-23: Mode of Implementation of Mitigation Measures during design phase

9.2.3.2 Mode of Implementation of mitigation measures during pre-construction, construction and operation

The details of the impact and the mitigation measures have been already discussed earlier in this chapter.

Table 9-24: Mode of Implementation of Mitigation Measures during Plant Life Cycle

Sensitive Receptor	Site- Specific Impacts	Mitigation Measures	Responsible Party	Supervised By
A. PRECONSTRUCTION PHASE				
A-1 Air Environment				
Worker, EPGE staff, Nearby Resident	Increase in particulate matter due to dismantling of plant and transportation, storage and disposing of machineries.	Water sprinkling in vulnerable areas Maintaining and checking the construction equipment & vehicles regularly to avoid gaseous emission above the stipulated norms.	EPC Contractor	EPGE Environmental and Social Unit (ES)
A-1 Solid Waste				
Worker, EPGE staff, Nearby Resident	C&D wastes and metal scraps from plant dismantling will be generated	Proper segregation, storage and disposal of municipal solid wastes in separate dust bins. wastes will be collected by Pollution Control and Cleansing Department, YCDC	EPC Contractor	EPGE Environmental and Social Unit (ES)
A-3 Social Environment				
Worker, EPGE staff, Nearby Resident	The impact will be mainly beneficial with generation of employment, both direct and indirect, which will also lead to increase in livelihood options	Development and implementation of Stakeholder Engagement Plan Development and implementation of a Grievance Mechanism Skill Development Training for local people as per eligibility to make them suitable for jobs to be generated at the plant Development and implementation of a Gender Based Violence Plan	EPGE/EPC Contractor	EPGE Environmental and Social Unit (ES)
B. CONSTRUCTION PHASE				
B-1 Air Environment				
Worker, EPGE staff, Nearby Resident	There will be mainly fugitive emission from the project site and lay-down areas. In addition, there may be some gaseous emissions from heavy vehicles and machineries.	Water sprinkling in vulnerable areas Proper maintenance of vehicles and construction equipment Transportation of construction material in covered trucks, wherever possible	EPC Contractor	EPGE Environmental and Social Unit (ES) and CSC

Sensitive Receptor	Site- Specific Impacts	Mitigation Measures	Responsible Party	Supervised By
		Temporary stockpiles of dusty materials will be either covered entirely by impervious sheets or sprayed with water to maintain the entire surface wet all the time;		
B-2 Noise Environment				
Worker, EPGE staff, Nearby Resident	Noise level outside the boundary of the plant will be higher than the prescribed level. Thus there will be constant disturbances in the adjacent residential area due to movement of heavy vehicles and machineries.	Regular maintenance of machineries such as lubricating moving parts, tightening loose parts and replacing worn out components. Provision of acoustic covers/ enclosures on machinery and equipment. Noise control and insultation measures to project the surrounding apartments from the impacts of noise and vibrations Provision of earmuffs/ earplugs to the workers in high noise areas and enforcement of its use	EPC Contractor	EPGE Environmental and Social Unit (ES) and CSC
B-3 Water Environment				
Worker, EPGE staff, Nearby Resident River ecosystem	Contamination of Hlaing River and nearby drains from oil and grease of machineries Pollution from domestic waste water generated by construction workers	Channelization of effluents after treatment in soak pits Septic tanks from construction area through existing network of drains	EPC Contractor	EPGE Environmental and Social Unit (ES) and CSC
Worker, EPGE staff, Nearby Resident	Risk of run-off from stock piles and construction sites into neighbouring residential areas	Construction of temporary sedimentation tanks for the effluents from construction area	EPC Contractor	EPGE Environmental and Social Unit (ES) and CSC
A-4 Solid Waste Management				
Worker, EPGE staff, Nearby Resident	C&D wastes and metal scraps from plant dismantling will be generated which unless disposed	Disposal of surplus earth and construction debris Proper segregation, storage and disposal of municipal solid wastes in separate dust bins.	EPC Contractor	EPGE Environmental and

Sensitive Receptor	Site- Specific Impacts	Mitigation Measures	Responsible Party	Supervised By
	properly will have adverse impact on neighboring residential areas. Generation of municipal solid waste	wastes will be collected by Pollution Control and Cleansing Department, YCDC		Social Unit (ES) and CSC
A-4 Ecology				
Flora and Fauna Community in and around the Project site	Site clearance will be done for preparation of the site in lay-down area. Tree cutting will also do in plant site. However trees near the boundaries will be retained. About 49 trees will be cut for the project	Trees will be planted in EPGE properties to compensate the trees felled for the project	EPC Contractor	EPGE Environmental and Social Unit (ES) and CSC
A-5 Socio-Economic Environment				
Nearby Resident		Arrangements for water supply and sanitation facilities Health check-up programmes Formation of Grievance Redressal Cell to address any complaints or problems faced by stake-holders. Stakeholder Consultation every quarter and annual social audit Skill Development Training for local people as per eligibility to make them suitable for jobs to be generated at the plant Development and implementation of a Gender Based Violence Plan Measures in place to minimize disturbances during construction works	EPC Contractor/EPGE	EPGE Environmental and Social Unit (ES) and CSC
B. OPERATION PHASE				
B-1 Water Environment				

Sensitive Receptor	Site- Specific Impacts	Mitigation Measures	Responsible Party	Supervised By
EPGE staff, Nearby Resident, Hlaing River eco system	The effluent streams from the power plant will be mainly process water discharge, oily effluents from maintenance, cooling tower blow-down, effluent from DM Plant, etc.	Water from process cycle will have to be pH neutralized and will be discharged to Hlaing River. Cleaning water from RO membrane will be neutralized before discharge to Hlaing River.	EPGE Environmental and Social Unit (ES) and CSC	Independent Environmental and Social Monitoring Consultants (IESMC)
EPGE staff, Nearby Resident	Domestic waste-water will be generated from workers	Domestic waste-water will be treated in septic tank	EPGE Environmental and Social Unit (ES) and CSC	Independent Environmental and social monitoring consultants (IESMC)
B-2 Noise Environment				
EPGE staff, Nearby Resident	The noise level due to the proposed plant with 4 gas turbines, one steam turbine and the gas engine plant is predicted to be much higher	Provision of acoustic enclosures/ barriers/shields to reduce noise Noise control and insultation measures to project the surrounding apartments from the impacts of noise and vibrations under the prescribed WBG EHS Guidelines' limit of 55 dB(A) during day time and 45 dB(A) during night time for residential areas Provision of personal protective equipment's (PPE) like ear plugs and earmuffs Afforestation and Green Belt Development	EPGE Environmental and Social Unit (ES) and CSC	Independent Environmental and social monitoring consultants (IESMC)
B-3 Solid Waste				
EPGE staff, Nearby Resident	The adverse impact of MSW can be due to aspects such as improper storage and disposal, which can lead to spillage to drains, Hlaing River and open	Proper segregation of wastes at source with separate bins for bio-degradable (kitchen wastes, garden wastes, vegetables, etc) and non bio-degradable wastes (plastics, paper, glass, metal)	EPGE Environmental and Social Unit (ES) and CSC	Independent Environmental and social monitoring consultants (IESMC)

Sensitive Receptor	Site- Specific Impacts	Mitigation Measures	Responsible Party	Supervised By
	spaces and consequently pollute the area.			
B-4 Social Aspects				
Nearby Resident	Basic services for the people and their quality of life	Monitoring of the socio-economic and living condition of stake-holders Closure of Stakeholder Consultation activities Closure of all the pending complaints under the Grievance Redressal Mechanism	EPGE Environmental and Social Unit (ES) and CSC	Independent Environmental and social monitoring consultants (IESMC)

9.3 WORKPLACE ENVIRONMENTAL QUALITY AND SAFETY

The proposed power plant project has several phases - the construction of infrastructure and installation and commissioning of plant equipment, operation of the plant etc.

9.3.1 Health Hazards

The construction phase includes site preparation and plant construction, access road construction etc. The health hazards associated with these activities are mainly due to dust and noise pollution. Excessive noise contributes to loss of hearing and triggers physiological and psychological body changes. Dust pollution can cause eye and respiratory irritation and, in some cases, allergic reactions. The inhalation of exhaust gases from vehicles and machinery are also harmful for health. Stress can be caused by working in shifts, high workload, poor living condition of workers etc.

Table 9-25: General Measures for Workers' Health

Issues	Requirements
Health and Hygiene	• Cleanliness • Ventilation and temperature • Dust and fumes • Disposal of wastes and effluents • Overcrowding • Illumination • Latrines and urinals • Spittoons and dustbins
Dust and Fumes	• Any dust or fumes or other impurities likely to be injurious to the workers, effective measures shall be taken to prevent its accumulation and its inhalation by workers
Overcrowding	• No work room in any factory shall be overcrowded • At least five hundred cubic feet of space shall be provided for every worker employed in a work room
Latrines and urinals	• Sufficient latrines and urinals shall be provided • Shall be maintained in clean and sanitary condition • Shall be adequately lighted and ventilated
First aid	• Provided and maintained first aid facility • One for every one hundred and fifty workers • Shall be kept with a responsible trained person who shall be available during the working hours • In every facility where five hundred or more workers are employed, a dispensary shall be provided and maintained
Disposal of wastes and effluents	• Provide with proper disposal system for solid waste and effluents • In case of a factory where no public sewerage system exists, prior approval of the arrangements should be made for the disposal of wastes and effluents

9.3.2 Safety hazards

Hazards related to safety of workers have been explained in Chapter 7. The main risks are related to physical injuries due to fall from heights, objects falling on persons, risk of working in confined environment, fire, electrocution and impact of electromagnetic waves. All the above risks can be life threatening and utmost care should be taken to reduce the risks. The section below gives the details of the mitigation measures to reduce the risks.

Table 9-26: General Measures for Workers' Safety

Risk of working at heights	• Construction workers should wear protective helmets, protective glasses, safety belts and protective shoes. • Installation of fixtures on tower components to facilitate the use of fall protection systems. • Implementation of a fall protection program that includes training in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment; and rescue of fall-arrested workers, among others; • Safety belts and harnesses should be of not less than 16mm two-in-one nylon or material of equivalent strength. • When operating power tools at height, workers should use a second (back-up) safety strap. • Signs and other obstructions should be removed from poles or structures prior to undertaking work.
Risk of falling objects	• Putting nets above the ground level in areas where work is in progress so as to avoid falling objects reaching the ground • Tethering tools and equipment with connectors, connection points, and anchors • Proper training to workers who are working heights
Precautions in case of fire	• Shall be provided with means of escape in case of fire • Effective measures shall be taken to ensure that all the workers are familiar with the means of escape • Fire-fighting apparatus should be provided and maintained
Working in Confined Places	• Workers should not be exposed for more than 4 hours • Ear muffs and other PPEs should be provided
Heat during operation and maintenance of combustion units	• Regular inspection and maintenance of pressure vessels and piping; • Provision of adequate ventilation in work areas to reduce heat and humidity; • Reducing the time required for work in elevated temperature environments and ensuring access to drinking water; • Shielding surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc; • Use of warning signs near high temperature surfaces and PPE as appropriate, including insulated gloves and shoes.
Electrical Hazards during operation	• Consider installation of hazard warning lights inside electrical equipment enclosures to warn of inadvertent energization; • Use of voltage sensors prior to and during workers' entrance into enclosures containing electrical components;

	• Deactivation and proper grounding of live power equipment and distribution lines according to applicable legislation and guidelines whenever possible before work is performed on or proximal to them; • Provision of specialized electrical safety training to those workers working with or around exposed components of electric circuits. This training should include, but not be limited to, training in basic electrical theory, proper safe work procedures, hazard awareness and identification, proper use of PPE, proper lockout/tagout procedures, first aid including CPR, and proper rescue procedures. Provisions should be made for periodic retraining as necessary.

9.4 RISK MANAGEMENT

As mentioned earlier, in order to reduce the risks associated with accidents, internal and external threats, and natural disasters, a risk management program is essential. Risk management planning can be done during design and planning stage of the plant as well as during plant operation. While risk management is mainly preventive in nature during the plant operation stage, the design and planning stage of the plant can incorporate changes in basic engineering to include safety design for all processes, safety margins for equipment, and plant layout. The following steps among others are important in managing the risks mentioned:

- The power plant should be located on a reasonably large plot of land giving ample space to locate all units whilst maintaining safe distances between them.
- The plant layout should provide roads of adequate width and service corridors so that no undue problems arise in the event of fires or other hazards.
- Gas storage is to be designed with adequate precautions in respect of fire hazard control.
- Storage of hazardous substances such as acids and alkalis should be sited in protected areas.
- With respect to plant operation, safe operating procedures should be laid down and followed to ensure safety, optimum operation and economy.
- A fire-fighting group with adequate manpower and facilities such as water tank of sufficient capacity, CO_2 tank, foam tank, portable fire extinguishers should be provided and facilities located at strategic locations e.g. generator area, high voltage panel, control rooms, and fuel tank area.
- Regular checks on safe operating practices should be performed.

In order to achieve the objective of minimizing risks at the Ywama power plant complex, in addition to Environmental Management Unit for the complex, a disaster management unit with adequate manpower and facilities for each plant within the complex must be in place. The unit will be trained to act in a very short time in a pre-determined sequence to deal effectively and efficiently with any disaster, emergency or major accident to keep the loss of life, human injury, material, plant machineries, and impacts on the environment to the minimum.

During implementation, the EPC contractor will undertake a hazard and operability study (HAZOP) to identify and evaluate problems that may represent risks to personnel or equipment. Among others, the study would focus on assessing explosion risks and their impact on the nearby residential areas.

9.4.1 Emergency Preparedness

Well planned emergency procedures, drills shall be employed viz, Emergency Evacuation Plan, Disaster Management Plan and Industrial Safety plan to meet the requirement in case of failure of any pollution control equipment. In case it is not possible to take appropriate corrective measures immediately, the unit will be shut down.

9.4.2 Emergency Response Plan

Emergency response plans are developed to address a range of plausible risk scenarios and emphasize the tasks required to respond to a physical event. The Emergency Response Plan(“ERP”) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster. The primary objective of the plan is to keep the loss of life, material, machinery damage and impacts on the environment to minimum.

9.4.2.1 *Emergency Response Cell*

It is highly recommended that an Emergency Response Cell (“ERC”) adequately equipped with highly trained manpower and appropriate gears are established within the power plant complex in order to effectively implement the emergency response plan. The main functions of the emergency response cell should include the following:

- Identification of various types of emergencies
- Identification of groups, communities, and areas those are vulnerable to different kinds of emergencies
- Preparing service teams for various operations within the organization through extensive training
- Establishment of early detection system for emergencies
- Developing reliable, instant information communication system
- Mobilizing all units in the complex within a very short time to address any emergency

9.4.2.2 *Emergency Preparedness*

The ERC headed by a trained Manager should establish an Emergency Control Room with links to all plant control rooms and all other services. The ERC shall work as a team of the following officials:

- Emergency Manager (“EM”) (Team Leader),
- Fire Officer,
- Safety Officer,
- Chief Security Officer,
- Chief Medical Officer,
- Rescue Officer, and
- Public Relations Officer

The Senior Environmental Engineer of the proposed Environmental Management Unit for the Ywama Plant with adequate skills of facing emergency situation can act as the Emergency Manager of ERC. The Emergency Manager shall have the prerogative of shutting down the relevant units or the complete plant, which are affected or may further deteriorate damages, in case of an emergency. The EM however, shall have to report to the Chief Engineer of the complex of such an event without any delay.

The team will be responsible for preparing and executing a specific emergency response plan for the power plant complex. The team should meet at regular intervals to update the plan, based on plant emergency data and changes in support agencies.

The team should undertake some trial runs, e.g. fire drill, in order to be fully prepared and to improve upon the communication links, response time, availability and workability of emergency gears and other critical factors. Upon receiving information about an accident, the ERC team will assemble in the Emergency Control Room within the shortest possible time and formulate emergency control procedure.

9.4.2.3 *Fire Fighting Services*

- The Fire Officer ("FO") will be the commanding officer of the fire-fighting services. The FO will head a fire fighting team of trained officers and workers. The size of the team should be determined by the management considering requirement of all existing and proposed power plants within the complex.
- Adequate fire-fighting equipment e.g. fire extinguishers of different types appropriate for different strategic locations must be planned according to requirements of existing and future plants in the complex.
- Depending on the scale of emergency, the fire-fighting team will work in close association with security and maintenance personnel of the complex. Additional assistance may also be sought from outside fire stations when required.
- Preparedness is extremely important for efficient and effective fire-fighting services at the time of emergency. This can be better achieved by organizing fire drills at regular intervals, e.g. once every two weeks during dry summer months and once every two months during wet months involving all team members, all other service groups, all staff of the power plant complex, and utilizing all fire-fighting gears.

9.4.2.4 *Emergency Medical Services*

- The Chief Medical Officer will be responsible for providing medical services within the Power plant complex at the time of any emergency. The services should also be rendered to people living in the close vicinity of the complex and affected by any accident within the plant complex.
- The existing Medical Centre, nearby the Plant must be equipped with adequate medical personnel and equipment for providing emergency services in addition to normal Medicare services to population of the complex.
- A team of well-trained Medical Officers specializing in burn injury, orthopedics, electrocution, chemical toxicity or poisoning, and shock treatment must be available at the nearby power plant Medical Centre. The number of officers may be determined considering the total number of staff and their family members in the complex. Special attention must be given to child injury treatment.

The following services must be on alert at all times in the plant complex.

- First aid services for attending patients on the spot. The Medical Centre should provide training on first aid services to some designated staffs of important areas of operation, e.g. boiler area, turbine hall, transformer area, electrical rooms, and chemical storage facilities, for immediate attention to the injured.

- Ambulance services for transport of casualties from spot to nearby Medical Centre, and from nearby Medical Centre to outside hospital, as necessary. Facilities for transportation of fatalities to appropriate hospital or to relatives or to the police following prescribed procedure should be available.
- All potential areas for emergency/ accidents in the plant complex must have an information chart including contact phone numbers of relevant services.

9.4.2.5 *Rescue Services*

Without going for additional manpower, the rescue team can be formed with potential staffs of the Power Plant Complex, e.g. from medical services, security services and fire fighting services, for conducting rescue operations following an emergency. A senior member can be designated Rescue Officer who will be responsible for formulating rescue plan and guiding the team. Important functions include:

- Cut-off electricity, gas or water supply to accident spots
- Rescue people from debris of collapsed structures
- Demolish damaged structures that may endanger human lives
- Rescue people from fire areas with adequate protection
- Assist other services promptly to save human lives
- Isolate damaged equipment or machineries that may endanger human lives
- Provide repair services as appropriate to restore operations

9.4.2.6 *Safety*

Safety implies the reduction of risk of accidents at the work site. Accident prevention is more valuable than any mitigation or compensatory measures. This may be achieved through strict rules and procedures for the execution of specific tasks, enforcement of the rules, and discipline amongst workers, maintenance of machineries used and by providing all necessary gear or equipment that may enhance the safety of the workers. The following guidelines should be followed to maintain the safety of the workers:

- Workers have to be informed about the possible damage or hazards related to their respective jobs
- If pedestrian, traffic or plant movements at or near the site are affected by construction works, the person with control of the construction project must ensure that these movements are safely managed so as to eliminate or otherwise to control any associated health and safety risks
- Must ensure sufficient lighting in the area where a person performs construction work or may be required to pass through, including access ways and emergency exit or passage without risk to health and safety
- Construction site needs to provide safe access to and egress from all places where they may be required to work or pass through. This includes the provision of emergency access and egress route that must be free from obstructions
- Adequate perimeter fencing should be installed on the site before construction work commences and that should be maintained during the construction work and signs should be placed which is clearly visible from outside the site including emergency phone numbers.
- Must ensure that electrical installations materials, equipment and apparatus are designed, installed, used, maintained to eliminate the risk of electrical shock, burns, fire or explosion.

- Arrangements of first aid facility should me made accessible when construction work is being undertaken.
- Construction site should be kept orderly and tidy. Access ways should be kept clear of materials and debris and maintained in a non-slippery condition. Materials should be stored in an orderly manner so that it does not pose any risk to the health or safety of any person

9.5 CAPACITY BUILDING PROGRAMME

Training programs will be developed and implemented by a team for Technical Assistance for the implementation of safeguard policies for EPGE. EPGE/IESMC with the help of the Technical Assistance Team will provide training for contractors, CSC and other groups.

Trainee groups: the EPGE staff, the ESU staff, contractor environmental and social specialists, construction supervision consultants (CSC), the building contractors, representatives of relevant stakeholders and local communities in the project area. The contractors take the responsibility for training workers and drivers.

Training Schedule: Training will be given at least one month before performing the first construction contract. Subsequent training sessions can be modified to suit the construction schedule for project components.

Frequency of training: The basic training programs given in the table below will be provided every 6 months annually, and the contents will be updated and tailored to items to be implemented. Training programs for EPGE staff are expected to continue in the first years of the project. One-day training for CSC and contractors is also planned to take place twice a year for at least 2 years.

Table 9-27: Training program on environmental monitoring management capacity

I. Subjects	**Project Environmental Management**
Training	Environmental monitoring and reporting
Participants	Staff in charge of environmental issues and environmental management staff
Frequency of training	Immediately after the effective project, but at least one month before the first bid package. The next training will be planned according to the needs.
Time	Four days of training
Content	Environmental monitoring and reporting for the project include: ✓ The requirements of environmental monitoring; ✓ Monitoring and implementation of mitigation measures; ✓ The involvement of the community in environmental assessment. ✓ Guidance and monitoring contractors, CSC and community representatives in the implementation of environmental monitoring ✓ The form used in environmental monitoring processes; ✓ Reaction and risk control; ✓ How to receive and submit Form. ✓ Other issues will be decided
Responsibility	Independent environmental and social monitoring consultant (IESMC), EPGE, with the help of technical assistance teams implement safeguard policies
II. Subjects	**CSC, Contractors, Ward / Communes, Community representatives**

Training	Implementation of mitigation measures
Participants	CSC; The construction managers, environment officer of the contractor; ward / commune representatives; representatives of urban groups
Frequency of training	Shortly after the award of contract for the contractor, updated on demand
Time	2 days of training for CSC and contractors and two days of training for others
Content	✓ Summary overview of the monitoring of the environment; ✓ The requirements of environmental monitoring; ✓ The role and responsibility of the contractor and of CSC; ✓ The content and methods of environmental monitoring; ✓ Reaction and risk control; ✓ Introduce the monitoring form and instructions on how to fill out a form of environmental monitoring and incident reporting; ✓ Other issues will be determined ✓ - Prepare and submit a report.
Responsibility	EPGE, independent environmental monitoring consulting (IESMC) with the help of technical assistance teams implement safety policies
III. Subjects	**Community / Workers**
Training	Safety and hygienic environmental
Participants	Representatives of workers (team leaders) working directly for the project components
Frequency of training	Accordingly
Time	1 day presentation and 1 day presented at the site
Content	✓ Presentation of the preliminary safety issues and environmental overview ✓ Key issues require the attention of the public and construction workers to mitigate the safety risks (roads, waterways, equipment, machinery, etc.) as well as reduce pollution (dust, exhaust, oil spills, waste management, etc.) ✓ Management of safety and hygienic environmental on site ✓ Mitigation measures applied on site ✓ Safety measures for electrical, mechanical, transportation, air pollution ✓ Methods for dealing with emergency situations ✓ Other issues will be determined ✓ The rights and responsibilities of environmental monitoring ✓ Environmental monitoring, environmental monitoring form ✓ Measures to mitigate the social impact and monitoring implementation ✓ Code of Conduct ✓ Other issues to be determined
Responsibility	Contractors, EPGE with the assistance of independent environmental monitoring consulting(IESMC)

9.6 TOTAL COST ESTIMATES FOR ESMP IMPLEMENTATION

The following table provides a cost estimate for the implementation of environmental management plan (ESMP). The cost of ESMP implementation will include: (i) the costs of implementing mitigation measures by the contractor; (ii) expenses for supervision of ESMP implementation by CSC; (iii) cost of the independent environmental and social monitoring consultant (IESMC); (iv) the costs of environmental quality monitoring; and (v) the cost of environmental and social safeguard management by EPGE, including both technical assistance in implementing safety policies and training programs. The costs of implementing mitigation measures during pre-construction and construction will be a part of the value of construction contracts. The costs for supervision of ESMP by the construction supervision consultant (CSC) and the IESMC will be financed by the proceeds of the IDA credit. Finally, EPGE will allocate adequate internal resources for the overall oversight of the ESMP implementation, including safety training programs, and basic allowances to participants in the monitoring programs. After the project has been completed, the costs of environmental monitoring of constructed works will be taken from the operation and maintenance budget of the power plant.

It should be noted that the involvement of the community in the process of ESMP implementation is completely voluntary participation for the benefit of own community and households. Therefore, communities partaking in monitoring the ESMP will not get paid. However, in order to encourage community participation, it is necessary to allocate costs of materials and instruments for monitoring activities and some remuneration for a small number of members chosen by the public to participate in monitoring activities. The following table provides the estimated costs for ESMP implementation. However, final costs could be updated in the detailed design phase.

Table 9-28: Estimated cost of ESMP implementation*

	Cost (thousands of $US)	Source of funds
Mitigation measures during pre-construction and construction	Part of contracts	IDA loan
Supervision of safeguards during construction (by Construction Supervision Consultant)	Part of CSC Contract	IDA loan
Independent Environmental and social monitoring consultant (IESMC) during Construction Phase	Approx. 1,000	IDA loan
Environmental Quality Monitoring during Operation and Maintenance Phase	32.6 per year	EPGE
Environmental Safeguards unit (ESU) of EPGE for safeguard management	50	EPGE

* Estimated costs do not include potential cost for the relocation of EPGE workers. If necessary, these costs will be responsibility of EPGE

9.7 GRIEVANCE REDRESS MECHANISM (GRM)

9.7.1 Grievance Redressal

Grievance may be raised by stakeholders due to various reasons such as failure to fulfill commitments, poor management of construction activities, inappropriate planning of vehicle movement, gender-based violence issues at workplace and conflicts between workers and local communities.

Therefore, it is imperative to have an internal mechanism in place where the aggrieved party/s can lodge their complaints and get it amicably settled prior to approaching the formal mode of solution available to them i.e. access to legal system through courts. In order to provide a formal forum to the aggrieved parties to deal with issues arising out of project, it is proposed that a joint grievance redress mechanism be instituted for both environmental and social related issues.

The proposed Grievance Redress Mechanism (GRM) will be developed and implemented by project's effectiveness in order to settle as many disputes as possible through consultations. Such a mechanism is important as it is expected that most cases, if not all, would be resolved amicably; and the process, as a whole, will promote dispute settlement through mediation to reduce litigation. However, the options of legal recourse will not be restricted in any way by the project proponent.

9.7.2 Objective of GRM

The basic objective of the GRM shall be to provide an accessible mechanism to the affected people, community and any stakeholder(s) having stake in the project to raise their issues and grievances as well as concerns. The Grievance Redress Cell (GRC) shall be officially recognized "non-judicial" body that will seek to resolve non-judicial disputes arising out of various matters related to the implementation of the ESMP, as well as other aspects of the project, as may deemed fit to be raised before the GRC.

The fundamental objective of GRM is to resolve any resettlement and environmental related grievances locally in consultation with the aggrieved party to facilitate smooth implementation of the EMP. Another important objective is to democratize the development process at the local level and to establish accountability towards the stakeholders.

9.7.3 Stakeholders and Issues

The GRM will be accessible to a broad range of project stakeholders who are likely to be affected directly or indirectly by the project. These will include beneficiaries, community members, project implementers/contractors, civil society, media—all of whom will be encouraged to refer their grievances and feedback to the GRM. The GRM will handle issues such as:

- Mismanagement, misuse of Project Funds or corrupt practices.
- Violation of project policies, guidelines or procedures, including those related to child labour, health and safety of community/contract workers and gender-based violence.
- Disputes relating to resource use restrictions that may arise between or among affected communities.
- Grievances that may arise from members of communities who are dissatisfied with the eligibility criteria, community planning measures, or actual implementation of community energy investments or socio-economic infrastructure.
- Issues with land donations, asset acquisition or resettlement if there is land acquisition in any of the sub-projects.

9.7.4 Composition of GRC

It is suggested to have two levels of grievance redress mechanism for the project, viz. Grievance Redress Cell (GRC) at the project level and another at Head Office (HO) level. The aim of having two levels of grievance redress mechanism is to provide a higher forum to the aggrieved party, if the same is not satisfied with the decision of GRC.

The GRC will be formed with members from the Ywama Plant while the HO GRC will have members drawn from EPGE Nay Pyi Taw and MOEE. The GRC will have officials from Ywama Plant, local representative of nearby residential areas, local political leaders. The Cell at the Plant and HO will essentially have women members also to deal with cases related to gender-related violence.

The normal route to be followed for any type of grievance shall be GRC, and in case not satisfied, then to HO GRC. However, the grievances can be directly taken to HO GRC too. The HO GRC shall be empowered to take a decision which is binding and considered final. However, the decision of HO GRC is not binding on aggrieved person; he or she can take the legal course if not satisfied with the outcome of GRC decision.

The Process

Complaints relating to any issues listed above, will be solved through negotiations to achieve the consensus. A complaint will go through three stages before it can be transferred to the court. The enforcement unit will pay all administrative and legal fees relating to the acceptance of complaints. This cost is included in the project budget.

Complaint procedures and resolution will be performed as follows:

An affected household/individual/worker is to take his/her complaint to the GRC, through the local representative/ward member or directly to the GRC, in written or oral form. The GRC at the plant level will be headed by the Plant Manager and all grievances will be addressed to him. The details of the GRC contacts will be displayed publicly in all strategic places in and around the plant. The GRC will work directly in person with the said affected household and will decide on the settlement of the complaint 5 days after receiving such complaint. The Secretariat of the GRC is responsible for documenting and recording all the complaints that it is handling. The GRC will inform ward member and EPGE on the complaint and resolution reached.

After the GRC issued its decision, the relevant household/individual can make an appeal within 30 days to EPGE. Upon receiving a complaint or appeal from a household/individual, EPGE will have 15 days after receiving the complaint to resolve the case. EPGE is responsible for filing and storing documents on all complaints that it handles. After the EPGE has issued a decision, the household/individual can appeal within 45 days. In case a second decision has been issued the EPGE but the said household/individual is still not satisfied with such decision, such household/individual can appeal to the municipal city authority level, or Township Court level within 45 days. Upon decision of the highest authority or the court, The EPGE or contractor will then have to pay the compensation.

The decision ruling the settlement of complaints will have to be sent to complainants and concerned parties, and shall be publicly posted at the headquarters of the government authorities of the relevant level. The complainant will receive such ruling three days after the result of complaint resolution at the ward / commune / city level has been decided upon and 7 days at the district/city or provincial level.

Personnel: The environment and social staff chosen by the EPGE will design and maintain a database of the project-related complaints from affected households/ individuals, including information such as: the nature of the complaint, the source and date of receipt of the complaint, the name and address of the complainant, action plan, and current status.

For oral complaints, the receiving / mediator board will record these requests in a complaint form at the first meeting with the affected person.

Contractor and Construction Supervision Consultant:

During construction, the GRM will also be managed by the contractors under supervision of the CSC. The contractors will inform the affected communities about the GRM availability to handle complaints and concerns about the project. This will be done via the community consultation and information disclosure process under which the contractor will communicate with the affected communities and interested authorities on a regular basis. Meetings will be held at least quarterly, monthly information brochures will be published, announcements will be placed in local media, and notices of upcoming planned activities will be posted, etc.

All complaints and corresponding actions undertaken by the contractor will be recorded in project safeguard monitoring reports. Complaints and claims for damages could be lodged as follows:

- Verbally: direct to the CSC and/ or the contractor' safeguard staff or representatives at the contractor's site office.
- In writing: by hand-delivering or posting a written complaint to specified addresses.
- By telephone, fax, e-mails: to the CSC, the contractor's safeguard staff or representatives.

Upon receipt of a complaint, the CSC, the contractor's safeguard staff or representatives will register the complaint in a complaint file and maintain a log of events pertaining to it thereafter, until it is resolved. Immediately after receipt, four copies of the complaint will be prepared. The original will be kept in the file, one copy will be used by the contractor's safeguard staff, one copy will be forwarded to the CSC, and the fourth copy to the PPMU within 24 hours since receipt of the complaint.

Information to be recorded in the complaint log will consist of:

- The date and time of the complaint.
- The name, address and contact details of the complainant.
- A short description of the complaint.
- Actions taken to address the complaint, including contact persons and findings at each step in the complaint redress process.
- The dates and times when the complainants are contacted during the redress process.
- The final resolution of the complaint.
- The date, time, and manner in which the complainant was informed thereof.
- The complainant's signature when resolution has been obtained.

Minor complaints will be dealt with within one week. Within two weeks (and weekly thereafter), a written reply will be delivered to the complainant (by hand, post, fax, e-mails) indicating the procedures taken and progress to date.

The main objective will be to resolve an issue as quickly as possible by the simplest means, involving as few people as possible, and at the lowest possible level. Only when an issue cannot be resolved at the simplest level and/ or within 15 days, will other authorities be involved. Such a situation may arise, for example, when damages are claimed, the to-be-paid amount cannot be resolved, or damage causes are determined.

Independent environmental and monitoring consultant (IESMC), who has enough the specialized capacity, would be selected by EPGE through bidding. The IESMC consultant is responsible for checking the procedures and decisions on settling complaints. The IESMC may propose additional measures to address any outstanding complaints. While checking the procedure for complaint resolution and reviewing the decision on complaint resolution, the IESMC is required to closely coordinate with the EPGE, and local civil society organizations (CSOs).

World Bank Grievance Redress Service Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanism or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaints to the WB's independent Inspection Panel which determines whether harms occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the WB's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit www.worldbank.org/grs. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

Chapter-10

Public Consultation and Disclosure

Public Consultation and Disclosure discusses the findings of all the consultation held in connection with the proposed project with state agencies, government officials and local communities and individuals to be affected by the project etc, including that by the Project Developers. The discussions will cover the various issues of concern raised and how they have been addressed in the ESIA.

10 PUBLIC CONSULTATION AND DISCLOSURE

10.1 INTRODUCTION

This Chapter presents the stakeholder engagement process prior to the finalization of the ESIA report. Already one round of consultation was organized at the scoping stage to identify the expectation of the people from the ESIA report.

Consultation with stakeholders is a key aspect of the ESIA process. The consultation process gives stakeholders an opportunity to comment on the proposed project as well as on the reports that are produced during each phase of the ESIA. This enables the affected communities to actually be a part of the solutions when it comes to mitigating impacts or implementing management measures.

Consultations for this project was organized twice, viz. once during the scoping stage and once during the ESIA stage. One round of consultation was organized before commissioning of the ESIA, on the TOR and the planned safeguards approach. The consultation process was conducted by Greencindia Consulting Private Limited, an independent third party. The second round (or series) was held on draft environmental and social documents to integrate stakeholder concerns into the final versions and especially the derivative environmental and social management plans.

10.2 CONSULTATIONS AT SCOPING STAGE

Consultations with various levels of stake-holders were organized during the scoping stage. The objectives of stakeholder engagement during scoping consultations are to:

- Identify potential key stakeholders;
- Develop consultation tools (eg MS PowerPoint presentations, stakeholder register);
- Consult with key stakeholders and introduce the Project and identify key issues;
- Disclose the Scoping Report to key stakeholders and general public; and
- Obtain comments on the Scoping Report from key stakeholders to prepare the ESIA

In the scoping stage, meetings were mainly organized with EPGE and Ywama Plant staff and the local communities. A background information document (BID) was developed to further sensitize the local communities. The BID provided an overview of the Project and also outlined ways through which additional issues and comments could be raised with EPGE and the ESIA team.

10.2.1 Consultation Meetings

10.2.1.1 Consultation with EPGE Staff

Consultation was done with different levels of employees of Ywama Plant. Initially, the project features and the alternatives were discussed with the management. The various technological options and probable environment and social impacts were discussed with them. The issues discussed are as follows:

Space Constraints for setting up of plant: The space for the proposed plant is very compact and may have problems of setting up of a CCGT of 2-2-1 configuration. It was suggested that there are space outside the plant boundary (but EPGE area) which can be used for facilities such as storage and sedimentation tanks. These areas will be used as lay-down areas during dismantling and construction phase. The options of taking open spaces on rent from nearby industries were rejected by EPGE.

Transportation of construction materials and machines: It was suggested that there can be two alternatives for transportation of machineries, viz by road or through river. Concerns were raised in the public consultation regarding the capacity of the road to carry heavy machines. However it was confirmed by the plant authorities that the roads will have the capacity and if required they will be strengthened. They said it was not possible to transport all material through river.

Labour camps: It was told by the authorities that there will be no labour camps during the construction phase, as the workers will be sourced from local areas. For the technical personnel, they will stay in nearby guest-houses and hotels. Thus only facilities such as rest-rooms, toilets, drinking water and canteen facilities will be provided for the workers.

Water Sources: Water will be sourced from existing bore-wells in the plant. Thus there will be no requirement of additional water sources for the proposed plant. Waste water from the plant is not expected to have any chemical pollutants and will be discharged into the Hliang River after suitable treatment.

Figure 10.1: Consultation with EPGE employees

10.2.1.2 Consultation with Community

Consultation with the community was held by two methods: informal interaction with the stake-holders and formal public meeting.

For the informal interactions, the GCPL team met the residents in the nearby area, such as tea shops, play grounds, in front of residential buildings, etc. Their opinion regarding the proposed project was taken and an attempt was made to understand their aspirations from the project.

Figure 10.2: Informal Consultations

In general it was found that the people favour the project and did not have any grievance against the present plant. It was found that the economy of the nearby areas is dependent on the industries in the vicinity and thus they favoured new industries coming up. They said that they will be happy if the plant is expanded and subsequently their economy would improve. However some of the people expressed concern over the noise and apprehended that there may be increase in the noise.

The formal consultation with the community was held on 9th November 2018. The participants included residents of nearby colonies. The consultation was organized at Community Centre in the Ywama Power Plant colony. About 60 people participated in the consultation.

The consultation meeting followed the sequence given below:

- Introduction by the meeting facilitator, the stakeholders present, EPGE team and the ESIA team;
- Brief description of EPGE operations;
- Description of the proposed CCGT Plant development and the components;
- Description of the probable impact and mitigation measures to be studies, and
- Discussion of the key issues and any information that may be relevant to the Project.

Figure 10.3: The Venue of Consultation

The meeting was initiated by Mr. U Than Soe, Station Manager of Ywama Plant, by welcoming all present in the meeting. He gave the broad planning for the project, technical description of the proposed project, the location where the new plants would be installed, resources to be utilized, etc.

This was followed by a power-point presentation by Mr Nilanjan Das and Dr. Khin Lay Swe (EIA Consultants). The present environment of the area and probable environmental impact due to the project in all the stages (dismantling of exiting plant, construction and operation of proposed plant) were explained to the group. The existing environmental legislations of Myanmar were also described to the assembled people. The ESIA study to be conducted along with its content was also described.

Figure 10.4: Public Consultation during Scoping Phase

After this the participants were requested to clarify their doubts, give suggestions and express their concerns regarding the new project. The main issues which emerged from the consultation are as follows:

- Information about the present level of air pollution and water quality and the impact of the proposed project
- Traffic increase due to the new project in vicinity of the plant and maintenance of the access road to the plant.
-
- Problem of noise at the new residential block and what measures to mitigate them.

The reply to these queries and issues were given by the Environment Consultant and Plant Manager. It was told that there will be no addition to air and water pollution as the new plant will be more advanced than the existing ones and thus the pollution level as well as noise level will be much lower. It was also assured by the ESIA consultant that all the concerns raised will be addressed in the ESIA report to be prepared.

10.3 CONSULTATIONS AT ESIA STAGE

The Public Consultation for the Project was conducted as a participatory process to achieve the following specific objectives:

- Consult with key stakeholders and introduce the Project and identify key issues;

- Update the stakeholders regarding the findings of the ESIA study including the impact of the project and the suggested mitigation measures
- Obtain comments on the ESIA Report from key stakeholders and incorporation in the Final report.
- Allow the public to understand and appreciate their roles in the various phases of the Project.

10.3.1 Stakeholder Engagement Activities (SEA)

The SEA throughout the project life will include the following:

- Stakeholder Identification;
- Notifications of key stakeholders; and
- Consultation meetings with national, state-level, local-level and traditional authority stakeholders.

10.3.2 Stakeholder Identification (Mapping)

As part of consultation process, a stakeholder identification exercise was undertaken to select key stakeholder groups and organizations, based on experiences in similar ESIAs and discussions with local authorities of EPGE. These stakeholders were selected on the basis that they would have an interest in the Project and would also have knowledge through which to provide insight into possible issues and concerns related to the Project. In addition, further stakeholder groups were identified through the consultation process.

The public consultation with the identified stakeholders involved three levels. At the National Level the consultation covered officials from MoEE. The second level was organized with the employees of EPGE at Ywama plant. The third level was with the local NGOs, employees from adjacent industries and local people who would be directly or indirectly affected by the project. In absence of any PAPs, the main concentration was on locals residing within 2km from the plant site, representatives of NGO, representative from ECD and other government departments and political leaders.

10.3.3 Notifications of Key Stakeholders

Notice of the consultation was circulated in appropriate places and displayed in public areas such as schools, markets, community halls or any place where people gather. Advertisements were also given in local newspapers with the time and venue. Intimation was given to local NGOs who are working in the Yangon region. All notices were displayed one week before the consultation date. The summary of the draft ESIA report along with the executive summary was also circulated to the local community members beforehand, as requested by them during informal interactions and FGD.

10.3.4 Consultation with EPGE Employees

Consultation was organized with EPGE employees at Nay Pyi Taw to observe their understanding and expectations from the project. The main outcomes of the consultations included various issues related to the planning for the plant. Various decisions which were taken previously were changed based on the findings from the study and analysis of the ESIA consultant.

- It was agreed by EPGE that the option of exploring for lay-down areas will be kept open by them and if necessary take space on rent
- It was further agreed that the lay-down areas identified during the scoping stage will not be taken into consideration as the areas were small and also involved dismantling of residential quarters of EPGE. Thus there will be no shifting of people involved for the project
- It was further decided that the feasibility of using the river route for transportation of machines and equipment will be explored. This would avoid transportation through congested roads, which would have increased the pollution and even hampered the safety of the population staying near the plant site.

10.3.5 Consultation with the Staffs of Ywama Power Plant

The process of consultation with the staff and family members of Ywama Plant was conducted in an inclusive manner by the Consultant team on 22nd December, 2018 at the guest-house building of the staff compound (Figure 10.5).

Figure 10-5: Community Consultation in Study Area

Documentation of the consultation process and subsequent agreements among the staff members were maintained. The Issues raised during the consultation with were as follows:

- Most of the people have already experienced the impact of construction from the last unit installed.
- The concern was noise and fugitive emission as well as movement of heavy vehicles on the narrow access road. They wanted proper mitigation measures to be planned during construction.
- The staff wanted capacity building exercise to ensure that they have proper knowledge regarding the environmental and social safeguards and process of its implementation.
- As many of the personnel working in the plant are women, there was the need of developing a crèche and a park where the workers could leave their children while at work.

- Solid waste, especially hazardous waste generated during construction would be a concern as there is very less space in the plant area. It was expressed by the residents that the soil in the vicinity of the plant will be destroyed due to construction activities.
- Facilities for disposal of Municipal Solid Waste from the residential areas should be provided by the plant.

10.3.6 Consultation with Residents of Ywama West Quarter 5 & 6

The consultation meeting with the community of Ywama (West) Quarter was conducted at the office of General Administration Department at the Ward Level on 23rd December 2018.The ward Administrator discussed with the Consultant team on their concerns and interests. The discussions were interactive with precise questions and issues raised over the proposed project. Mr. Nilanjan Das and Dr. Khin explained to the participants the key potential environmental impacts from the proposed projects (Figure 10.6).

The issues raised during the consultation are:

- Full disclosure should be made to the community at all phases of the project. The people should be aware of all developments taking place in the area.
- Concern about acquisition of more lands for the project and subsequently people such as street vendors losing their livelihood.
- Domestic sewage from the residential quarters of EPGE flows through the quarters 5 before entering Hliang River. This is a concern and EPGE should treat all water before discharge.
- There is regular flooding of the quarters upto 2 feet due to high tide water entering the drain on which the settlements are built. EPGE should take up work of deepening and maintaining the drain so that there is less flooding.
- Concern about road safety was also mentioned and they wanted an estimate of additional vehicles to be used during construction.
- The local people should be given priority in employment during the construction phase and also operation whenever recruitment is taking place.
- They wanted EPGE to share the ESIA report with them so that they can give their feedback before consultation.

Figure 10-6: **Community Consultation with residents of Ywama Quarters**

10.3.7 Public Consultation Meeting

The formal consultation meeting was organized on 28th March 2019 at the Community Hall at Ywama Power Plant residential colony. The agenda for the consultation meeting is given below:

- Introduction by the meeting facilitator, the stakeholders present, EPGE team and the ESIA team;
- Brief description of EPGE operations;
- Description of the proposed CCGT Plant development and the components; and
- Discussion of the key issues and any information that may be relevant to the Project.

10.3.7.1 General Information

- Venue: Community Hall, Ywama Power Plant
- Date: 28th March 2019 ,9:00 A.M -12 :00 Noon
- Agenda: see Annex 10.1
- Participants list: : see Annex 10.1

10.3.7.2 Proceedings and Discussions

The project background was explained by U Than Soe (Station Manager of Ywama Plant) through a power point presentation. He highlighted the following points:

- Up-gradation of Gas-fired Ywama power plant in Yangon region, Myanmar, by phased replaced with high-efficiency CCGT technology.
- Replacing three of the five power plants with new improved ones
- Plant Area: 4.6 acres (1.86 Hectare) will be available for new plant

- Four types of power plants in the compound.
  - ✓ 50 MW Independent Power Producer (IPP), government-owned power plants;
  - ✓ 120 MW x 2 Nos Mitsubishi M701 D,
  - ✓ 23.4 MW Hitachi H25 CCGT (to be removed), and
  - ✓ 18.45 MW x 2 Nos John Brown Simple Cycle Power Plant (SCPP) (to be removed).

Figure 10-7: U Than Soe (Station Manager) welcoming public

He said that the new Combined Cycle Gas Turbine Power Plant to be installed will be in the range of 250 to 300MW. The power plant will be a modern machine with less fuel consumption and less pollution. He said that the new plant will significantly improve the power scenario of Yangon and neighbouring areas.

Secondly, Mr. Nilanjan Das (ESIA Team), on behalf of Greencindia Consulting Private Limited spoke about the salient findings of the ESIA study. His

- Build the new plants in the Ywama power plant Compound only, No land acquisition and no socio-economic impacts.
- Results of ESIA such as:
  i. The proposed project will be used to raise electricity production.
  ii. Air Quality: by using the recommended mitigation measures, air environment released from the proposed project activities will be controlled for the community who is affected the area.
  iii. Noise Quality - from construction activities of the proposed project, the noise will be increased at the east of the factory area and south of no.5 and 6 quarters of the community. The proposed power plants will be placed indoor to reduce the sound power level.
  iv. Water Quality- All waste-water from the proposed power plant will be treated and released to Hlaing River.

Figure 10-8: ESIA Team representative, behalf of GCPL

A third presentation was done by Dr. Khin Lay Swe (National Environmental Specialist of GCPL), who discussed in details the projected environmental impact as found from the ESIA study and the mitigation measures suggested in the study. The salient points she covered in her presentation included the following.

- The ESIA procedure and its objectives
- Objective of the Public Consultation
- Description of the Project site and study area
- The climate and air quality of the project area
- Waste water treatment and methodology
- Ambient Noise Quality Monitoring and its impact
- Surface & Ground Water Quality
- Soil Quality Monitoring Locations and results
- Nature of Trees and Green Belt
- Impact on Ecology

Figure 10-9:Presentation of Dr. Khin Lay Swe

The last presentation was done by Daw Theiant Theiant Aung (ESIA Consultant) for the following socio-economic impacts of the proposed project and mitigation measures:

- Socio-economic data of Insein Township
- Socio-economic impact on the population including health impact
- Solid Waste Management
- Risk Management

Figure 10-10:Presentation of Daw Theiant Theiant Aung

10.3.7.3 Open Session

This was followed by the open session where queries were invited from the public regarding the project.

The issues raised and the remarks by the project proponent are as follows.

Sl No	Issues/comments	Remarks
1	Pleasure was expressed that the plant people and the ESIA team had visited their community to understand their situation and also to invite them for the consultation. They said no-one had previously visited them.	He said that the plant wants to go along with the local people and that all development in the future will be informed to the community
2	It was requested that all the mitigation measures mentioned in the ESIA report should be followed when the project is implemented	It was told that the plant will be a modern one and the systems will ensure that the level of air and water pollution will be less that the existing machines. It was also assured that the plant will take care that there will

Sl No	Issues/comments	Remarks
		be no pollution which may impact the life of the people.
3	Request was made to provide employment too the local people during the implementation of the plant	It was told that there will be opportunity for employment during the construction stage. Also there would be generation of indirect employment in form of development of shops, restaurants, etc.
4	Concern was raised that there may be more pollution during the construction and operation of the plant	It was assured that due to the modern machines with less emission and discharge, there will be no risk of increased pollution and the ambient condition will remain the same as it is at present.

Figure 10-11: A participant from Ywama (6) Quarter

10.3.7.4 The Closing Session

The consultation came to an end with a vote of thanks by U Than Soe (Station Manager of Ywama Plant).

Figure 10-12: ESIA team with all stakeholders (General Administrative Department of Insein Township ,EPGE staff Yangon, Staff of MOEE, representative of WB , staff officers of ECD, staff officers of steel factory, staff officers of YDCD ,Insein Township , local representatives of no.5 ,6 and 7 quarters of Ywama East -West ,Insein Township and staff of factory of Ywama Plant) recorded a group picture after successful completion of Public Consultation.

10.4 CONSULTATIONS DURING PROJECT IMPLEMENTATION

Continual engagement is an important part of the Project. Stakeholder Engagement Activities will continue throughout the project life. The process of disclosure and consultation does not end with disclosure of ESIA Report to local communities. Engagement should also be undertaken periodically with local communities to ensure that they are informed on the Project and to present the results of the grievance mechanism.

It is proposed that there will be consultation with the local community every six months and the proceedings are recorded. The frequency may be changed on basis of the feedback from the grievance redressal mechanisms.

ANNEX 1.1 STUDY TEAM

The ESIA report has been prepared by GCPL, India engaged by EPGE, MoEE, Government of Myanmar to prepare ESIA and Environmental and Social Management Plan (ESMP) reports for Upgrading of Ywama Power Plant.

The ESIA team of GCPL is composed of a senior staff with extensive experience in process technology and environmental impact assessment of power plants and large industries and other team members. The team has rich ESIA experience with international lenders and on World Bank projects on Environmental Issues in Power Sector Reform and Restructuring in India combined with several well qualified international and local experts in terrestrial and aquatic ecology and social issues. **Table 1-2** identifies the key team members as well as the local environmental, social, and engineering experts.

Table 1-1: List of Experts involved in Project

Name	Company	Role & Specialist Study	Years of Experience	Qualification
A. Key Members				
Dr. Mohit Roy	GCPL	Team Leader	37	PhD, Engineering
Nandini Choudhury	GCPL	International Environment Specialist	19	Masters in Planning
Nilanjan Das	GCPL	International Social Specialist	20	M Phil in Research Methodology & Social Work
Dr. Khin Lay Swe	Local Expert (Registered with ECD)	Myanmar Environment Specialist	31	PhD, Environmental Physiology
Thieant Theiant Aung	Local Expert	Myanmar Social Specialist	21	B.Sc Agriculture, Master in Development Studies
B. Engineering Member				
K D Choudhury	GCPL	Engineering Expert	35	B E Mechanical, MBA and PGDM Environmental Law
C. Team Members				
Dr. Subinoy Mondal	GCPL	Environment & Analysis Expert	9	PhD, Environment Science
Rahul Singh	GCPL	GIS and Urban Expert	19	B.Tech (Civil), Masters in Planning, Chemistry, and Law
Subhasis Dutta	GCPL	Environment and Geology Expert	4	M.Sc. Geology
Aung Thu	Local	Myanmar Facilitator	3	Graduate